Federal Aviation Administration

MU-2B SERIES AIRPLANE SAFETY EVALUATION REPORT APPENDICES DOCUMENT DECEMBER 2005

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List of Acronyms

Acronym	Definition
AAI	Office of Accident Investigation
AC	Advisory Circular
ACO	Aircraft Certification Office
ACS	Airworthiness Concern Sheet
AD	Airworthiness Directive
AEG	Aircraft Evaluation Group
AFM	Airplane Flight Manual
AFS	Flight Standards
AIR	Aircraft Certification Service
AMOC	Alternative Method of Compliance
AOPA	Aircraft Owners and Pilots Association
ASL	Atmospheric Sea Level
ASRS	Aviation Safety Reporting System
CAMI	Civil Aeromedical Institute
CAR	Civil Aviation Regulations
CFIT	Controlled Flight into Terrain
CFR	Code of Federal Regulations
CG	Center of Gravity
COSM	Continued Operational Safety Management
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulations
FFFSCR	Fact Finding Focused Special Certification Review
FITS	FAA Industry Training Standards
FSB	Flight Standardization Board
FTD	Flight Training Device
ICA	Instructions for Continued Airworthiness
IFR	Instrument Flight Rules
IFSD	In-flight Shutdown
IMC	Instrument Meteorological Conditions
IPC	Illustrated Parts Catalog
JCAB	Japan Civil Aviation Bureau
MAI	Mitsubishi Aircraft International, Inc.
MAOPA	MU-2B Aircraft Owners and Pilots Association
MCAI	Mandatory Continued Airworthiness Information
MDA	Minimum Descent Altitude
MEOT	Multiple Expert Opinion Team
MHI	Mitsubishi Heavy Industries, Inc.

MHIA	Mitsubishi Heavy Industries of America
MPH	Miles Per Hour
MRR	Mechanical Reliability Reports
MTOW	Maximum Takeoff Weight
NAR	No Action Required
NASA	National Aeronautical Space Administration
NBAA	National Business Aircraft Association
NTSB	National Transportation Safety Board
NTS	Negative Torque Sensing
OEI	One-engine-inoperative
POH	Pilot Operating Handbook
P.R.O.P.	Pilot's Review of Proficiency
PTRS	Program Tracking and Reporting System
RACA	Regional Air Carriers Association
RGL	Regulatory and Guidance Library
RPM	Revolutions Per Minute
SAIB	Special Airworthiness Information Bulletin
SB	Service Bulletin
SCR	Special Certification Review
SFAR	Special Federal Aviation Regulation
SDR	Service Difficulty Report
SLD	Supercooled Large Droplet
SPAC	Standards, Policy, Administrative Controls
STC	Supplemental Type Certificate
STOL	Short Take-Off and Landing
TAS	Turbine Aircraft Services
TC	Type Certificate
TCDS	Type Certificate Data Sheet
V_{LOF}	Lift-off Speed
V_{MC}	Minimum Control Speed with the Critical Engine Inoperative
V_{MO}	Maximum Operating Limit Speed
V_{REF}	Landing Approach Speed

Appendix 1

Safety Evaluation Report Background

Two of the most recent fatal MU-2B accidents prompted the Federal Aviation Administration (FAA) to launch a safety evaluation team to conduct a thorough and complete evaluation involving not only a review of the certification aspects of the airplane, but also including a review of operations, maintenance and training. The FAA has received numerous Congressional inquiries about the safety of MU-2B airplanes with some asking the FAA to ground these airplanes. The Congressional inquiries resulted from the two MU-2B accidents in Colorado by an individual 14 Code of Federal Regulations (CFR) part 135 air taxi operator since December 2004.

The MU-2B Safety Evaluation team's initial goal was to complete this safety evaluation by September 30, 2005. However, that was not enough time to complete the evaluation. Additional time allowed the FAA to participate in several meetings with industry. Participants in these meetings agreed that something needs to be done reduce the number of accidents in the MU-2B. All supported recurrent mandatory type specific standardized training for pilots and maintainers of MU-2B airplanes. The Airplane Flight Manual (AFM) /Pilot Operating Handbooks (POHs) also needs to be reviewed and revised.

The safety evaluation report is a compilation of studies done by the different offices and these appendices contain supportive information connected to the report but are too lengthy to include in the body of the report.

The team conducted a detailed review and analysis of the MU-2B series airplane accidents, incidents, safety data, maintenance, and commercial operations. The team's review included all areas of operation, maintenance, and certification of the MU-2B airplane currently used in 14 CFR part 91, part 129, and part 135 operations within the United States. The team also reviewed the airplane's certification basis and operating environment.

During this safety evaluation, the team reviewed all data from previous Special Certification Reviews (SCR) done in 1984 and 1996. The team gave credit to the previous SCRs because the data shows the accident rate decreased as a result of the recommendations made in those SCRs. However, in the past two years the accident numbers increased.
In reevaluating the previous SCRs and identifying new areas of concern, the team used two new tools for reviewing recent MU-2B accidents and used new analytical tools for assessing risk of the recommendations from the previous SCRs. One of the new tools used was the Small Airplane Directorate's Airworthiness Concerns Process Risk Assessment. Another tool was the "Taproot®" program. The team also sought input by contacting MU-2B training facilities, operators, Mitsubishi Heavy Industries of America (MHIA) and Honeywell. This contact was done by sending out an Airworthiness Concerns Sheet (ACS) on September 2, 2005, making telephone calls, and conducting on-site meetings. See appendix 5, figure 1 of this document for a copy of the ACS.

One area the team evaluated was the use and operation of the airplane today compared with that during the previous SCRs. At the time of the previous SCRs, many of the MU-2Bs were used as corporate and private airplanes. Because of the decrease in price, MU-2Bs are now used in 14 CFR part 135 “check hauling” operations and are being flown by both high and low time pilots and may be maintained by mechanics who are new to the MU-2B.

The first SCR done in 1983-1984 followed a series of accidents involving the MU-2B. This SCR involved extensive testing of the airplane in all certified flight regimes, including controllability and stability while flying with one engine inoperative. The FAA concluded that the aircraft met all the applicable requirements and found no major deficiencies that adversely affected normal operation of these airplanes. As a result of the SCR, the FAA issued Airworthiness Directives (AD) that are described further in appendix 4 of this document. The number of MU-2B accidents declined following the implementation of the SCR recommendations, but started to gradually climb upward again two years later.

A second SCR was initiated in 1996 following a fatal MU-2B accident in Malad City, Idaho, on January 15, 1996. The purpose of this review was to look into the characteristics of the MU-2B when flown in icing conditions. After extensive investigation, testing, and analysis, the FAA decided that icing awareness training and airplane system modifications were needed to prevent icing-related accidents. Following this review, the FAA issued ADs to mandate pilot training and airplane modifications as referenced in appendix 4 of this document. Again, the number of MU-2B accidents declined following the implementation of the SCR recommendations. A year later, the accident rate again began to slowly increase.

The recent MU-2B accidents in 14 CFR part 135 operations prompted FAA to reevaluate current operations of the airplane in both air taxi and personal use.

Two of the three most recent accidents involved an air taxi operator located in Englewood, Colorado. They lost 2 MU-2B airplanes within the last 12 months. Another air taxi operator has experienced seven MU-2B accidents (two of these airplanes were involved in the same ground accident). During this safety evaluation, another 14 CFR part 135 accident occurred on September 23, 2005.

As of August 2005 there were a total of 66 MU-2Bs in operation by 20 Air Taxis, Air Carriers, and Foreign Air Carriers within the United States. These operators are shown in Table 1 of this appendix.

Appendix 1 - (Continued)

Table 1

FAR Part 129/135 Operators of Mitsubishi MU-2B Series Airplane as of 8/22/05

Operator Name	Designator	Operator 14 CFR Part	Certificate Holding District Office	Make/ Model/ Series	Aircraft Count
AIR 1ST AVIATION COMPANIES OF OKLAHOMA INC	OXKA	135	SW15	MU-2B-35	5
AIR 1ST AVIATION COMPANIES OF OKLAHOMA INC	OXKA	135	SW15	MU-2B-36	4
AIRCRAFT CHARTER SERVICES INC	P4HA	135	SO17	MU-2B-40	1
American Check Transport Inc.	VOXA	135	NM03	MU-2B-36	4
American Check Transport Inc.	VOXA	135	NM03	MU-2B-60	7
American Flight Group, Inc.	BVIA	135	EA07	MU-2B-35	1
Bankair Inc.	BKAA	135	SO13	MU-2B-35	4
Bankair Inc.	BKAA	135	SO13	MU-2B-36	1
Bankair Inc.	BKAA	135	SO13	MU-2B-60	5
Bohlke International Airway, Inc.	FISA	135	SO21	MU-2B-20	1
EPPS AIR SERVICE INC	ESMA	135	SO11	MU-2B-60	11
EXECAIRE, A DIVISION OF I.M.P. GROUP LIMITED	ZGCF	129	EA29	MU-2B-60	2
Guardian Flight, Inc.	G1IA	135	AL01	MU-2B-60	1
Howell Enterprises, Inc.	QHEA	135	SO03	MU-2B-60	1
Jaax Flying Service, Inc.	DKKA	135	WP09	MU-2B-60	1
Jetprop, Inc.	J25A	135	SW15	MU-2B-26A	1
McNeely Charter Service, Inc.	MCCA	135	SW11	MU-2B-36	1
McNeely Charter Service, Inc.	MCCA	135	SW11	MU-2B-40	1
Mid-Coast Air Charter, Inc.	MM9A	135	SW09	MU-2B-60	1
North Flight, Inc.	NF8A	135	GL09	MU-2B-35	1
Northeast Aviation, Inc.	NZZA	135	GL03	MU-2B-30	1
Panther Aviation Inc.	FOVA	135	SO17	MU-2B-35	1
Panther Aviation Inc.	FOVA	135	SO17	MU-2B-36	1
Premier Jets Inc	CMWA	135	NM09	MU-2B-36	1
Royal Air Freight, Inc.	BUHA	135	GL23	MU-2B-35	1
Royal Air Freight, Inc.	BUHA	135	GL23	MU-2B-36	2
Thunder Airlines Limited	T3NF	129	EA23	MU-2B-36	1
Thunder Airlines Limited	T3NF	129	EA23	MU-2B-36A	1
Thunder Airlines Limited	T3NF	129	EA23	MU-2B-60	3
Total Number of MU-2B Airplanes in part 129/135 operations					**66**

Since 1968, the MU-2B has been involved in 189 accidents. Of these, 27 were in 14 CFR part 135 air taxi operations. A summary of MU-2B accidents is included in Table 2 of this appendix. According to the accident data, the break out of air taxi was only apparent from 1983. Since 1983, 27 of the 91 total MU-2B accidents were in 14 CFR part 135 operations. Since 1996, there have been 35 total MU-2B accidents. Fourteen of those were in 14 CFR part 135 operations. The percentage of accidents has increased to approximately 40 percent of the accidents and 60 percent of the fatalities are in 14 CFR part 135 operations.

Numerous operators state that the MU-2B is the perfect size and price for “check hauling” operations. More and more of these airplanes are showing up performing these types of operations.

During the first phase of this evaluation, the FAA established a Flight Test team to do a flight familiarization and cursory review of the current Airplane Flight Manuals (AFMs). Based on further information, the FAA held a Flight Standardization Board (FSB) to validate the need for pilot specific training, standardized checklists, and a revised flight manual.

Other areas of ongoing evaluation included: operations of a specific operator whose accidents led to this evaluation, a review of the Service Difficultly Reports (SDRs), reevaluation of the previous SCRs, a review of current and previous Pilot Operating Handbooks (POH)/AFMs, training techniques and how they differ from the POH and AFM, and information obtained from industry (Mitsubishi Heavy Industries of America (MHIA), operators, and training providers).

As of December 2005, the FAA has issued 29 ADs against the MU-2B airplane. The most recent MU-2B AD issued is AD 2003-22-07 R1. A complete list of the 29 MU-2B ADs issued against the airplane is included in Table 3 of this appendix.

The MU-2B series airplanes incorporate a Honeywell (formerly known as Allied Signal and Garrett) Model TPE331 series engine and either a Hartzell Model HC-B3TN-5 or HC-B4TN-3 propeller. In addition to the ADs referenced above that are written against the airplane, there are 33 more ADs written against the engine and 12 more ADs written against the propellers on these airplanes.

Table 4 of this appendix contains a list of the engine ADs issued.

Table 5 of this appendix contains a list of the propeller ADs issued

Currently, there are no open NTSB or FAA Safety Recommendations on the MU-2B.

According to the FAA SDRs, there have been only two reports made from January 1, 2005, through August 2005. There were only three SDRs for all of 2004. See Table 6 of this appendix for a chart of SDRs reported since 1974.

As part of this evaluation, FAA reviewed mandatory continued airworthiness information (MCAIs) received from the Japan Civil Aviation Bureau (JCAB), who is the state of design for one of the TCs. The FAA has processed them in accordance with International Civil Aviation Organization Annex 8. The MCAI process evaluates ADs issued by a foreign authority or the manufacturer's mandatory service information provided by that foreign airworthiness authority to determine if FAA needs to mandate the service information by issuing an AD, recommend incorporation of the service information via a Special Airworthiness Information Bulletin (SAIB), or take no action.

During the course of this safety evaluation the FAA consolidated all TC oversight responsibilities into a single office – the Fort Worth Aircraft Certification Office (ACO). With this consolidation the FAA once again reviewed all of the mandatory service bulletins and JCAB ADs since 1996 even though no outstanding continued airworthiness actions are identified as contributing to any MU-2B accidents. This review was done using the Small Airplane Directorate Airworthiness Concerns Process.

The Fort Worth ACO is working the following MCAI/JCAB ADs:

- JCAB TCD 4889-98: Incorporated SB 233A / 095/77-002, Inspection of engine torque indication system.
- JCAB TCD 4379-96: Incorporated SB 218A / 090/76-003, Inspection of feather valve/Linkage Inspection.
- JCAB TCD 4890-98: Incorporated SB 234 / 097/73-001, Flight check of the flight idle fuel flow setting.
- SBs 241 / 103/57-004, SAIB CE-04-84, Inspection of cracked wing attachment barrel nuts.

Results of the review conducted by the Fort Worth ACO showed that appropriate corrective actions are being taken to address most of the service difficulty data. Results are presented in the separate, single-page spreadsheet in Table 7 of this appendix. Appropriate FAA actions are determined by considering the safety effect and risk factor as well as a review of service history. See Table 8 of this appendix for a list of JCAB AD summary and proposed FAA action and see Table 9 of this appendix for a list of JCAB ADs and corresponding service bulletin for each TC.

On the date of this report, the last four U.S. MU-2B accidents did not have official NTSB final reports or conclusions developed.

Appendix 1 - (Continued)

Table 2

Summary of U.S. MU-2B Accidents

MU-2B	Total Accidents	Fatal Accidents	No. of Fatalities	Notes
1983	8	4	15	1 air taxi/ the first MU-2B 135 accident
1984	5	2	2	
1985	5	2	2	2 air taxi
1986	3	2	6	1 air taxi
1987	4	1	1	
1988	3	2	2	2 air taxi
1989	4	2	5	2 air taxi
1990	8	3	7	3 air taxi
1991	4	3	8	
1992	7	5	22	1 air taxi
1993	4	2	12	1 air taxi
1994	0	0	0	
1995	1	0	0	
1996	7	1	8	2 air taxi
1997	1	1	2	
1998	2	1	2	
1999	1	0	0	
2000	5	3	7	2 air taxi
2001	4	3	5	
2002	2	1	2	1 air taxi
2003	2	1	1	2 air taxi
2004	7	4	6	4 air taxi
2005	3	2	5	2 air taxi
Total	**90**	**45**	**120**	**26**

Appendix 1 - (Continued)

Table 3

MU-2B Airplane Airworthiness Directives

AD No.	Docket No.	Amendment No.	Subject
2003-22-07 R1	2003-CE-22-AD	39-13504	AFM- forecast icing conditions
2003-17-04	97-CE-27-AD	39-13278	Cockpit Windshield and Cabin Window
2000-09-15 R1	97-CE-21-AD	39-11819	Icing Conditions
2000-02-25	99-CE-38-AD	39-11543	Airframe Pneumatic Deicing Boots
98-20-39	98-CE-39-AD	39-10807	Forward Attachment Fitting Bolt
97-25-02	97-CE-22-AD	39-10225	Airplane Flight Manual (AFM) - Power Levers
97-04-13	96-CE-45-AD	39-9938	Vent Check Valve Assembly
96-25-02	96-CE-61-AD	39-9843	Airplane Flight Manual (AFM) - Icing Limitations
94-04-16	92-CE-50-AD	39-8836	Elevator Nose-Down Trim
91-23-08	91-CE-33-AD	39-8077	Rudder Trim Tab
88-23-01	Unknown	39-6056	Torque Tube Joints
88-21-01 R1	Unknown	39-6096	Control Yoke
88-13-01	Unknown	39-5951	Autopilots
87-04-03	Unknown	39-5527	Flap Flexible Shafts
86-26-02	Unknown	39-5498	POH/AFM Appendix - Icing
86-20-01	Unknown	39-5428	Pitot System Modification
86-15-03	Unknown	39-5354	NLG Strut Assembly
84-25-02	Unknown	39-4962	Trim Tab Brackets
84-12-04	Unknown	39-4883	Engine Air Inlet Anti-ice System
82-21-03	Unknown	39-4472	Fire Detection
82-08-02	Unknown	39-4360	Electrical Wiring Inspection
81-06-01 R1	Unknown	39-4086	Engine Aft Nacelles
80-15-03	Unknown	39-3843	Rear Baggage Compartment
79-24-02	Unknown	39-3612	Outer Fuel Tank Wiring
78-03-05	Unknown	39-3137	Cowling Latches
75-16-20	Unknown	39-2294	Propeller Pitch Control Lever
74-11-01	Unknown	39-1844	Windshield Outer Panes
73-19-03	Unknown	39-1716	Nose Gear Actuating System Failure
71-14-01	Unknown	39-1238	Fuel Tank Fungus Coating Peeling

Appendix 1 - (Continued)

Table 4

Honeywell TPE-331 MU-2B Engine Airworthiness Directives

AD Number	Description	Additional Info
2004-09-29	First Stage Turbine Disks	Disk bore crack due to melt issue (quality). Initial and repetitive FPI and ECI. Optional terminating action to replace specific serial numbered disks.
2002-21-15	Second Stage turbine stator inner seal support	Remove and replace to prevent uncontained engine failures - due to blocked stator rubbing stg 2 disk arms
2002-25-02	First Stage Compressor Impellers	Removal of weld repaired 1st stage comp impellers to prevent uncontainment
2001-21-02	Electronic Engine Controls	Remove and replace EEC by Aug 2003, to prevent power loss.
98-26-07	Fuel Manifold	Remove and replace repaired manifolds to prevent fuel leakage resulting in fuel spray on turbine components resulting in engine fires.
98-04-15	Turbine Stators	Remove and replace specific serial numbers outer band weld crack due to thermal fatigue, resulting in contact with 3rd stage turbine wheel and uncontainment
97-15-10	Engine Inlet Ice Protection	Requires revising the applicable Emergency Procedures or Abnormal Procedures Section of the applicable AFM or Pilot's Operating Handbook (POH) to include a paragraph relating to a non-responsive power lever. In addition, this AD requires replacing or reworking orifice fittings and restrictors, which would constitute terminating action to the requirement to revise the applicable AFM.
96-06-11	Engine Compressor Components	Establishes cyclic retirement lives for certain compressor components
95-16-08	Life Limited Turbine Components	For engines determined to have repair, assembly, modification, or installation work performed by Fliteline, this action requires verification of all life limited components, inspection of affected components, and verification of compliance with all applicable AD's.

Appendix 1 - (Continued)

Table 4 (Continued)

Honeywell TPE-331 MU-2B Engine Airworthiness Directives

AD Number	Description	Additional Info
94-26-07	Fuel Control Governor Drive	This AD requires an amendment to the Emergency Procedures section of the applicable FAA Approved Airplane Flight Manual (AFM) for each applicable engine installation in an aircraft, and initial and repetitive dimensional inspections of the fuel control drive shaft splines for wear, or replacing the affected fuel controls with alternate fuel controls. This amendment is prompted by reports of excessive wear of the internal fuel control drive splines in fuel controls, which can result in loss of fuel control governor drive. The actions specified by this AD are intended to prevent an uncontained engine failure, damage to the aircraft, or loss of aircraft control.
94-09-08	Third Stage Stator Turbine Assemblies	This action requires inspection of certain third stage turbine stator assemblies, and replacement, if necessary, with serviceable assemblies. This amendment is prompted by reports of six third stage turbine stator assemblies assembled with inner seal supports made of incorrect material that results in a significantly reduced cyclic life. The actions specified by this AD are intended to prevent an uncontained failure of the third stage turbine wheel.
93-15-11	Propeller Pitch Control (PPC) Gasket replace un-reinforced gaskets with serviceable metal reinforced gaskets	To prevent a sudden loss of propeller control during application of thrust reverse that may cause asymmetric thrust and loss of aircraft control.
93-05-09	Third Stage Turbine Stator Assemblies	In order to prevent engine uncontainment, replace specific third stage turbine stator assemblies with new or reworked assemblies.
93-02-01	Stratoflex Fuel Manifold Assemblies	To prevent fuel spraying on hot turbine components, which can result in an engine fire, remove and replace specific manifolds within next 50 hours.

Appendix 1 - (Continued)

Table 4 (Continued)

Honeywell TPE-331 MU-2B Engine Airworthiness Directives

AD Number	Description	Additional Info
92-26-08	Third Stage Stator Assemblies	To prevent an uncontained failure of the third stage turbine wheel, replace affected third stage stator assemblies.
92-02-19 PL	Fuel Manifold Assembly Leak	To prevent an engine fire caused by a fuel manifold assembly leak, remove and replace affected manifolds.
89-07-07 R1	Oil Scavenge Pump Assembly	To prevent turbine failure, inspect and modify applicable engines
88-12-10	Turbine Rotor	To prevent an uncontained engine failure, remove from service the second stage turbine rotor
86-08-06 R1	Second Stage Turbine Rotor Assembly	To prevent uncontained failure of the second stage turbine rotor assembly, inspect 2nd stg turbine stator plate assembly or mis-assembly or warpage.
84-10-06 R1	Fuel Pump Assemblies	Inspect low-time engine fuel control/pump assembly to determine drive shaft running torque. Remove from service assemblies having unsatisfactory inspection results.
84-01-04	Third Stage Turbine Wheels	Inspect and remove from service those turbine wheels having unsatisfactory inspection results.
79-12-04	Forged Third Stage Turbine Wheel Blade	
78-25-08 R3	Turbine Rotor	
78-05-02	Propeller Pitch Control Cam Follower Pin	
76-16-01	Bearing Oil Transfer Tube	
75-10-05	Torque Sensor Assembly Mounting Arm	
74-24-05	Propeller Pitch Control Sleeve Assembly	
74-10-10	Fuel control Assembly Support Bracket	
73-26-07 R3	Fuel Pump Shaft Internal Drive Splines	
73-26-03	Fuel Pump Shaft External Drive Splines	
72-05-07	High Speed Pinion Assembly	
70-19-02	High Speed Pinion bearings	

Appendix 1 - (Continued)

Table 4 (Continued)

Honeywell TPE-331 MU-2B Engine Airworthiness Directives

AD Number	Description	Additional Info
70-16-09	High Speed Pinion Assembly	
70-04-04	High Speed Pinion Retaining Nut	

Table 5

Hartzell Propeller ADs

MU-2B Model Airplane Propeller Installations

Airworthiness Directive (AD) and Service Document Background Description

AD(s) Note: AD(s) below affect both propeller models unless highlighted otherwise
AD 2005-14-12 - Requires initial and repetitive visual inspection and torque checks/replacement of certain propeller mounting installation bolts
AD 2005-14-11 - Requires inspection and teardowns of certain propellers that were improperly inspected or Overhauled by Southern California Propeller Service (Former FAA Approved Repair Station)
AD 2003-13-17 - Inspections and teardowns of certain propellers that were improperly inspected or Overhauled by T&W Propellers, Inc. (Former FAA Approved Repair Station)
AD 2003-04-23 - Requires replacement of affected propeller blades with blades of the latest design. **(HC-B3TN only)**
AD 96-18-14 - Propeller Hub replacement with concurrent blade and clamp inspection.
AD 95-03-03 - Hub Pilot Tube Bore Inspection (Not MU-2B related)
AD 95-01-02 - Fatigue crack inspections in propeller assemblies and replacement of propeller blades. **(HC-B4TN only)**
AD 94-11-04 - Propeller Hub Arm assembly failure due to high vibration during ground idle speed **(HC-B4TN only)**
AD 94-03-11 - Fatigue crack inspections in propeller Hub Arm assemblies. **(HC-B4TN only)**
AD 93-01-09 - Hub Pilot Tube Bore Inspection (MU-2B)
AD 83-08-01R2 - Propeller mounting bolt failures, bolt replacement program
AD 74-14-01 - Inspect propeller blades for cracks due to blade failures

Appendix 1 (Continued)

Table 6

MU-2B Service Difficulty Reports

1974 through November 2005

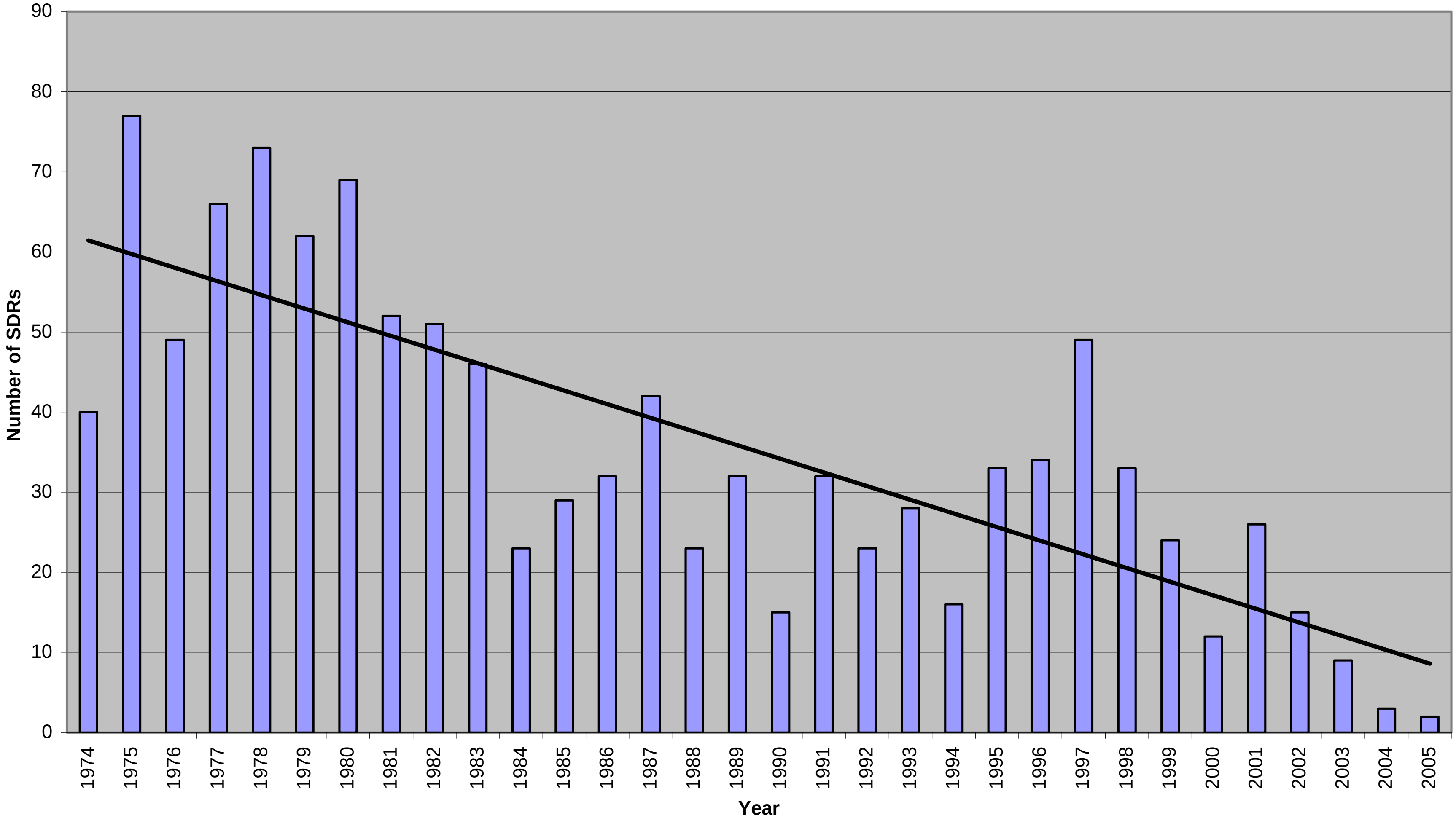


Table 8 (Continued)

MU-2B JCAB AD Summary

Service Bulletin Number	Subject	Safety Effect	Risk Factor	Original Action	Proposed Action
79	Elevator Hinge Attachment to Stabilizer	4	14	CLOSED	No Change
112	Fuel Anti-Ice Additive	2	8	CLOSED	No Change
114	Fuel Quantity Indicator	2	8	CLOSED	No Change
116	Engine Nacelle Modification	2	8	CLOSED	No Change
119	Bolt & Bolt Hole Diameter of Nose Landing Gear	1	5	CLOSED	No Change
123	Bearing oleo Strut Nose Landing Gear	1	5	CLOSED	No Change
169B	Shimmy Damper, Inspect and Modify	1	5	CLOSED	No Change
172	Support, MLG Forward Door Actuating Mechanism	1	9	CLOSED	No Change
173A	Drag Strut Main Landing Gear	3	11	CLOSED	No Change
175A	Replacement of Barrel Nut, Inner/Outer Wing Connecting	3	15	OPEN	ACS issued-Refer to SB 241***
188	Nose Gear Down Lock Mechanism	2	8	CLOSED	No Change
195	Inspect for cracks and Replace bracket on L/H Drag Strut of Nose Landing Gear	1	5	CLOSED	No Change
209B	Fuselage Frame Inspection & Repair	4	19	SAIB 26	No Action Required
210A	Engine Ignition Unit Replacement	2	8	CLOSED	No Change
212A	Anti Ice/Deice system	1	8	CLOSED	No Change
213	M-4C Autopilot Engage Switch guard installation	2	8	CLOSED	No Change
217B	Ice Detector System Installation	2	7	CLOSED	No Change
219A	Emergency Gear Down Lower Pin Replacement	1	5	SAIB 49	No Change
221	Tip Tank Conduit Tube Inspection	1	5	CLOSED	No Change
229	Feathering Valve Linkage Inspection	2	8	OPEN	ACS issued 10/12/05***
230	Bearing Box landing Gear Actuating Mechanism	2	12	SAIB-49	NAR issued 11/22/05
233A	Inspection of Engine Torque Indication System	1	13	OPEN	ACS issued 10/12/05***
234	Flight Check of Fuel Idle Flow Setting	3	17	OPEN	ACS issued 10/12/05***
235	Inspection of Landing Gear Power Train Spline Joint	2	9	CLOSED	No Change
236	Tip Tank Brackets, Inspection of	2	8	CLOSED	NAR issued 10/12/05
237	Flap Drive Train, Inspection of	4	14	CLOSED	NAR issued 11/22/05
238	Main Landing Gear Door Safety pin & Linkage	1	5	CLOSED	No Change
239	Pneumatic Line Inspection and Modification	2	13	SAIB 34	No Change
240	Throttle Quadrant Placard	1	5	CLOSED	NAR issued 11/22/05
241	Wing Attachment Hardware, Barrel Nuts	3	11	OPEN/ SAIB CE-04-84	ACS issued on 10/13/05***

The service bulletins (SBs) above with "No Change" in the Proposed Action column remain closed after re-evaluation on 9/24/05.

***These SBs were re-opened after re-evaluation of the closed SBs was completed on 9/24/05 using current Small Airplane Directorate Airworthiness Concern Sheet process.

Appendix 1 (Continued)

Table 8

MU-2B JCAB AD Summary

TC	JCAB AD's/ or Mandatory SB's	AD's Issued by U.S.	SB's Closed or SAIB Issued	Re-Opened
A2PC	65	35	30*	8**
A2PC	0	3	N/A	N/A

NOTES:

* These SB's were closed after engineering analysis revealed that no further action was necessary.

** These SB's were re-opened after a re-evaluation of the Closed SB's was completed on 9/24/05 using current Small Airplane Directorate Airworthiness Concern Sheet processes. Proposed Action status as of 11/22/2005.

TC A2PC		MHIA TCD/AD WORKSHEET		PROPOSED ACTION
JCAB AD Number	DATE	Subject	AD NUMBER	
TCD 518-68	01/12/96	Rib, Stabilizer Inspection and Modification of	CLOSED*	No Change**
TCD 642-70	01/30/70	Fuel Anti-Ice Additive	CLOSED*	No Change**
TCD 643-70	01/30/70	Fuel Quantity Indicator- Readjustment of	CLOSED*	No Change**
TCD 653-70	03/16/70	Engine Nacelle Tail Modification	CLOSED*	No Change**
TCD 652-70	03/10/70	The Bolt & Bolt Hole Diameter of Nose Landing Gear - Special Inspection Request of	CLOSED*	No Change**
TCD 660-70	04/01/70	Bearing, Oleo Struct, Nose Landing Gear - Replacement of	CLOSED*	No Change**
TCD 1209-75	07/24/80	Shimmy Damper - Inspection and Modification of	CLOSED*	No Change**
TCD 1272-75	07/25/75	Support, MLG Forward Door Actuating Mechanism - Inspection and Replacement of	CLOSED*	No Change**
TCD 1284-1-76	07/24/80	Drag Strut, Main Landing Gear- Modification of	CLOSED*	No Change**
TCD 1353-76	07/27/80	Barrel Nut, Inner/Outer Wing Connecting-Replacement of	OPEN	ACS Issued 10/12/05(ref. SB 241)***
TCD 2070-81	07/13/81	Down Lock Mechanism, NLG Inspection of	CLOSED*	No Change**
TCD 2263-83	02/10/83	Inspection for Cracks and Replacement of the Bracket Attaching L/H Drag Struct of Nose Landing Gear	CLOSED*	No Change**
TCD 5030-99	04/19/99	Fuselage Frame Inspection and Repair	SAIB CE-03-26	NAR Issued
TCD 2679A-97	11/12/96	Engine Ignition Unit Replacement	CLOSED*	No Change**
TCD 3393A-96	04/25/96	Inspection of Anti-ice/Deice Systems	CLOSED*	No Change**
TCD 3464-91	04/18/91	M-4C Autopilot Engage Switch Guard Installation	CLOSED*	No Change**
TCD 4529-97	11/07/96	Ice Detector System Installation	CLOSED*	No Change**
TCD 3942-1-94	10/24/94	Emergency Gear Down Gearbox Lower Pin Replacement	SAIB CE-03-49	NAR issued 11/22/05

Appendix 1 (Continued)

Table 8 (Continued)

MU-2B JCAB AD Summary

TC A2PC		MHIA TCD/AD WORKSHEET		PROPOSED ACTION
JCAB AD Number	DATE	Subject	AD NUMBER	
TCD 3901-93	08/10/93	Tip tank Conduit Tube Inspection and Repair	CLOSED*	No Change**
TCD 4379-96	02/20/96	Feathering Valve/Linkage Inspection	OPEN**	ACS Issued 10/12/05***
TCD 4889-98	01/14/99	Inspection of engine torque indication system	CLOSED*	ACS Issue 10/12/05***
TCD 4684-97	03/05/97	Modification of Bearing Box-Landing Gear Actuating Mechanism	SAIB CE-03-49	No Change**
TCD 4890-98	10/7/1998	Flight Check of Fuel Idle Fuel Flow Setting	OPEN	ACS Issued on 10/12/05***
TCD 4838-98	8/4/1998	Inspection of Landing Gear Power Train Spline Joint	CLOSED*	No Change**
TCD 5747-2001	8/28/2001	Tip Tank Brackets, Inspection of	CLOSED*	NAR Issued 11/22/05
TCD 5864-2001	12/13/2001	Flap Drive Train, Inspection of	CLOSED*	NAR Issued 11/22/05
	12/5/2002	Main Landing Gear Door Safety Pin & Linkage, Inspection of	CLOSED*	No Change**
	12/26/2002	Pneumatic Line Inspection and Modification	SAIB CE-03-34	No Change**
	2/26/2003	Throttle Quadrant Placard - Installation of	CLOSED*	No Change**
	07/14/04	Wing Attachment Hardware, Inspection of	OPEN - SAIB CE-04-84	ACS Issued on 10/13/05***

NOTES:

* These SB's were closed after the initial engineering analysis revealed that no further action was necessary.

** These SB's remained closed after the re-evaluation on 9/24/05.

*** These SB's were re-opened after a re-evaluation of the Closed SB's was completed on 9/24/05 using current Small Airplane Directorate Airworthiness Concern Sheet processes.

Appendix 1 (Continued)

Table 9

MU-2B JCAB ADs Corresponding with Service Information for Both TCs

A2PC SECTION				MHIA TCD/AD WORKSHEET	A10SW SECTION		
DOC	DATE	TCD/AD Number	AD NUMBER	Subject	DOC	DATE	FAA AD
SERVICE BULLETINS							
NA	NA	NA	NA	Outer Tank Switch Wiring Modification	SB013/28-001	2/1/1980	AD 79-24-01
NA	NA	NA	NA	Outer Tank Switch Wiring Modification	SB014/28-002	10/18/1979	AD 79-24-01
SB070C	01/07/76	TCD 1328-76	AD 76-21-02	Heatproof Material Around Engine Bleed Air Tubing,....	NA	NA	
SB079	01/12/96	TCD 518-68	CLOSED	Rib, Stabilizer Inspection and Modification of	NA	NA	NA
SB112	01/30/70	TCD 642-70	CLOSED	Fuel Anti-Ice Additive	NA	NA	NA
SB114	01/30/70	TCD 643-70	CLOSED	Fuel Quantity Indicator- Readjustment of	NA	NA	NA
SB116	03/16/70	TCD 653-70	CLOSED	Engine Nacelle Tail Modification	NA	NA	NA
SB119	03/10/70	TCD 652-70	CLOSED	The Bolt & Bolt Hole Diameter of Nose Landing Gear - Special Inspection Request of	NA	NA	NA
SB123	04/01/70	TCD 660-70	CLOSED	Bearing, Oleo Struct, Nose Landing Gear - Replacement of	NA	NA	NA
SB130A	07/19/71	NA	AD 97-04-13	Vent Check Valve, Main Fuel Tank- Removal of	NA	NA	
SB138	05/31/71	TCD 734-2-72	AD 71-05-07	Magnetic Chip Detector, Engine - Wiring Provisions for	NA	NA	NA
SB138	05/31/71	TCD 734-2-72	AD 71-05-07	Magnetic Chip Detector, Engine - Wiring Provisions for	NA	NA	NA
SB143C	10/20/86	TCD 730-2-86	AD 71-14-01	Top Coating, Wing Integral Main Fuel Tanks-Special Inspection on	NA	NA	NA
SB155	06/26/72	TCD 866-72	AD 73-19-03	Housing & Attaching Bolts of Bracket, Nose Landing Gear Actuator - Replacement of	NA	NA	NA
SB156	08/03/72	TCD 859-72	AD 71-05-07	Two Battery Engine Starting System- Modification of	NA	NA	NA
SB162	02/15/74	TCD 947-74	AD 74-11-02	Flexible Shafts, Flap Control System- Inspection of	NA	NA	NA
SB162A	10/03/74	TCD 947A-74	AD 75-02-01	Flexible Shafts, Flap Control System- Inspection of	NA	NA	NA
SB163B	11/16/78	TCD 948A-1-78	AD 74-11-01	Inspection of Outer Pane, Front Windshield & Installation of De-fogging Air Temp. Warning System for Windshield.	NA	NA	NA
SB163B	11/16/78	TCD 948A-1-78	AD 75-03-06	Inspection of Outer Pane, Front Windshield & Installation of De-fogging Air Temp. Warning System for Windshield.	NA	NA	NA
SB166	05/13/74	TCD 1001-74	AD 74-19-08	Elevator Trim Tab Bracket - Replacement of (SUPERSEDED BY SB176)	NA	NA	NA
SB167B	07/26/76	TCD 1094A-76	AD 75-16-13	Jackscrew Inspection and Gearbox Adjustment	NA	NA	NA
SB168	04/18/75	TCD 1188-75	AD 75-16-20	Propeller Pitch Control Inspection	NA	NA	NA

Appendix 1 (Continued)

Table 9 (Continued)

MU-2B JCAB ADs Corresponding with Service Information for Both TCs

A2PC SECTION				MHIA TCD/AD WORKSHEET	A10SW SECTION		
DOC	DATE	TCD/AD Number	AD NUMBER	Subject	DOC	DATE	FAA AD
SB169B	07/24/80	TCD 1209-75	CLOSED	Shimmy Damper - Inspection and Modification of	NA	NA	NA
SB170	05/16/75	TCD 1235-75	AD 76-22-04	MLG Forward Door Emergency Cable Inspection	NA	NA	NA
SB171A	07/14/75	TCD 1202-75	AD 76-16-05	Engine Upper Door Cowel Latch (SUPERSEDED BY SB180A)	NA	NA	NA
SB172	07/25/75	TCD 1272-75	CLOSED	Support, MLG Forward Door Actuating Mechanism - Inspection and Replacement of	NA	NA	NA
SB173A	07/24/80	TCD 1284-1-76	CLOSED	Drag Strut, Main Landing Gear- Modification of	NA	NA	NA
SB174C	10/02/81	TCD 1370-81	AD 83-09-02	Tip Tank Conduit Tube - Inspection of, and Rework of	NA	NA	NA
SB175A	07/27/80	TCD 1353-76	CLOSED	Barrel Nut, Inner/Outer Wing Connecting- Replacement of	NA	NA	NA
SB176E	09/26/84	TCD 1001B-2-84	AD 84-25-02	Elevator Trim Tab Bracket - Replacement of	SB031/27-005A	09/26/84	AD 84-25-02
SB177B	09/11/80	TCD 1379-1-80	AD 81-06-01R1	Modification of Engine Nacelle Tail	NA	NA	NA
SB180A	11/17/77	TCD 1520-77	AD 78-03-05	Link, Engine Nacelle Upper Door Replacement of	SB005/54-002A	11/17/77	CLOSED
SB181B	04/08/85	TCD 1768-1-85	AD 86-15-03	Inspection and Replacement of Nose Landing Gear Strut Assy	NA	NA	NA
SB182	11/16/79	TCD 1817-79	AD 80-15-03	Addition of Ceiling Cover, Rear Baggage compartment	NA	NA	NA
SB187B	06/16/82	TCD 2048-81	AD 82-21-03	Engine Fire Detecting System and D.C Power Emergency Relay System	NA	NA	NA
SB188	07/13/81	TCD 2070-81	CLOSED	Down Lock Mechanism, NLG Inspection of	SB048/32-008	07/13/81	CLOSED
SB189B	05/27/88	TCD 2252-2-88	AD 88-23-01	Flap Torque Tube Joint Inspection and Replacement	SB067/27-008	11/16/87	AD 88-23-01
SB191	12/21/81	TCD 2113-82	AD 82-08-02	Engine Electrical Wire Inspection and Replacement of	SB036/71-003B	12/21/81	AD 81-25-04R1
SB195	02/10/83	TCD 2263-83	CLOSED	Inspection for Cracks and Replacement of the Bracket Attaching L/H Drag Struct of Nose Landing Gear	SB046/32-005	02/10/83	CLOSED
SB196A	04/12/84	TCD 2342-1-84	AD 84-12-04	Re-torque of Coupling Nut on the Bleed Air Tubing for the Engine Air Inlet Lip Anti-Icing System	SB047/30-001	04/12/84	AD 84-12-04
SB198	02/13/85	TCD 2451-1-87	AD 87-04-03	Additional Seal and Torque Inspection of Flap Flexible Shafts	SB051/27-007	02/13/85	AD 87-04-03
SB201A	03/02/88	TCD 2545-1-88	AD 87-12-02	Generator Circuit Wires Inspection and Modification	SB058/24-005	03/02/88	CLOSED
SB206A	10/13/87	TCD 2856-1-97	AD 88-13-01R1	Bendix Autopilot Disengagement Method Standardization	SB066/22-006A	10/13/87	AD 88-13-01
SB209B	04/19/99	TCD 5030-99	SAIB CE-03-26	Fuselage Frame Inspection and Repair	SB073/53-002B	04/27/99	SAIB CE-03-26
SB210A	11/12/96	TCD 2679A-97	CLOSED	Engine Ignition Unit Replacement	SB074/74-001	11/12/96	CLOSED
SB211	12/09/91	TCD 3378-90	AD 91-23-08	Rudder Trim Tab Modification	NA	NA	NA
SB212A	04/25/96	TCD 3393A-96	CLOSED	Inspection of Anti-ice/Deice Systems	SB075/30-002A	04/25/96	CLOSED
SB213	04/18/91	TCD 3464-91	CLOSED	M-4C Autopilot Engage Switch Guard Installation	SB076/22-008	04/18/91	CLOSED

Appendix 1 (Continued)

Table 9 (Continued)

MU-2B JCAB ADs Corresponding with Service Information for Both TCs

A2PC SECTION				MHIA TCD/AD WORKSHEET	A10SW SECTION		
DOC	DATE	TCD/AD Number	AD NUMBER	Subject	DOC	DATE	FAA AD
SB216	09/11/92	TCD 3740A-98	AD 94-04-16	Elevator Nose Down Trim Limit Change	SB079/27-010	09/11/92	AD 93-07-11
SB217B	11/07/96	TCD 4529-97	CLOSED	Ice Detector System Installation	SB080/30-003B	11/07/96	CLOSED
SB219A	10/24/94	TCD 3942-1-94	SAIB CE-03-49	Emergency Gear Down Gearbox Lower Pin Replacement	SB082/32-012	10/24/94	SAIB CE-03-49
SB221	08/10/93	TCD 3901-93	CLOSED	Tip tank Conduit Tube Inspection and Repair	SB084/28-003	08/10/93	CLOSED
SB224A	10/20/95	TCD 4311-95	AD 2003-17-04	Acrylic Windshield Inspection and Replacement	SB087/56-001C	04/20/98	AD 2003-17-04
SB225	09/29/95	TCD 4310-96	AD 98-20-39	Forward Fitting Bolt of Wing Tip Tank Insp/Replacement	SB089/57-002A	09/29/95	AD 98-20-39
SB226E	09/18/01	TCD 2679A-97	AD 2000-09-15	Auto-Ignition System Installation	SB086/74-002	10/05/00	AD 2000-09-15
SB228	07/13/98	TCD 3740A-98	AD 94-04-16	Elevator Trim Indicator Modification	SB091/27-011	07/13/98	AD 93-07-11
SB229	02/20/96	TCD 4379-96	CLOSED	Feathering Valve/Linkage Inspection	SB090/76-003	02/20/96	CLOSED
SB230	03/05/97	TCD 4684-97	SAIB CE-03-49	Modification of Bearing Box-Landing Gear Actuating Mechanism	SB092/32-015	03/05/97	SAIB CE-03-49
SB231B	12/11/2002	TCD 4625A-2001	AD 2000-09-15	Trim-in-Motion Alert System & Automatic Autopilot Disconnect System Installation of…	SB093/22-009	12/11/02	AD 2000-09-15
SB232A	6/6/2002	TCD 4626-97	AD 2000-09-15	De-ice System Modification	SB096/30-014	07/08/97	AD 2000-09-15
SB233A	1/14/1999	TCD 4889-98	CLOSED	Inspection of Engine Torque Indication System	SB095/77-002	07/15/98	CLOSED
SB234	10/7/1998	TCD 4890-98	CLOSED	Flight Check of Fuel Idle Fuel Flow Setting	SB097/73-001	07/24/98	CLOSED
SB235	8/4/1998	TCD 4838-98	CLOSED	Inspection of Landing Gear Power Train Spline Joint	NA	NA	NA
SB236	8/28/2001	TCD 5747-2001	CLOSED	Tip Tank Brackets, Inspection of	SB098/57-003	09/06/01	CLOSED
SB237	12/13/2001	TCD 5864-2001	CLOSED	Flap Drive Train, Inspection of	SB099/27-012	11/18/01	CLOSED
SB238	12/5/2002		CLOSED	Main Landing Gear Door Safety Pin & Linkage, Inspection of	SB100/32-016	03/11/02	CLOSED
SB239	12/26/2002		SAIB CE-03-34	Pneumatic Line Inspection and Modification	SB101/30-016	12/26/02	SAIB CE-03-34
SB240	2/26/2003		CLOSED	Throttle Quadrant Placard - Installation of	SB102/11-009		CLOSED
SB241	07/14/04		SAIB CE-04-84	Wing Attachment Hardware, Inspection of	SB103/57-004	08/02/04	SAIB CE-04-84
SB242							
SERVICE NEWS							

Appendix 1 (Continued)

Table 9 (Continued)

MU-2B JCAB ADs Corresponding with Service Information for Both TCs

A2PC SECTION				MHIA TCD/AD WORKSHEET	A10SW SECTION		
DOC	DATE	TCD/AD Number	AD NUMBER	Subject	DOC	DATE	FAA AD
SN104A	08/15/99	NA	NA	Improvement of Speed Meter	SN059/77-003	8/31/1994	AD 94-11-04
SN108	12/13/96	TCD 4552-96	NA	Flight in Severe Icing Conditions	SN063/30-009	12/13/1996	NA
SN117A	01/09/98	TCD 4753-98	AD 97-20-14	FAA Approved Training Video Program YET97336 (SUPERSEDE BY AD 2003-22-07)	SN071/00-006A	1/9/1998	AD 97-20-14
SERVICE LETTERS							
SL068A	6/10/1993	NA	NA	Propeller Hub Inspection	SL042/72-027A	6/10/1993	AD 95-01-02
SERVICE RECOMMENDATIONS							
SR053A	10/23/1984	TCD 2450A-87	AD 86-20-01	Anti-Ice Capability Increase on Pilot Tube	SR020/34-005B	5/24/1998	AD 86-20-01
SR066B	11/13/1986	TCD 2679-97	AD 86-26-02	Manual Ignition Switch Installation	SR040/74-001A	12/11/1986	AD 86-26-02

Appendix 2

MU-2B Series Airplanes Type Certificate and Airplane History

A. Airplane History

The MU-2B is a high-wing, nine passenger, pressurized cabin, twin-engine turboprop airplane capable of short take-off and landings (STOL). These airplanes have historically been a multi-purpose aircraft that was initially popular with corporate and business users. Several versions of the MU-2B have been produced since the early 1960's. The MU-2A airplane, which had very limited production and was primarily a prototype, first flew in September 1963. The early MU-2B added a more powerful Garrett TPE331 engine and larger wing, which extended 11.95 meters or a full meter longer than the MU-2A wing. The MU-2A had a maximum speed of 249 miles per hour (MPH). The initial MU-2B had a higher maximum speed of 280 MPH, which was later increased to 311 MPH.

The MU-2 airplane was designed to be powered by turbo propeller engines from the beginning. Most manufacturers of the time started with an airplane designed for reciprocating engines and then later would retrofit turboprop engines on their aircraft. Surveys taken during the 1950s indicated that the United States (U.S.) corporate aviation market had a need for fast, economical aircraft with short field landing capability. To achieve these requirements, Mitsubishi Heavy Industries, Ltd. (MHI) designed an aircraft to operate with the latest state-of-the-art turboprop engines. The turboprop engines provide not only the high cruise performance, but also efficiency at higher altitudes. In order to achieve the STOL capability for the aircraft, a highly efficient double slotted Fowler flap was chosen and designed to run the full span of the wing. A spoiler system was utilized for roll control instead of ailerons, thereby permitting the full-span wing flap. Use of spoilers for roll control was the latest state-of-the-art and has many advantages over typical ailerons for roll control. One characteristic of spoilers over ailerons is the retention of positive roll control even during slow flight, a realm in which ailerons become sluggish, heavy, and are much less effective. In-flight, comfort in turbulent air was enhanced by utilizing higher wing loading when the airplane is in the cruise configuration (flaps retracted). Landing gear was designed to be rugged since the designers expected considerable demand to be placed on the gear when unimproved runways were utilized.

B. The First FAA U.S. Type Certificate No. A2PC

The Federal Aviation Administration (FAA) type certificated the MU-2B series airplane in November 1965 after successfully completing a validation process between the Los Angeles Aircraft Certification Office (ACO) and the Japan Civil Airworthiness Board (JCAB) under the Civil Aviation Regulation (CAR) 10. CAR 10 is the predecessor to the current 14 Code of Federal Regulations (CFR) part 21, section 21.29 regulation for imported type designed airplanes. As a result of the validation project, FAA issued U.S. type certificate (TC) No. A2PC to MHI of Nagoya, Japan. Japan is the state of design for this TC. The corresponding type certificate data sheet (TCDS) is No. A2PC.

C. The Second FAA U.S. Type Certificate No. A10SW

In 1963, Mitsubishi's New York trading company proposed a new seven place executive turboprop aircraft to Mooney Aircraft based in Kerrville, Texas. The process was that MHI would fabricate the new aircraft and Mooney would be responsible for assembly and marketing. The agreement was finalized two years later in 1965. MU-2 aircraft from the MHI production line were packaged into containers and shipped from Nagoya, Japan, to the United States and then trucked to San Angelo, Texas, for final assembly. Final assembly included installation of engines, propellers, avionics, instrumentation, and the interior. The airplanes were flight tested prior to delivery.

In late 1969, Mooney Aircraft filed a petition of bankruptcy. On May 14, 1970, MHI terminated the contract with Mooney and organized Mitsubishi Aircraft International, Inc. (MAI), a wholly owned subsidiary of MHI incorporated in the state of Texas. Marketing, executive, and administrative functions were moved to Dallas, Texas, in 1977.

On January 20, 1976, FAA, Fort Worth ACO issued U.S. TC No. A10SW to MAI for Models MU-2B-25 and MU-2B-35 airplanes. MU-2B series airplanes covered under this TC include letters “S.A.”, which stands for San Angelo. (Example: S/N xxxS.A). Since this TC was issued as 14 CFR part 21.21, the United States is the state of design for this TC.

In 1980, the San Angelo facility was expanded with the addition of a large production facility to provide the capability to support the MU-300 (Diamond Jet) product lines. By this time, employment levels had reached a peak. In the early 1980s, sales of business aircraft for all aircraft manufacturers began to decline and the outlook for future sales activity was bleak. MAI had recently certified the "Diamond I", which later grew into the Diamond "IA", and later still the "Diamond II". The Diamond II evolved into what later became known as the Beechjet 400. Sales continued to decline for the aircraft manufacturers and the decision was made by MHI and MAI to remove themselves from the U.S. market. On March 31, 1986, MAI transferred production of the Diamond Jet to the Beech Aircraft Corporation along with continued support of the MU-2. Final dissolution of MAI was filed on August 31, 1987. Raytheon Aircraft Corporation was contracted by MHI to provide MU-2 product support during the years 1986-1998.

On March 30, 1998, Mitsubishi Heavy Industries America, Inc. (MHIA), supported by Turbine Aircraft Services, assumed total responsibility for the MU-2 Product Support Program for MHI. Per Note 5 of the TCDS, MHIA is licensed by MHI of Japan to maintain the type design and to manufacture replacement and modification parts for the MU-2B series airplane listed on TCDS A10SW. There is no such note on the original TCDS No. A2PC.

MHIA currently provides spare parts and the technical services for the continued safe operation of the fleet including field service, engineering, continuing airworthiness, type certificate maintenance, and air safety investigation. Turbine Aircraft Services provides spare parts handling, storage and distribution, publications distribution, and service center administration for the MHIA approved service centers and special programs such as the Pilots’ Review of

Proficiency (P.R.O.P.) seminars offered free of charge to all MU-2 owners and operators on a biennial basis.

Currently, the FAA TCDS revisions for the MU-2B are: Revision 16, dated June 30, 1975, for TC No. A2PC, and Revision 14, dated August 25, 2003, for TC No. A10SW.

D. Airplane Information

MHI produced 831 MU-2Bs. There are currently 397 MU-2Bs on the FAA U.S. Aircraft Registry. Twelve different models were produced in two basic categories of fuselage length, a "short body" and a "long body." Both U.S. TCs for the MU-2Bs include both of these fuselage categories.

Several variants to the MU-2B produced by MHI are under each TC. Each variant was certificated with a numerical suffix, but was marketed by MHI with an alpha suffix. For example, the MU-2B-10 was marketed as the MU-2D. Production of all MU-2B variants ended in early 1984 as new orders had steadily declined.

As stated above, a total of 831 MU-2Bs were produced. This number includes 73 aircraft that were designed for military use mostly in Japan. Table 1 of this appendix identifies each numerical series and its marketing designation, along with a brief summary of changes that each variant introduced.

Appendix 2 (Continued)

Table 1

MU-2B Designations, Model Series, and Characteristics

Marketing Designation	Series	Characteristics
MU-2B	MU-2B	Typically 8 seats (including crew), TPE331-25A engines, 562 horsepower (HP), 11.95-meter wings, 280 MPH cruise speed, max takeoff weight (MTOW) of 8,930 pounds.
MU-2C	MU-2B-LR1	Un-pressurized MU-2B for surveillance and search-and-rescue (in Japan).
MU-2D	MU-2B-10	MU-2B with MTOW of 9,350 pounds.
MU-2DP	MU-2B-15	MU-2D with TPE331-1-151A engines, 665 HP.
MU-2E	MU-2B-LR1	MU-2C with up-graded avionics, electronic search equipment, and larger observation windows.
MU-2F	MU-2B-20	MU-2DP with larger wing-tip tanks, MTOW of 9,920 pounds.
MU-2G	MU-2B-30	Fuselage long 1.9 meters; up to 3 additional seats, MTOW of 10,800 pounds, 2 more windows each side, on-board lavatory, larger vertical tail, and rear entry door.
MU-2J	MU-2B-35	MU-2G (long-body) with 724-HP TPE331-6-251M engines.
MU-2K	MU-2B-25	MU-2F with 724-HP TPE331-6-251M engines.
MU-2L	MU-2B-36	MU-2J with MTOW of 11,575 pounds and cruise speed of 311 MPH.
MU-2M	MU-2B-26	MU-2K with MTOW of 10,470 pounds.
MU-2N	MU-2B-36A	MU-2L with quieter 776-HP TPE331-5-252M engines, new low-RPM gearbox & 4-blade props.
MU-2P	MU-2B-26A	MU-2M with quieter 776-HP TPE331-5-252M engines, new low-RPM gearbox & 4-blade props.
MU-2S	MU-2B-LR1	MU-2E modified for search-and-rescue in Japan.
Marquis	MU-2B-60	MU-2N with 778-HP TPE331-10 engines, increased fuel capacity, and MTOW of 11,575 pounds.
Solitaire	MU-2B-40	MU-2P with 778-HP TPE331-10 engines, increased fuel capacity, and MTOW of 10,450 pounds.

Note: Shaded rows denote long-body versions.

Table 1 of this appendix indicates the early MU-2B was normally configured for eight people, including the crew. Thereafter, MHI continued to modify the MU-2B to increase power, payload, range, and maximum speed. Eventually, the maximum speed was increased from 280 MPH to 311 MPH. For the purposes of this report, the significant change in design and configuration began with the MU-2G (MU-2B-30), which increased the length of the aircraft cabin by 1.9 meters creating the “long-body” aircraft.

The early MU-2Bs were most popular as a corporate or business aircraft. Though it continues to appear in business operations, the MU-2B is rarely seen today in corporate fleets. Instead, the aircraft has migrated primarily to 14 CFR part 135 cargo market and personal ownership.

Table 2 of this appendix shows the breakdown of the MU-2B fleet currently on the FAA U.S. Aircraft Registry.

Appendix 2 (Continued)

Table 2

MU-2B Fleet in the United States as of August 15, 2005

Aircraft Make-Model	On The FAA U.S. Aircraft Registry 8/15/05	Withdrawn From Use Or Written 0ff While On US Registry	Formerly On The FAA U.S. Aircraft Registry - Now On Foreign Registries	TOTAL - Once On FAA U.S. Aircraft Registry
Mitsubishi Short Models				
MU-2B	15	19	1	35
MU-2B-10	7	12	0	19
MU-2B-20	48	41	11	100
MU-2B-25	37	26	8	71
MU-2B-26/26A	46	8	7	61
MU-2B-40	41	9	5	55
Sub-Total	194	115	32	341
Mitsubishi Long Models				
MU-2B-30	13	24	1	38
MU-2B-35	50	41	10	101
MU-2B-36/36A	44	11	9	64
MU-2B-60	96	22	13	131
Sub-Total	203	98	33	334
Total, Mitsubishi	397	213	65	675

Sources: FAA Aircraft Registry

Per MHIA, since the MU-2 has been in service, over four million hours have been logged and the aircraft are still being utilized at a fleet average rate of over 30 hours per month.

E. FAA U.S. Type Certification Basis

The type certification basis for TC No. A2PC is CAR 10 dated March 28, 1955. Applicable regulations are CAR 3 dated May 15, 1956, including Amendments 3-1 through 3-8; Special Conditions stated in FAA letter to the JCAB dated May 14, 1965, modified by FAA letters to the JCAB dated January 25, 1968, and May 12, 1971.

The type certification basis for TC No. A10SW is CAR 3, dated May 15, 1956, including Amendments 3-1 through 3-8; Special Conditions stated in FAA letter to the JCAB dated May 14, 1965, modified by letters to JCAB dated January 25, 1968, and May 12, 1971; and Exemption No. 1951, dated February 4, 1974, granted an exemption from section 21.17.

F. Highlights

- Designed during the 1950s to be a high speed, business aircraft with STOL capability into and out of unimproved fields.

- Designed using the latest technology and philosophies of the times. Results:

    - Spoilers – roll authority all the way down to stall
    - Minimal wing area for cruise
    - Full span, double-slotted Fowler flaps – increases wing area and lift for low-speed operation
    - Built-in leading edge cuff on wing – improve stall characteristics
    - Turbine engines – more power than piston engines

- Multiple TCs in two ACOs and two states of design created coordination issues when resolving JCAB type design change/airworthiness directives (ADs) that could affect both type certificated airplanes.

- Shift from corporate use to cargo and personal use.

- TCDS No. A2PC needs to be updated and revised to clarify licensing agreement.

- TDCS No. A10SW needs to be revised to include “Type Certificate Holder Record” per FAA Order 8110.4.B, paragraph 3-3.d.(5) and the addition of “14 CFR 21.21”.

- The two TCs are basically identical as far as type design of the airplane is concerned.

- Currently RGL shows the Wichita ACO as the responsible office for the A10SW TC and this is incorrect and it should be updated to be Fort Worth.

Appendix 3

Accident Summary Report From the Office of Accident Investigation (AAI)

From December 10, 2004, to August 4, 2005, the MU-2B was involved in three fatal accidents in the United States, killing all seven occupants. Two of these accidents occurred near Englewood, Colorado, and initially were interpreted by some observers as similar to each other and to earlier accidents that involved icing, which was a concern with the MU-2B before the 1997 Special Certification Review (SCR) and subsequent airworthiness directives (ADs). In fact, the two accidents at Englewood did not involve icing and the two scenarios were quite different from each other. One of the two aircraft descended below minimum descent altitude (MDA) and flew into high terrain. The other aircraft crashed while the pilot tried to return to the airport after reporting a loss of engine power on climb out, though post-accident teardown found the engine had no anomalies. Nevertheless, the three recent accidents led to renewed interest in the inherent safety of the MU-2B, reminiscent of earlier concerns in the mid-1980s and again in the mid-1990s.

In response to this renewed interest, this report provides a broad review of the MU-2Bs accident record in the United States, including a fatal accident in Arkansas that occurred as this report was being drafted. The report summarizes the general characteristics of the MU-2B and its several variants, summarizes the MU-2B fleet in the United States, compares accident rates for the MU-2B and other similar aircraft, and reviews MU-2B accidents to identify common factors and the degree to which those factors differ among the several variants of the MU-2B.

In short, this appendix provides an overview of the MU-2B and cannot and does not substitute for a more detailed engineering review of aircraft performance, flight characteristics, etc. With that caveat, the core findings are as follows when compared to a group of similar twin-turboprops:

- The MU-2B accident numbers per fleet size are about 2.2 times greater than those for a comparison group of similar twin-turboprops, while the MU-2B fatal accident numbers for fleet size are 2.5 times higher than similar aircraft.

- This disparity is more modest than the Federal Aviation Administration (FAA) estimated in the 1996 Special Certification Review (SCR) when FAA estimated the fatal accident numbers were 5 times greater than comparable aircraft. However, as the 1996 SCR concluded, the data cited in this report suggest that the MU-2B indeed has more accidents and even more fatal accidents compared to similar aircraft.

- From the mid-1980s to 1999, the number of MU-2B accidents has typically ranged between 3 and 7 per year, while fatal accidents averaged about 2 per year. However, fatal accidents have increased since 2000, with 4 in 2004 and 3 year-to-date in 2005 (through December 30, 2005).

- Fatal accident rates in icing conditions are 4 times higher in the MU-2B than similar aircraft.

- The frequency of fatal accidents involving loss of control on initial climb out is 3.5 times greater and 2.5 times greater from loss of control in flight than similar aircraft.

- The fatal accident rate involving loss of control during emergencies is 7 times higher than similar aircraft.

- The fatal accident rate for the MU-2B is 3 times greater for power plant issues and 5 times greater for other system and component issues.

The early MU-2B was normally configured for 8 people, including crew. Mitsubishi thereafter continued to modify the MU-2B to increase power, payload, range, and cruise speed, eventually increasing the initial speed from 280 to 311 MPH. However, for the purposes of this report, the significant change in design and configuration began with the MU-2G (MU-2B-30), which increased the length of the aircraft by 1.9 meters. The various long-body versions have been of most concern to observers for icing accidents.

A. The MU-2B Fleet In the United States

As of August 15, 2005, the FAA U.S. Aircraft Registry showed a total of 397 MU-2Bs. This included 64 aircraft operated by 14 Code of Federal Regulations (CFR) part 135 air carriers. Another 65 MU-2B's are currently registered abroad, but once were registered in the United States. In addition to these aircraft, 213 MU-2Bs were withdrawn from use or written off while they were on the FAA U.S. Aircraft Registry.

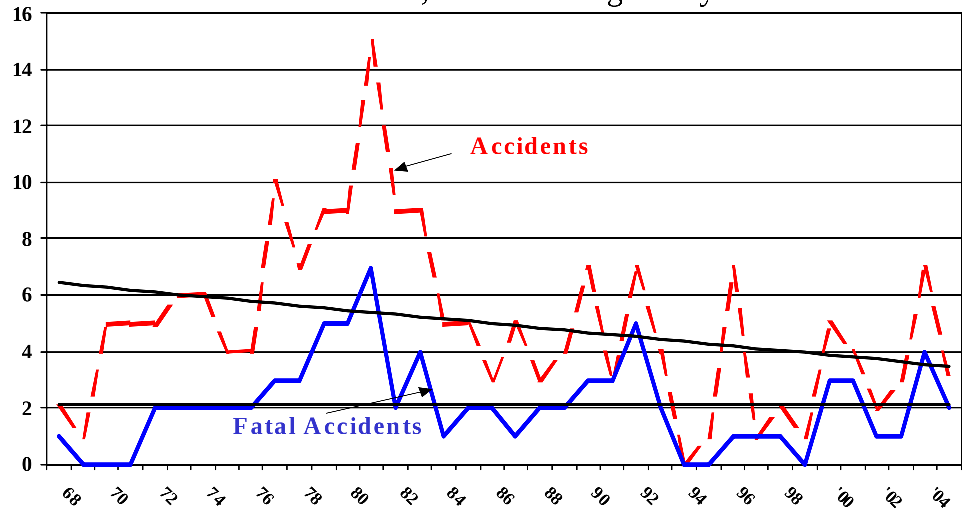
The MU-2B was most popular early as a corporate or business aircraft. Though it continues to appear in business operations, the MU-2B is rarely seen today in corporate operations. Instead, the aircraft has migrated primarily to the 14 CFR part 135 cargo market and personal ownership.

B. Mitsubishi MU-2B Accidents

Figure I of this appendix shows the number of accidents and fatal accidents from 1968 through 2004 involving the MU-2B. The National Transportation Safety Board (NTSB) recorded the first MU-2B accident in 1968. As Figure1 shows, the number of accidents and fatal accidents peaked from 1977 through 1983, followed by a more modest peak in fatal accidents in the early years. Figure 1 also shows that the trend line for overall accidents in the MU-2 is decreasing, while the long-term trend for fatal accidents is very stable at about two per year, with some modest increase in recent years, reaching four in 2004.

The first core question for this report is how the MU-2B accident and fatal accident rate (based on cumulative fleets) compare to similar aircraft. Accidents per flight hour or per aircraft departure are the preferred basis for computing rates, but FAA does not maintain estimates of flight hours by make-model for 14 CFR part 23 airplanes. Consequently, accident rates based on flight hours are not available for the MU-2B or for comparable aircraft. Instead, this report uses cumulative aircraft in the fleet as the basis for computing accident and fatal accident comparison.

Figure 1
Number of Accidents and Fatal Accidents
Mitsubishi MU-2, 1968 through July 2005



This has two conceptual weaknesses. First, we must assume that various make-models of aircraft are used with roughly equal intensity. The problem with this approach is that airplanes used for personal transportation or business travels typically fly less than airplanes used for daily "check hauling" or cargo operations. It is possible that the MU-2B has a higher utilization rate than the airplanes it is being compared to. This would subject the MU-2B to greater exposure for accidents.

Second, FAA has not maintained fleet histories since 1994. As a result, data from the FAA U.S. Aircraft Registry is limited to a single point in time and says nothing of when various models entered service or how the population of each model may have fluctuated over time. This report, therefore, starts with the number of aircraft currently on the FAA U.S. Aircraft Registry and then uses data from the BizJet and Biz Prop Directory to identify aircraft by make-model that previously had been on the FAA U.S. Aircraft Registry. The Directory also identifies the production year for each aircraft by tail number. This enables the numbers to account, to some degree, for differences in cumulative exposure for the MU-2B and for several comparable twin-turboprops that were produced during the same general era of the mid-1960s through the mid-1980s. Table 1 of this appendix shows the relevant fleet data for the MU-2B and selected aircraft, then computes a pseudo-accident and fatal accident rate for each make-model based on the total number of aircraft that have been on the FAA U.S. Aircraft Registry over the years.

Table 1 of this appendix shows the MU-2B accident rate (per aircraft) is about 2.2 times that of the comparison group and has a fatal accident about 2.5 times that of the comparison group. These ratios are substantially below those estimated by the FAA in the 1996 SCR. That SCR used a different comparison group, including several business jets, the Piper PA-42 and the Fairchild 226-227. That comparison group included aircraft that were much larger than the MU-2B (the 226/227), had different power plants (the Lear), were designed considerably later than the MU-2B (the PA-42 and later Lear models), or operated in very different environments (the 226/227 and Lear).

Table 1
Accident and Fatal Accident Rates, MU-2B and Comparable Aircraft Based on Total Fleets Once on the U.S. Registry

	Population on US Registry				Build Year		Accidents as % of Fleet				% Indexed	
Aircraft Make-Model	On US Registry 8/15/05	Withdrawn Or Written 0ff	Now On Foreign Registry	TOTAL, Once On Registry	Mean	Median	# All	# Fatal	Percent All	% Fatal	All	Fatal
Mitsubishi Short Models												
MU-2B	15	19	1	35			16	4	45.7	11.4	3.65	2.39
MU-2B-10	7	12	0	19			5	3	26.3	15.8	2.10	3.30
MU-2B-20	48	41	11	100			32	10	32.0	10.0	2.55	2.09
MU-2B-25	37	26	8	71			14	7	19.7	9.9	1.57	2.06
MU-2B-26/26A	46	8	7	61			16	5	26.2	8.2	2.09	1.71
MU-2B-40	41	9	5	55			17	5	30.9	9.1	2.47	1.90
Sub-Total	194	115	32	341			100	34	29.3	10.0	2.34	2.08
Mitsubishi Long Models												
MU-2B-30	13	24	1	38			13	7	34.2	18.4	2.73	3.85
MU-2B-35	50	41	10	101			33	12	32.7	11.9	2.61	2.48
MU-2B-36/36A	44	11	9	64			10	7	15.6	10.9	1.25	2.27
MU-2B-60	96	22	13	131			33	21	25.2	16.0	2.01	3.35
Sub-Total	203	98	33	334			88	46	26.3	13.8	2.10	2.88
Total, Mitsubishi	**397**	**213**	**65**	**675**	**1975**	**1974**	**189**	**81**	**28.0**	**12.0**	**2.24**	**2.50**
OTHER AIRCRAFT											0.00	0.00
Cessna-425	182	16	22	220	N/A	N/A	23	9	10.5	4.1	0.83	0.86
Cessna-441	232	25	50	307	N/A	N/A	32	16	10.4	5.2	0.83	1.09
Sub-Total, Cessna	414	41	72	527	1980	1981	55	25	10.4	4.7	0.83	0.99
King Air 90 (All)	1203	178	410	1791	1979	1978	200	67	11.2	3.7	0.89	0.78
King Air 100	190	26	84	300	1976	1976	40	15	13.3	5.0	1.06	1.05
Sub-Total King Air 90/100	1393	204	494	2091	1978	1978	240	82	11.5	3.9	0.92	0.82
Aero Commander 690-695	433	59	119	611	1976	1976	86	39	14.1	6.4	1.12	1.33
Commander 680/81 (T/V/W)	89	57	8	154	1968	1967	45	14	29.2	9.1	2.33	1.90
Sub-Total, Commander	522	116	127	765	1973	1974	131	53	17.1	6.9	1.37	1.45
Piper PA-31	474	79	119	672	1978	1978	82	34	12.2	5.1	0.97	1.06
SUM OTHER AIRCRAFT	**2803**	**440**	**812**	**4055**	**1979**	**1978**	**508**	**194**	**12.5**	**4.8**	**1.00**	**1.00**

The comparison group used here is limited to twin turboprops with comparable capacity that were produced roughly in the same period as the MU-2B, including the Aero Commander 680 and 681 turboprops, the Cessna 425 and 441, the King Air 90 and the King Air 100. Note that the relatively tight range of fatal accident rates and the respective mean- and median-build-years in Table 3 of this appendix indicate that the comparison group is reasonably consistent internally. In the end, this should be a more legitimate comparison group.

Yet, despite all these caveats, ratios like 2.5 and 2.2 do not change the central conclusion reached in the 1996 SCR. When measured against comparable aircraft, the MU-2B has a high accident rate and a similarly high fatal accident rate.

C. Characterizing MU-2B Accidents

Table 1 of this appendix showed the overall accident rate for the short-body version of the MU-2B was slightly higher than the rate for the long-body versions, but the fatal accident rate was higher for the long-body versions. Table 2 of this appendix shows the number of accidents, by accident type, for short- and long-body MU-2Bs since 1968.

Table 2
MU-2B Accidents by Accident Type
1968 through September 2005

ACCIDENT TYPES	Accidents			Fatal Accidents		
	Short	Long	Total	Short	Long	Total
Controlled Flight into Terrain (CFIT) High	2	10	12	1	10	11
Emergency Maneuver	13	11	24	4	4	8
Gear-Up/Gear Collapse	25	3	28	0	0	0
Landing: Overrun-Excursion	11	6	17	0	0	0
Loss of Control (LoC) – Take-off -Climb out	6	9	15	5	8	13
LoC In Flight & Low-Level Maneuvering	12	11	23	12	9	21
LoC – Take-off Roll & Rejected Take-off (RTO)	5	3	8	0	0	0
Midair Collision	1	1	2	1	1	2
Ramp	1	6	7	1	3	4
Land Short – LoC on Approach	19	19	38	10	9	19
Hard Landing-Wing Strike on Landing	3	2	5	0	0	0
Ground Collision	1	3	4	0	0	0
Missing-Unknown	0	3	3	0	2	2
Other	1	2	3	0	1	1
TOTAL	100	89	189	34	47	81

Among several themes, Table 2 of this appendix indicates that different accident scenarios generally have different consequences. For example, the second most common accident scenario, gear-up landings and gear collapses on landing, accounted for 15 percent of the 189 MU-2B accidents but accounted for none of the 81 fatal accidents. Conversely, loss of control in flight accounted for 21 accidents (11.1 percent of all accidents), but 20 of them were fatal (25 percent of fatal accidents). Since different accident scenarios generally have different consequences, this report will focus on fatal accidents. Table 3 of this appendix compares basic accident scenarios for fatal accidents in the MU-2B and other selected twin-turboprops.

Table 3
Accidents by Accident Type, MU-2B Versus Other Twin-Turboprops
1966 Through September 2005

ACCIDENT TYPES	**MU-2B Fatal Accidents**			**Fatal Accidents, Other Twin Turboprops of Era**						
	Short	Long	Total	G-680	G-690	BE-90	BE-100	Conquest	PA-31T	Sub-Tot
Controlled Flight into Terrain (CFIT) High	1	10	11	3	1	7	1	3	4	19
Emergency Maneuver	4	4	8	1	0	2	0	0	3	6
Gear-Up/Gear Collapse	0	0	0	0	0	0	0	0	0	0
Landing: Overrun-Excursion	0	0	0	0	0	0	0	0	0	0
Loss of Control (LoC) – T/O -Climb out	5	8	13	0	3	11	2	0	6	22
LoC In Flight & Low-Level Maneuvering	12	9	21	1	19	19	0	7	6	52
LoC – T/O Roll & Rejected Take-off (RTO)	0	0	0	1	1	0	0	3	0	5
Midair Collision	1	1	2	0	3	1	0	1	2	7
Ramp	1	3	4	0	0	2	1	0	0	3
Land Short – LoC on Approach	10	9	19	8	10	24	10	10	12	74
Hard Landing-Wing Strike on Landing	0	0	0	0		0	0	0	0	0
Ground Collision	0	0	0	0	0	1	1	1	0	3
Missing-Unknown	0	2	2	0	0	0	0	0	0	0
Other	0	1	1	0	2	0	0	0	1	3
TOTAL	34	47	81	14	39	67	15	25	34	194

Given the difference in overall fleet numbers and the selected comparison aircraft from Table 1, Table 2, and Table 3 of this appendix, the following is indicated:

- Loss of control in flight or during low-level maneuvering[1] is about 2.5 times more common per aircraft in the MU-2B than in other comparison aircraft.
- Loss of control on initial climb out is about 3.5 times more common in the MU-2B than in the comparison aircraft.
- Loss of control during emergency maneuvering is 7 times more frequent per aircraft in the MU-2B than in the comparison aircraft.

[1] "Maneuvering" includes flights that operate outside of typical flight profiles, such as surveillance flights, certain segments of training flights, intentionally low-level cruise flight (as with a total of six drug-running flights in the comparison group), etc. The term does not include "maneuvering" on a normal approach sequence, nor does it include emergency "maneuvers" when a pilot tries to recover from a mechanical or other problem.

- Fatal CFIT accidents are 3.5 times more frequent in the MU-2B than in the comparison aircraft.
- Fatal accidents related to landing short or other approach-and-landing scenarios accidents are about 50 percent more common in the MU-2B than in the comparison aircraft.

All these high ratios may reflect the type of operations that MU-2Bs are commonly used today. For example, Table 4 of this appendix distributes fatal accidents according to common causes or factors and day or night flight. Table 4 also distributes fatal accidents according to purpose of flight, by period.

Table 4

Fatal Accidents by Common Factors - Day-Night and Purpose of Flight
1966 Through September 2005

MAJOR FACTORS	MU-2B Fatal Accidents			Fatal Accidents, Other Twin Turboprops of Era						
	Short	**Long**	**Total**	**G-680**	**G-690**	**BE-90**	**BE-100**	**Conquest**	**PA-31T**	**Sub-Tot**
Airport (Runway Condition, plowing, etc.)	0	0	0	0	1	0	0	1	0	2
Crew Incapacity	1	0	1	0	1	2	0	1	1	5
Crew Impaired	1	2	3	2	3		1	4	0	10
Fuel Exhaustion, Starvation, Management	1	1	2	5	4	7	0	0	0	16
System-Component, Power Plant	7	4	11	2	0	10	2	4	3	21
Component or Systems Failures	6	3	9	0	1	5	0	1	4	11
Icing Conditions	6	11	17	5	4	5	2	6	3	25
IFR Conditions	12	11	23	10	16	38	11	16	19	110
LIGHT CONDITIONS										
Day	22	25	47	6	28	43	7	8	21	113
Night	12	22	34	8	11	24	8	17	13	81
PURPOSE OF FLIGHT										
Corporate, 1965-1975	3	2	5	2	1	10	2	0	0	15
Corporate 1976-1985	6	7	13	1	4	8	1	2	1	17
Corporate Since 1985	0	2	2	0	0	1	0	0	0	1
Business, 1965-1975	4	0	4	1	0	0	0	0	0	1
Business, 1976-1985	3	1	4	1	4	1	0	3	3	12
Business Since 1985	1	2	3	0	3	2	3	6	6	20
Personal, 1965-1975	0	1	1	0	0	2	0	0	0	2
Personal, 1976-1985	4	4	8	3	2	5	0	0	4	14
Personal Since 1985	8	3	11	2	7	12	0	4	9	34
135 Ops (Rev & Non-Rev), 1965-75	1	1	2	2	0	0	0	0	0	2
135 Ops (Rev & Non-Rev), 1975-85	1	2	3	2	2	1	1	1	0	7
135 Ops (Rev & Non-Rev) since 1985	1	12	13	0	7	4	5	4	2	22

Table 1 of this appendix indicates the following, again recognizing the differences in fleet sizes:

- Fatal accidents resulting from power plant issues are more than 3 times more common in the MU-2B and fatal accidents resulting from other system or component failures are 5 times more common. These two ratios are likely due to the same usage differences as previously indicated. Analysis of underlying failure rates and causes (not just accident rates) may indicate design or maintenance also play a role.

- Icing-related fatal accidents are about 4 times more common in the MU-2B.

- Fatal accidents at night are about 50 percent more common in the MU-2B.

- All the twin-turboprops for the first 2 decades covered in the table were used commonly in corporate and business flight and sparingly in 14 CFR part 135 or personal operations. In the past 20 years the twin-turboprop fleet in general has virtually been abandoned by corporate operators, while the MU-2B, especially the long-body version has migrated more sharply to 14 CFR part 135 and personal-flight operations.

The more pronounced shift for the MU-2B to 14 CFR part 135 operations (mostly cargo today) and to personal flight exposes the MU-2B disproportionately to night flying (part 135) and to lower levels of pilot experience or proficiency in high-performance aircraft. The high rate of night flying, especially for the long-body MU-2B, which is the version largely used in 14 CFR part 135 operations, explains most of the difference in controlled flight into terrain (CFIT) accidents and some of the difference in various loss-of-control accidents. Night flying greatly increases the frequency of pilot disorientation in any aircraft.

D. Icing

The 1996 SCR concluded that the most frequent and fatal type of accident in the MU-2B involved uncontrolled descent from altitude during or after flight in reported or suspected icing conditions. Accident investigations cannot always definitively establish that icing caused an accident, but icing may have been a factor in as many as 22 accidents and 17 fatal accidents, two-thirds of which involved long-body versions of the MU-2B. The NTSB explicitly identified icing as a cause or factor in 14 fatal MU-2B accidents that resulted 46 fatalities and no survivors. Of the 14 aircraft, 13 were long-body versions of the MU-2B (through August 15, 2005).

The best explanation of this disparity in risk related to icing between the short- and long-body versions comes from the manufacturer. In February 1990, an internal Mitsubishi report, which was later used in litigation following a fatal accident in Putnam, Texas, found that on the long-body versions of the MU-2B, the larger water droplets of 40 to 50 micron (see 14 CFR part 25, appendix C) impinge on the wing, tailpipe, and vertical stabilator airfoils aft of the active portion of the de-icing boot. The result is icing that cannot be removed in flight. The 1996 SCR subsequently concluded that in certain “infrequently encountered environmental conditions with large droplets present, ice that cannot be cleared likely forms and initiates a sequence of events that leads to unrecoverable loss of control in one or more axes.” FAA added that the sequence of events might involve use of the autopilot.

E. Autopilot

On June 2, 1986, an MU-2B autopilot pushed the aircraft nose-down at 9,000 feet atmospheric sea level (ASL). The aircraft crashed at high speed in Bartlett, Texas, killing the lone pilot. In January 1987, the NTSB noted 10 fatal MU-2B accidents involving sudden loss of control in which aircraft were equipped with Bendix M-4C or M-4D autopilots. The NTSB recommended that FAA issue an Airworthiness Directive (AD) to require periodic inspection, servicing and testing of the M-4 Bendix autopilot and compliance with the manufacturer's recommended schedule for replacement of mechanical accessories, such as servo motors, electromagnetic clutches, and clutch brush assemblies. A subsequent review by FAA, with Mitsubishi, Bendix, and Beech Aircraft, found no specific problems with the M-4 that required an AD. However, the review documented that the MU-2B had at least seven autopilot configurations. Pilot proficiency on one system did not guarantee proficiency with systems in otherwise comparable aircraft. Mitsubishi agreed to issue a mandatory service bulletin to standardize autopilot configurations. Bendix also agreed to issue a service letter recommending periodic inspection of the autopilot. In February 1989, the NTSB found its recommendation to be "closed - - unacceptable action."

The NTSB also recommended that FAA require Mitsubishi to issue an advisory notice to all MU-2B owners and operators on the proper and safe operation of the autopilot systems. Mitsubishi did so in November 1986. In May 1987, the NTSB found the recommendation to be "closed - - acceptable action." Since these actions were taken, the autopilot has not been identified as a causal factor in any fatal accident.

F. Propeller Blades and Prop Hubs

Following the same accident at Bartlett, Texas, the NTSB noted that failure of propeller blades or hubs had caused nine accidents in the MU-2B. Consequently, the NTSB recommended revised maintenance and repair limits for propeller blades on the Hartzell HC-B4 hubs, and that FAA issue an AD to require inspection of certain hubs for fatigue. FAA later did so and Hartzell also issued a service bulletin with revised blade maintenance procedures and a life limit on the blades. Based on the service bulletin, FAA issued AD 95-01-02, which required new procedures and retirement at 10,000 hours for "N" configuration blades.

Finally, the NTSB recommended a greater minimum revolutions per minute (RPM) speed for the H4-B4 prop to increase the margin between the resonant frequency of the reaction-less mode and the ground idle speed. Mitsubishi, Beech Aircraft, and Hartzell agreed to increase the ground idle RPM speed from 72 percent to 76.5 percent, and the FAA mandated compliance with this revision in AD 94-11-04.

In 1995, the NTSB found all its recommendations to be "closed - - acceptable action." Since then, blade failures have resulted in six accidents in the MU-2B. ADs 2003-04-23 and 96-18-14 were issued to address these blade failures. Therefore, the issue has not been completely eliminated, but its frequency has been substantially reduced.

G. Special Certification Review (SCR)

On March 24, 1983, an MU-2B disappeared from radar at FL180 and crashed near Jefferson, Georgia, killing all four occupants. The NTSB recommended a SCR of the MU-2B engines, fuel systems, autopilot, flight control systems, and handling characteristics in instrument meteorological conditions (IMC), plus aircraft performance in icing conditions. FAA convened the SCR in cooperation with Mitsubishi and addressed two design characteristics: revision of the trim tab push rod clevis assembly and replacement of the pitot heater with a higher wattage unit. All other items were found to meet the provisions of the type certificate.

FAA used a short-body model aircraft for the flight tests in the SCR and concluded that the airplane complied with the certification requirements of Civil Air Regulation (CAR) 3, the rule to which the MU-2B was certified in 1965. FAA issued several AD's following the SCR and FAA made seven changes to 14 CFR part 23 and a corollary change to 14 CFR part 91. On June 13, 1985, the NTSB found the recommendation to be "closed - - acceptable action." Nevertheless, accidents involving uncontrolled descent continued to occur.

H. Highlights

- Many of the safety concerns with the MU-2B identified relatively early in its history have been resolved or at least alleviated. However, the MU-2B continues to have more accidents and fatal accidents than comparable twin-turboprops produced roughly during the same period as the MU-2B.

- All aircraft reviewed in this report were commonly used in corporate aviation when they first entered the fleet. Since then, each has migrated toward 14 CFR part 135 and personal-flight operations, but the relative migration has been sharper for the MU-2B. This partly explains the higher accident numbers in the MU-2B, as it is more exposed to night flight and to operation by pilots who may be relatively less proficient in high-performance aircraft. Additionally, airplanes used in these operations may be flying relatively higher hours than is typical for twin turboprops, providing another possible explanation for the disparity in accident rates per registered aircraft.

- The MU-2B has higher rates for several accident types that typically have severe outcomes, including loss of control on climb-out, loss of control in flight, and accidents related to power plants, other systems or components, and to icing.

- Power plant issues are more than 3 times more common as causes or factors in MU-2B accidents in the MU-2B and other system or component failures are 5 times more common as causes or factors in accidents.

- The bottom line is straightforward. The MU-2B has relatively high accident and fatal accident rates, based on the cumulative number of aircraft that have been in the U.S. fleet.

Appendix 4

Special Certification Reviews (SCR)

The Federal Aviation Administration (FAA) conducted a Special Certification Review (SCR) of the Mitsubishi MU-2B in 1983-1984, followed by a Fact Finding Focused Special Certification Review (FFFSCR) in 1996-1997. The reasons for conducting these two reviews, the scope of review in each case, and the teams' findings and recommendations are described in detail in references cited in paragraphs D(1) and D(2) of this appendix. In summary, the FAA concluded during the SCR that all models of the MU-2B complied with the certificating regulations on which the Type Certificates (TCs) were issued. The FAA concluded during the FFFSCR that the original icing certification of the MU-2B series airplanes was conducted properly. Although the MU-2B was found to comply with the regulations, the review teams did make several recommendations in both the SCR and FFFSCR final reports. Some of these recommendations were addressed during the SCR, and in those cases the SCR final report describes the actions taken. But other recommendations were in the process of being acted upon at the time the SCR report was published. Similarly, the FFFSCR report included recommendations but did not describe what actions had been taken or were in work at the time the report was published. Therefore, the Safety Evaluation conducted in 2005 included a review of the recommendations and resulting actions from the previously conducted SCR and FFFSCR. The intent of this appendix is to document in Sections A and B below the results of this review.

A. 1983-1984 SCR

A list of the MU-2B-specific actions that were pending at the completion of the SCR is provided in Table 1 of this appendix. Not all of the SCR recommendations are presented here – only those that had not been completely addressed at the time the SCR final report was published are shown. As part of the Safety Evaluation conducted in 2005, these pending actions were reviewed to determine if they had been completed. The results of that review are also provided in Table 1. Pending actions that were not MU-2B-specific, such as regulatory changes to 14 Code of Federal Regulations (CFR) part 23, are not included in Table 1. Note that the original recommendation numbering system contained in the SCR report has been retained in Table 1 where possible. Recommendations that were not numbered in the SCR report are denoted in Table 1 with a sequential number in parentheses.

Highlights

- The FAA concluded that all models of the MU-2B complied with the certificating regulations on which the TCs were issued.
- The FAA concluded that a minimum crew of one pilot was adequate to safely operate the airplane, and that a type rating specifically for the MU-2B was not required.
- A review of the SDRs led to the issuance of three ADs as a result of the 1983-1984 SCR.
- Although they have not appeared to contribute to fatal accidents in the MU-2B, the 1983-1984 SCR recommendations listed in Table 1 of this appendix, items (1) and S-4.1, should be further evaluated.

Appendix 4 (Continued)

Table 1

Status of MU-2B 1983-1984 SCR Recommendations

Recommendation		Status of Corrective Action When SCR Final Report Was Published	Notes from Review Conducted in 2005
No.	**Description**		
(1)	Several flight manual revisions and additions were recommended to enhance understanding and result in more consistent application of existing flight manual data. A detailed list of these recommendations is contained in Reference D(1) and will not be repeated here.	MHI planned to incorporate the recommended revisions and additions to the applicable manuals and expected to complete this task by the end of 1985.	All flight manual revisions recommended by the SCR report appear to have been incorporated, with the following possible two exceptions: (1) One of the recommendations was to, "Add take-off and weight limitation chart to AFMs if not available." The only weight limitation chart in the performance section of the manuals is in reference to maximum tire speed for a flaps 5 takeoff. Other performance charts concerning takeoff distance and single-engine climb performance are in terms of gross weight; however, it could not be determined if this recommendation was specifically complied with. (2) One of the recommendations was to, "Add procedures for use of the windshield deicer system for those airplanes using liquid (ethylene-glycol) as a means of deicing the pilot's windshield." It appears that liquid deice was available only on the earlier model airplanes. No specific procedures for liquid deice could be found other than the assumption liquid deice would be included where "anti-icing – as required" was identified in the normal and abnormal procedures.

Table 1 (Continued)

Status of MU-2B 1983-1984 SCR Recommendations

Recommendation		**Status of Corrective Action When SCR Final Report Was Published**	**Notes from Review Conducted in 2005**
No.	**Description**		
S-1.1	Regarding the elevator trim tab push rod clevis assembly, Amend ADs 77-04-07 and 77-13-19 for all MU-2Bs to require compliance with the [then] current optional provisions defined in Paragraph (d) of AD 77-04-07 so as to reduce the potential for human error when using the current repetitive inspection and lubrication procedures.	Southwest Region Aircraft Certification Office prepared an Airworthiness Directive (AD) for all FAR 21.21 aircraft and recommended that similar action be taken on FAR 21.29 aircraft. Central Region was considering these ADs and expected final mandatory action to be completed by December 3, 1984.	AD 84-25-02 addressed this recommendation and superseded ADs 77-04-07 and 77-13-19. The AD applies to both A2PC and A10SW airplanes, S/Ns 1-799 and 1501-1530, with or without the SA suffix.
S-3.2	On all Model MU-2B airplanes, review the heating function of the pitot probes and static ports and determine if the level of heat is adequate for the required ice protection function (see S-5 recommendations also).	Southwest Region Aircraft Certification Office conducted the review, prepared an NPRM requiring replacement of the pitot heater with a higher wattage unit, and recommended that similar action be taken on FAR 21.29 aircraft. Central Region was considering this AD and expected final mandatory action to be completed by December 3, 1984.	AD 86-20-01 addressed this recommendation for both A10SW and A2PC airplanes, S/Ns 1-753, with or without the SA suffix.

Appendix 4 (Continued)

Table 1 (Continued)

Status of MU-2B 1983-1984 SCR Recommendations

Recommendation		Status of Corrective Action When SCR Final Report Was Published	Notes from Review Conducted in 2005
No.	**Description**		
S-4.1	For all Model MU-2Bs, review the present landing gear position versus throttle position warning system design and determine if an additional throttle position is required in order to provide a more positive warning when the landing gear is not extended and throttles are not fully closed during landing operations.	Southwest Region Aircraft Certification Office conducted the review and found that the landing gear warning system complied with CAR 3.359. However, the FAA was aware that some pilots periodically make power-on-landings in the MU-2B. MHI planned to issue a service recommendation to introduce a modification that would activate the landing gear warning at some advanced throttle position.	Mitsubishi published a service bulletin after the SCR that repositioned the micro-switch on the throttle quadrant to allow the gear position warning to activate at a higher throttle position. However, issuance of this service bulletin doesn't appear to have completely addressed the problem. Conversation with MHIA indicates that there have been a number of inadvertent gear-up landings. The Aircraft Certification Office (ACO) in Fort Worth, Texas, will investigate this issue and determine if additional airworthiness action is necessary.
S-5.1	On all Model MU-2B airplanes, review the pitot pressure and static pressure system designs to determine if the designs are vulnerable to moisture accumulation and entrapment which may cause system pressure blockage, particularly when the moisture freezes. The review must include an evaluation to determine the criticality of the system during IFR flights in event of the loss of airspeed and/or altitude indication systems during critical portions of a flight.	Southwest Region Aircraft Certification Office conducted the review and found no design defects, non-compliance issues, or un-airworthy practices. However, MHI planned to revise the flight manual and maintenance manual to amplify the importance of draining.	All manuals have procedures for draining the pitot-static system, and the requirements for performing the service are identified in the normal procedures.

Appendix 4 (Continued)

Table 1 (Continued)

Status of MU-2B 1983-1984 SCR Recommendations

Recommendation		Status of Corrective Action When SCR Final Report Was Published	Notes from Review Conducted in 2005
No.	**Description**		
S-5.3	Revise flight manuals to call attention to pitot/static system draining requirements in the maintenance manual. Review the flight manual procedures to prescribe the use of pitot heat in flight when visible moisture is present.	Southwest Region Aircraft Certification Office found that flight and maintenance manuals were adequate. However, MHI planned to revise the flight manuals to call pilots' attention to the use of pitot heat during flight in visible moisture and to draining the pitot/static system after flying in rain and washing the aircraft.	Requirements and procedures for flight into known icing are extensively covered in the AFM.
S-8.1	Location of the oxygen shutoff valve control in the cockpit would enhance the probability of having oxygen when needed in an emergency.	Southwest Region Aircraft Certification Office found that the oxygen shutoff valve was in compliance with the applicable regulation. However, MHI planned to change the flight manuals in order to amplify to the pilot that the oxygen valve should be turned on during preflight.	Preflight procedures for arming the oxygen valve on the cylinder and cockpit check of the oxygen system is adequately covered in the AFM.
P-1	All flight manuals should be reviewed and revised as necessary to require the pilot to perform a pre-takeoff Negative Torque System (NTS) check prior to the first flight of each day.	Southwest Region Aircraft Certification Office responded that this item was covered in the flight manual change recommendations. MHI planned to incorporate revisions and additions to the flight manuals by the end of 1985.	The AFM includes requirements regarding the NTS check and the pilot action if the NTS or feather valve checks fail to operate normally. It should be noted that the AFM requires an NTS check for the first flight of the day and when an engine will be intentionally shutdown (other requirements for NTS check exist as well). However, it has been reported that most operators perform an NTS check during every engine start.

B. 1996-1997 FFFSCR

A list of MU-2B-specific recommendations for ADs is provided in Table 2 of this appendix. As part of the Safety Evaluation conducted in 2005, these recommendations were reviewed to determine what actions had been taken since the FFFSCR was completed. The results of that review are also provided in Table 2. Table 3 of this appendix provides similar information for the FFFSCR Team's non-AD recommendations. Note that the original recommendation numbering system contained in the FFFSCR report has been retained in Tables 2 and 3 of this appendix.

Highlights

- The FAA concluded that the original icing certification of the MU-2B series airplanes was conducted properly under the CAR by the JCAB. The TCs were properly issued, including approval for flight into known icing conditions.

- One of the recommendations made during the 1996-1997 FFFSCR was to require an ice detector be installed on all MU-2B airplanes. Although an ice-detector installation was approved, an AD was not issued to mandate its installation. The need for an AD should be reevaluated.

- One of the recommendations made during the 1996-1997 FFFSCR was to require incorporation of a limitation in the Airplane Flight Manual (AFM) that requires a propeller negative torque sensing (NTS) and feather valve check prior to the first flight of the day. Although the manuals were changed, an AD was not issued. The need for an AD should be reevaluated.

- A review of the 1996-1997 FFFSCR report led the FAA to specifically consider and/or evaluate the appropriateness of the AFM takeoff schedules, stall warning system, and stall characteristics during its flight test evaluation. These areas are discussed in the Familiarization Flight appendix (appendix 7) of this document.

Appendix 4 (Continued)

Table 2

Status of MU-2B 1996-1997 FFFSCR Airworthiness Directive Recommendations

Recommendation		Corrective Action Taken (as Determined in 2005)	Comments
No.	**Description**		
1	By means of an AD, require all MU-2B pilots (PIC) to attend an initial training course with a biennial requirement to include icing awareness, anti/de-icing system operation, icing severity cues, and icing environment exit criteria. This training should include, as a minimum, the items in the training syllabus in appendix 2.	AD 2003-22-07 R1 requires that pilots complete FAA-approved Mitsubishi Icing Awareness Training video YET-01295 before serving as pilot-in-command of an MU-2B in a flight into known or forecast icing conditions. This training must have been completed since the beginning of the 24^{th} calendar month before the scheduled flight.	The FFFSCR Team reviewed and approved this video produced by MHI. As noted in the AD, a revision has been made to the video to update information provided by the manufacturer.
2	By means of an AD, require a longitudinal trim in motion aural notification system (for nose up trim) be installed on all MU-2Bs, with an autopilot installed.	AD 2000-09-15R1, paragraph (d)(2), requires that a trim-in-motion alerting system be installed.	Alternate Methods of Compliance (AMOCs) have been issued for paragraph (d)(2) of the AD. In lieu of installing the equipment required by paragraph (d)(2) of the AD, the AMOCs prohibit the use of the autopilot in icing conditions.
3	By means of an AD, require an ice detector be installed on all MU-2B airplanes	The Rosemont Ice Detector System was developed by MHI and installation instructions approved by the FFFSCR team. However, an AD was never issued to mandate installation of an ice detector system.	

Appendix 4 (Continued)

Table 2 (Continued)

Status of MU-2B 1996-1997 FFFSCR Airworthiness Directive Recommendations

Recommendation		**Corrective Action Taken (as Determined in 2005)**	**Comments**
No.	**Description**		
4	By means of an AD, require installation of an autopilot disconnect system. The system will disconnect the autopilot, with suitable annunciation, at a suitable airspeed, during an uncommanded deceleration, with the aircraft in a clean configuration (the system will incorporate a cue to notify the pilot that the autopilot will disconnect in 2 ½ seconds prior to disconnect).	AD 2000-09-15R1, paragraph (d)(2), requires that an autopilot disconnect system be installed.	Alternate Methods of Compliance (AMOCs) have been issued for paragraph (d)(2) of the AD. In lieu of installing the equipment required by paragraph (d)(2) of the AD, the AMOCs prohibit the use of the autopilot in icing conditions.
5	The Team requested an AD be created to incorporate the recommended Garrett P2T2 sensor modification. The Los Angeles Aircraft Certification Office (LA ACO) subsequently drafted an AD, and the Engine and Propeller Directorate will issue a Notice of proposed rulemaking, which is in the final stages of coordination.	AD 97-15-10, paragraph (c), requires the replacement of orifice fittings and addressed this recommendation.	
6	Issue an AD to remove Circuit Breakers CB2107 and CB2108 for the essential systems that are protected by combination switch/circuit breakers.	This change in design was part of the action required by AD 2000-09-15R1 for the tail deice modification (see item 8 below) and addressed this recommendation.	

Appendix 4 (Continued)

Table 2 (Continued)

Status of MU-2B 1996-1997 FFFSCR Airworthiness Directive Recommendations

Recommendation		**Corrective Action Taken (as Determined in 2005)**	**Comments**
No.	**Description**		
7	An immediately adopted AD was issued (AD 96-25-02, dated 12/5/96) to require changes to the AFM to include: Limitations on minimum speed in icing conditions – 180 knots in level flight; prohibit use of flaps for sustained operations in icing conditions, except for approach and landing; provide cues to allow pilot recognition of SLD conditions; and provide icing environment exit criteria.	AD 96-25-02 addressed this recommendation.	
8	By means of an AD, modify the airframe de-ice system by installing a pressure switch in the tail de-ice boot pressure line, and revise the circuitry so the cockpit light will illuminate only when both pressure switches read the required pressure, and both pressure switches must have a minimum set point, such that illumination of the light annunciates to the pilot that both wing and tail systems are operating at a pressure that ensures all boots are at least 90 percent of full inflation.	AD 2000-09-15R1, paragraph (d)(1), requires the installation of a pneumatic deice monitoring system and addressed this recommendation.	Sales of deice monitoring systems tend to indicate the field is indeed complying with this portion of the AD. (As noted above, AMOCs have been issued for paragraph (d)(2) *only* of this AD.)
9	Require an AD to incorporate the Auto Re-light ignition system per the manufacturer's Service Bulletin, and require both engines to be modified with the Auto Re-light ignition system.	AD 2000-09-15R1, paragraph (d)(3), requires the installation of an auto-ignition system.	Sales of auto-ignition systems tend to indicate the field is indeed complying with this portion of the AD. (As noted above, AMOCs have been issued for paragraph (d)(2) *only* of this AD.)

Table 2 (Continued)

Status of MU-2B 1996-1997 FFFSCR Airworthiness Directive Recommendations

Recommendation		**Corrective Action Taken (as Determined in 2005)**	**Comments**
No.	**Description**		
10	The Team recommends that the manufacturer's Propeller Rigging Service Bulletin be incorporated into the appropriate manufacturer's Maintenance Manual sections. The Team recommends that an AD be issued to incorporate a limitation in the AFM that requires a propeller negative torque sensing (NTS) and feather valve check prior to the first flight of the day.	MHI released a service bulletin to require a propeller rigging check after maintenance and continues as a first flight of the day check. Feather valve and NTS are required checks per the AFM. Data is also presented in the Maintenance Manual. It appears that these manual changes requiring the feather valve check were published in the 1996 time frame. Awareness of this issue also became part of the MHI "P.R.O.P." training effort. An AD was never issued.	Evaluate whether it is necessary to mandate the current limitation in the AFM.

Table 3

Status of 1996-1997 FFFSCR Other Recommendations

Recommendation		**Corrective Action Taken (as determined in 2005)**	**Comments**
No.	**Description**		
1	Support continuing research, and encourage certification of sensors that can measure the extent, thickness, and roughness of ice accretions, notify the crew, and automatically operate anti-ice/de-ice systems.	The FAA has issued ADs on most existing airplanes equipped with deicing boots, including the MU-2, to activate the boots at the first sign of ice accretion. Current FAA guidance recommends that deicing boots be activated at the first sign of icing. Guidance on primary automatic ice detection systems has also been added to FAA guidance material, and primary ice detectors that automatically activate airframe and engine IPSs have been approved. Some ice detection systems that can measure the extent, thickness, and roughness of ice accretions, notify the crew, and automatically operate anti-ice/de-ice systems have been investigated by airframe manufacturers and found unreliable. The FAA is encouraging the development of Aerodynamic Performance Monitors.	
2	Recommend the FAA provide funds for NASA to conduct a near vertical spiral mode investigation to determine if the mode is probable following a departure in the MU-2B, and, if probable, determine the recovery procedure. If software is available for similar studies, in lieu of spin tunnel testing, recommend NASA procure and make available to the FAA and National Transportation Safety Board (NTSB) use of the software programs, and assist in analyses.	The research recommended by the FFFSCR Team was not conducted.	In 2005 following the safety evaluation, the FAA no longer believes this research is necessary.

Appendix 4 (Continued)

Table 3 (Continued)

Status of 1996-1997 FFFSCR Other Recommendations

Recommendation		**Corrective Action Taken (as determined in 2005)**	**Comments**
No.	**Description**		
3	Review FAA ice certification policies, with the intent to improve the process and information to industry, to determine and test the most critical ice shapes for relevant aerodynamic characteristics. This may require that more than one shape be considered.	Task 12A of the Federal Aviation Administration (FAA) Aircraft In-Flight Icing Plan states that the "FAA, along with industry and research organizations, shall form a working group to explore categories of ice accretions that represent potential safety problems on aircraft" with the goal of developing guidance material on the determination of critical ice accretion shapes and roughness in aircraft certification. The 12A Working Group was formed under the joint leadership of the FAA and the National Aeronautics and Space Administration (NASA) in November 1997. Their report, DOT/FAA/AR-00/37, was published in September 2000 and provided a method for determining critical ice accretions. One of their recommendations is that more empirical data, particularly 3D, needs to be obtained. The FAA has funded such testing and results are published in technical papers such as AIAA, as well as in draft Advisory Circular 20-73A. On November 4 2005 the FAA published a Notice of Proposed Rulemaking for part 25 performance and handling qualities in icing and a Notice of Availability for the related draft Advisory Circular. Ice accretions due to each phase of flight and accretions critical for performance versus handling qualities are addressed. This guidance had been added to the part 23 icing certification Advisory Circular, 23.1419-2C, in August 2005. The FAA has funded numerous wind tunnel studies on the effects of roughness, residual ice and inter-cycle ice accretions on airfoil aerodynamics.	

Table 3 (Continued)

Status of 1996-1997 FFFSCR Other Recommendations

Recommendation		**Corrective Action Taken (as determined in 2005)**	**Comments**
No.	**Description**		
4	Support further general research to characterize SLD icing clouds, and to sufficiently understand the physics of formation in SLD conditions to enable computer modeling that will accurately model ice formations, accounting for the variations due to environmental and configuration dependent variables.	On November 4 2005, the Transport Airplane Engine Issues Group forwarded to the FAA a report from the Ice Protection Harmonization Working Group (IPHWG) as an ARAC recommendation. The report addresses Task 2 of the IPHWG and it provides recommended regulatory and advisory material changes relating to SLD and ice crystal environments. It recommends an appendix X to CFR part 25 that defines a supercooled large drop (SLD) environment for design and testing. Appendix X was derived from a database containing in-situ measurements of supercooled large drop icing conditions by suitably instrumented research aircraft. Data from many research campaigns, in various geographic locations and over the past several years, were used. Many organizations, including NASA and Meteorological Services of Canada, participated.	
5	Support NASA and industry-wide studies and research to conduct icing wind tunnel testing of SLD ice formations to better understand quantitatively the aerodynamic characteristics due to sharp edged surface roughness elements (often termed ice feathers) and inter-cycle ice shapes. Further research needs to be conducted to ascertain the effects of SLD icing conditions on General Aviation airplane performance and flying qualities.	The FAA has funded wind tunnel testing of spanwise ridge ice formations, which could be formed in SLD conditions, and published the results in an FAA Technical Center report in 2000. Icing tunnel and wind tunnel test results of residual ice and inter-cycle ice were published in an FAA Technical Center report in 2002. This data is also included in draft Advisory Circular 20-73A. Runback ice research has also been conducted in collaboration with NASA and a major airframe manufacturer.	

Table 3 (Continued)

Status of 1996-1997 FFFSCR Other Recommendations

Recommendation		**Corrective Action Taken (as determined in 2005)**	**Comments**
No.	**Description**		
6	Support research efforts to improve computer ice shape prediction codes so they will accurately model ice shapes in temperatures near freezing that is in appendix C and SLD conditions.	Significant progress in SLD drop impingement and ice accretion code simulation has been made by release of LEWICE 3.1 and 3.2. The FAA has sponsored excellent Wichita State University (WSU) work in SLD impingement dynamics. However, temperatures near freezing are one area in which research needs to do more and the IPHWG SLD Engineering Tool Development Road Map will be updated to reflect that. An FAA icing tunnel test conducted in 2005 showed that runback ice can occur with a non-thermal ice protection system in appendix C conditions. These results will be published in an FAA Technical Center report in 2006.	
7	The FAA, NASA, and industry should support the development and use of accurate icing test facilities, including the new USAF icing tanker, to learn more about simulating SLD conditions, and the effects of SLD ice on small airplanes.	In the November 4 2005 letter discussed in recommendation 3, the IPHWG noted that the maturity level of analytical tools and test techniques to address the SLD environment are lacking, particularly compared with the analytical and test techniques available to address compliance demonstrations for the existing appendix C icing envelope. Accordingly, the IPHWG strongly recommended that the FAA and NASA continue to fund efforts for development and validation of icing simulation methods (analytical and testing). The IPHWG will be providing the FAA a recommended roadmap for this research effort by the end of 2005. However, much work has been accomplished and continues. The FAA has contributed funding toward development of the new USAF Icing Tanker spray rig. Significant progress has been made toward simulation of freezing drizzle in the NASA Icing Research Tunnel (IRT) by calibrating the tunnel at the larger drop size, modification of the spray rig to achieve a more uniform test cloud, and toward testing techniques to simulate the bimodal character of SLD icing conditions. Cranfield University is developing a Vertical Icing Wind Tunnel, which may be the only way to simulate freezing rain. NASA has developed high speed photograph techniques for SLD impingement investigations.	

Table 3 (Continued)

Status of 1996-1997 FFFSCR Other Recommendations

Recommendation		**Corrective Action Taken (as determined in 2005)**	**Comments**
No.	**Description**		
8	Recommend a service bulletin be issued by MHI to require the installation of a water trap/drain in the low spot in the tail de-ice manifold pressure line, and require the trap be drained at each 100 hour inspection.	This was accomplished as part of the tail deice monitoring system required by AD 2000-09-15R1 and addressed this recommendation.	
9	The Team recommends that additional government and industry research into severe SLD conditions be performed, to better understand its affect on engine and propeller anti/de-icing performance, and capabilities for turbo propeller airplanes with pneumatic boots.	Representatives of the Engine Harmonization Working Group and Powerplant Installation Harmonization Working Group PPIHWG assisted the IPHWG. They reviewed commercial service engine events related to SLD and mixed phase icing conditions and reviewed ice ingestion standards due to increased potential for ingestion in an SLD environment. Recommendations were made in the following areas - defined a mixed phase/glaciated environment, revised Part 25 engine installation requirements, and revised Part 33 engine certification requirements. Similar to the SLD Engineering Tool Development Road Map, an Engine Icing Technology Road Map has been developed. The FAA is funding and planning propeller icing tests at the McKinley climactic chamber. The first phase in the summer of 2006 will address appendix C icing conditions. When SLD simulation tools are developed, this testing will be repeated with simulated SLD conditions.	

Table 3 (Continued)

Status of 1996-1997 FFFSCR Other Recommendations

Recommendation		**Corrective Action Taken (as determined in 2005)**	**Comments**
No.	**Description**		
10	The Team recommends a service bulletin that requires a calibration check on the engine's torque sensing systems be developed. Also, inform pilots, through training, on the pitfalls of changes to the torque sensing calibrations and its affect [sic] on airplane handling characteristics.	Service Bulletin No. 095/77-002, "Inspection of Engine Torque Indication System", was issued in 1998 for MU-2B models on the A10SW type certificate. Service Bulletin No. 233A of the same title was issued in 1999 for MU-2B models on the A2PC type certificate.	The subject matter of these service bulletins is being risk-assessed using the Airworthiness Concern Sheet Process (ACS). This may result in the issuance of a proposed airworthiness action. The training recommended by this item may have become part of a training syllabus developed by MHI and presented to the MU-2B series fleet operators. Further review is needed to verify this information.
11	The Team recommends that service information be published and made available to the airplane operators about the revised maximum fuel control fuel flow settings.	The Fort Worth ACO indicated that Service Bulletin No. 099/77-001 was issued for A10SW airplanes.	It is recommended that the subject matter of this service bulletin be risk-assessed using the Airworthiness Concern Sheet Process (ACS) for both the A10SW and A2PC airplanes. This may result in the issuance of a Special Airworthiness Information Bulletin (SAIB) or other airworthiness action.

Table 3 (Continued)

Status of 1996-1997 FFFSCR Other Recommendations

Recommendation		Corrective Action Taken (as determined in 2005)	Comments
No.	**Description**		
12	Require the manufacturer to release a service bulletin to the maintenance community to inform them that changes to the fuel control can affect the airplane's low speed handling characteristics, which affects safety.	Service Bulletin No. 097/73-001, "Flight Check of the Flight Idle Fuel Flow Setting", was issued in 1998 for MU-2B models on the A10SW type certificate. Service Bulletin No. 234 of the same title was also issued in 1998 for MU-2B models on the A2PC type certificate.	The subject matter of these service bulletins is being risk-assessed using the airworthiness concern sheet Process (ACS). This may result in the issuance of a proposed airworthiness action.
13	The Team recommends that MHI provide AFM Power Assurance Charts on all models of the MU-2B airplanes that use the TPE331 series engines.	These charts were added to the AFM in the 1999 time frame.	
14	The Team recommends that MHI establish a new section in the MU-2B Maintenance Manuals. Include in this section, mandatory compliance for the service bulletins issued for acrylic windows, including acrylic window/windshield inspections, and anti/de-ice system inspection.	This information is included in FAA Approved Section 1A of the maintenance manual. AD 2003-17-04 requires the inspection and repair or replacement (if required) of cockpit windshields and cabin windows.	

D. References

(1) Mitsubishi MU-2B Special Certification Review, Final Report, September 4, 1984.

(2) Mitsubishi MU-2B Fact Finding Focused Special Certification Review, Final Report, June 27, 1997.

Appendix 5

Airworthiness Concern Sheet (ACS) Responses and Outside Contact

One of the focuses of this evaluation was to communicate with the industry and user groups. This communication was facilitated using the Small Airplane Directorate's Airworthiness Concern Process by issuing an airworthiness concern sheet (ACS) and making telephone calls to operators, Flight Standards District Office (FSDO), and training facilities, along with reading aviation press articles in trade magazines and on the Internet. The Small Airplane Directorate uses the ACS to solicit technical information on safety issues prior to taking action. Figure 1 of this appendix is a copy of the ACS.

A. Written Industry Responses to the Airworthiness Concern Sheet

From a two-week comment period, the Federal Aviation Administration (FAA) received over 150 written comments, which represents approximately 40 percent of the U.S. MU-2B owners and operators. Table 1 of this appendix documents the pilot experience of the responders to the ACS. Table 2 of this appendix presents a consolidated listing of the responses that we received. In that table, if the commenter did not provide all the information gathered in the spreadsheet, "unknown" was entered. Commenters consisted of MU-2B pilots, owners, 14 Code of Federal Regulations (CFR) part 91 and part 135 operators, and 14 CFR part 91 and part 135 maintenance personnel. The spreadsheet is intended to provide information as to the commenter's experience (flight hours and years of experience), their use of Mitsubishi Heavy Industries, Inc. (MHI) recommended training, their recommendation as to the value of the training, and general comments regarding their experience with the MU-2B. A summary of the spreadsheet is provided below:

(1) Generally, the pilots that responded have several hundred, even thousands of hours total flight time. Their flight time in the MU-2B ranged from a few hundred to tens of thousands of hours. See Table 1 of this appendix for approximate hours of responding pilots. Many are typed and currently fly turbojet aircraft. Some are military A-6, F-16 and KC-135 pilots. A small percentage of these pilots transitioned to the MU-2B from general aviation type airplanes, such as the C-421, B-200, BE-58, Piper Cheyenne, Merlin, and Metroliner aircraft. A few had previous Honeywell TPE331 experience. Fourteen of the commenters were from a 14 CFR part 135 operation. All the others were 14 CFR part 91 owners and pilots. While many of the owner pilots use the airplane for their business, they also use it for family transportation.

(2) Most of the commenters stated that they use professional pilot training services and mentioned the service they use. See Table 1 of this appendix for the spreadsheet that summarize these responses. Some responses went into great detail as to why and the value they place on certain training services. This information was too vast to collect into this spreadsheet. Some state they use in-house training and some simply did not comment on their use of training.

(3) Nearly all commenters mentioned the importance of professional pilot training for the MU-2B. Some stated the FAA should require a type rating. Others simply stated that the

MU-2B could be safely operated if the pilot will attend "initial" and "recurrent" training taught by a MHI, recognized training facility. Some state it is important to have hands-on training in the airplane and especially for emergency (inoperative engine) operation. Others believe that simulator only training is sufficient.

(4) Some commenters noted the importance of MHI recognized maintenance training.

(5) The comments on operational experience show that the airplane is used successfully in extreme weather conditions, including icing. They state the airplane is stable in instrument meteorological conditions (IMC) flight conditions and that they feel the airplane is safe and reliable. Many commented that they have never encountered loss of control with the MU-2B. Many state that the MU-2B must be flown with a high level of discipline toward correct airspeed and procedure in order to operate it safely. This is not to say the airplane is hard to fly, but has features that, when understood and flown accordingly, will result in safe and easily manageable flight operation. Many of the pilots spoke of how much they simply enjoy flying the MU-2B. Many commenters stated the MU-2B is like flying a Lear Jet with propellers. They recognize the flight characteristics associated with an airplane with high (60 pound per square foot) wing loading. Many of these comments were from pilots that fly both civilian and military jets. Many of the military pilots understood the use of spoilers for roll control and commented how well the MU-2B roll control system works. Some commented on experiences with engine failures. They stated that when the failure occurred, "training kicked-in" and the situation was easily handled as "a non-event".

(6) A common thread from all of the responses is that the MU-2B safely provides the performance and operational efficiency that it was intended to have and that initial and recurrent training from an MHI recognized training facility "is a must" for the continued safe and reliable operation of the MU-2B. None of the commenters believe that there is a safety concern with the design of the MU-2B that warrants "grounding" these airplanes.

Table 1

Approximate Hours of Pilot Experience That Responded to ACS

Time (Hours)*	Total all airplanes	Total MU-2B
Less than 500	0	22
501 to 1,000	2	13
1,001 to 5,000	14	35
5,001 to 15,000	38	17

***Note: Not all provided this information when responding to ACS**

B. Other industry communications including telephone calls as a result of the ACS
This is a summary of some of the communications:

- Operators tweak the torques of the engines beyond certified operational limits
- MU-2Bs are cheaper with each airworthiness directive (AD) and operators are waiting to buy more for their fleets
- Insurance companies require specific training and some operators are not insuring their airplanes
- Specific training is needed
- The importance of viewing the Icing video as part of the Alternative Methods of Compliance (AMOC) to AD 2000-09-15R1 is stressed
- The operational use of the MU-2B in 14 CFR part 135 “check-hauling” should be watched closer
- MHIA Pilot's Review of Proficiency (P.R.O.P.) is helpful and should be required

C. Highlights

- Approximately130 ACS responses either stated MHI recognized training is needed or was implied
- Some stated specialized MU-2B maintenance training also needed
- Several stated MHIA P.R.O.P. training should be required
- Many personal owners of MU-2Bs seek the proper training and have their airplane maintained at good service centers
- Some suggested FAA to look closer at the operational use of the MU-2B
- MU-2B low cost of maintenance and high reliability contributes to airplanes being used in air taxi operations
- Some owners do not insure the airplanes so training is not required
- No mention of loss of control issues, but some good examples of emergency situations that were easily handled because of training
- No mention of the MU-2B being dangerous. Even commented that FAA would hear it if there was an issue
- Many believe MHIA provides excellent support for an out of production airplane
- A majority of the commenters stated that the MU-2B is a design that safely and successfully provides the performance and operational efficiency that it was intended to have

The overwhelming comment is that the airplane design is not the problem, and that the pilots must be trained

Appendix 5 (Continued)

Figure 1

Airworthiness Concern Sheet

Date: 9/2/05

Full Name Doug Rudolph Title Aerospace Engineer Organization Small Airplane Directorate Department ACE-112 Address 901 Locust Street, Room 301. City State Zip Kansas City, MO 64106 Telephone Number 816-329-4059 Fax Number 816-329-4090 E-Mail doug.rudolph@faa.gov	**Make, Model, Series, Serial No.:** Mitsubishi Model MU-2B airplanes all serial numbers (s/n). **Reason for Airworthiness Concern:** Safety Evaluation Investigation into all areas of the airplane, including airplane design, operation, training, and maintenance.

FAA Description of Airworthiness Concern (Who, What, Where, When, How? Attachments: RA and appropriate data) *and* **Request for Information** (Proposed Alternate Inspection/Repair Procedures, **Cost Impact**, Etc. Note: Any comments or replies to the FAA need to be as specific as possible. Please provide specific examples to illustrate your comments/concerns.)**:**

The FAA is conducting a Safety Evaluation Investigation concerning the Mitsubishi Model MU-2B airplanes. A review of accident data indicates that loss of control of the airplane is a big contributor to accidents of the MU-2B U.S. fleet. More than half of these fatal accidents were attributed to loss of control in all phases of flight and ground operations.

The FAA requests that all owners, operators and maintenance personnel of the MU-2B airplane provide any comments concerning any loss of control incident(s) with the MU-2B. Provide details of these incident(s), including the situation details and the method of recovery from any loss of control situation(s). Provide any details where operation, training, maintenance, or manuals helped in these situations or if any changes to these would help in the future.

In addition to the above requested information, we are requesting that you provide any other pertinent information for this investigation regarding any observed issues or peculiarities that would contribute to MU-2B accidents.

The FAA requests that you send comments to the Small Airplane Directorate office by September 12, 2005. Please submit comments to Doug Rudolph at the above address.

Thank you for your input.

Appendix 5 (Continued)

Figure 1 (Continued)

Request for Information (Proposed Alternate Inspection/Repair Procedures, **Cost Impact**, Etc. Note: Any comments or replies to the FAA need to be as specific as possible. Please provide specific examples to illustrate your comments/concerns.):
This Airworthiness Concern Sheet (ACS) is intended as a means for FAA Aviation Safety Engineers to coordinate airworthiness concerns with aircraft owner/operators through associations and type clubs. At this time, the FAA has not made a determination on what type of corrective action (if any) should be taken. The resolution of this airworthiness concern could involve an AD action or an SAIB, or the FAA could determine that no action is needed at this time. The FAA's final determination will depend in part on the information received in response to this ACS. The FAA endorses dissemination of this technical information to all manufacturers and requests association and type clubs comments. Response Date Requested: 10 days.
Attachments: *SDR(s) ☐ *A/IDS ☐ *SL(s) ☐ *SAIB ☐ *FAASR/NTSBSR ☐ *AD ☐ *AMOC ☐ *RA **Notification: FAA ☐ *AOPA ☐ *EAA ☐ Type Club ☐ *TC Holder ☐ Other:** **Response Requested 9/12/05: Emergency (10 days) Alert (30 days) ☐ Information (30 days) ☐** **(Word 97 Version: Manually Check Appropriate Boxes)**
*Service Difficulty Reports (SDRs); Accident/Incident Data System (A/IDS); Service Letter (SL); Special Airworthiness Information Bulletin(SAIB); Federal Aviation Administration (FAA)/National Transportation Safety Board (NTSB) Safety Recommendation (FAASR/NTSBSR); Airworthiness Directive (AD); Alternate Method of Compliance (AMOC); Risk Assessment (RA); Aircraft Owners & Pilots Association (AOPA); Experimental Aircraft Association (EAA); Type Certificate (TC)

Appendix 5 (Continued)

Table 2

Summary of ACS Responses

Response No.	Submitter	Yrs. of MU-2 Experience	Hrs. of MU-2 Experience	Commenter had MHI Recommended Training?	Commenter Recommend Pilot Training?	Commenter Recommend Maintenance Training?	Comments
1	Operator/pilot/MU-2 Instructor	34	17000	141 MU-2 school operator	Yes	Yes	Mandate initial & recurrent pilot & mechanic training, 31000 total pilot time, Lear and BAE3100/3200 rated.
2	Pilot/135/MU-2 instructor	20	10400	Operates MU-2 school	Yes	Yes	Mandate initial & recurrent pilot & mechanic training, trained over 110 MU-2 pilots.
3	Pilot/135 ops	Unknown	5000	Yes, Howell Enterprises	Yes	Unknown	Many years as check/freight hauler now Corporate flying MU-2. Airplane very predictable.
4	Operator/Pilot	Unknown	Unknown	Yes	Yes	Yes	Corporate MU-2 pilot. Lear rated. Airplane exceptionally safe if flown by trained pilot and maintained by trained mechanic. MU-2 has wing loading like a Lear and is safe when flown like a turbojet.
5	Pilot	44	14000	Yes	Yes	Yes	High recommend proper training.
6	Operator/Pilot/135	16	7081	Yes, Simcom	Yes	Unknown	Owner Charter Co. using MU-2, also flies Piper/Cessna twins. 2 engine fails, no problem to safe landing.
7	Owner/Pilot/91	Unknown	250	Yes, Howell Enterprises	Yes	Unknown	Corporate pilot, also flies Cheyennes, King Airs and Citations. Training most critical factor to safe MU-2 operation
8	Owner/Pilo/91	6	1500	Yes, Simcom and FSI	Yes	Yes	Very stable IFR airplane. Highly recommend MHI's PROP seminars

Appendix 5 (Continued)

Table 2 (Continued)

Summary of ACS Responses (Continued)

9	Chief Pilot/91, 4000 TT	2	930	Unknown	Yes	Unknown	FAA Grounding MU-2 unjust with no correlation to recent accidents
10	Pilot/91, Mil and Airline exp.	35	Unknown	Yes, Howell Enterprises	Yes	Unknown	Founder of AOPA. Total confidence in MU-2.
11	Pilot/91,	6	1200	Yes	Yes	Unknown	Airplane safe if flown by trained pilot, two engine failures, non-event because of training.
12	Pilot/91, 3800 TT	Unknown	850	Yes, Simcom and FSI	Yes	Unknown	Transitioned to MU-2 from Cessna 210,310 and 340.
13	Pilot/91, 6800 TT	Unknown	3300	Unknown	Yes	Yes	Operates 8 MU-2s, professional training should be required,
14	Pilot, 5200 TT	Unknown	750	Yes, Simcom and FSI	Yes	Yes	BE-58, 90 & 200, CE421, 500, Lear. Trial Attorney.
15	Pilot	26	Unknown	Yes, FSI	Yes	Yes	Production and Demo pilot for Mitsubishi. Flew MU-2 all over U.S., Mexico, and Canada.
16	Pilot, 4000 TT	10	1300	Yes, FSI	Yes	Yes	Flies MU-2 all over U.S., Northern Canada, and Costa Rica. Highly recommends training and MHI's PROP seminars.
17	Pilot, 2600 TT	1	250	Yes, Howell Enterprises	Yes	Yes	AeroStar 700 background. MU-2 very good airplane.
18	Both/135	15	12000	Yes	Yes	Yes	3 eng fails, system fails, training and adherence to procedures cannot be overstated.
19	Pilot	Unknown	Unknown	Unknown	Yes	Yes	Valid training and PROPs seminal should be required.
20	Pilot	6	500	Unknown	Yes	Unknown	Training is essential.

Appendix 5 (Continued)

Table 2 (Continued)

Summary of ACS Responses (Continued)

21	Operator/135	Unknown	1000	Yes, Howell Enterprises	Yes	Yes	Highly recommends training, and has very high confidence in the airplane.
22	Owner/Pilot, 3000 Mil F-16	Unknown	3000	Yes	Yes	Yes	Type Rating or specific training needed. The airplane is not unsafe.
23	Pilot, 10000 TT, Mil T-37/38, KC-135	28	3993	Unknown	Yes	Yes	MU-2 needs to be flown like a turbojet. Have complete confidence in airplane if properly flown.
24	Pilot	Unknown	Unknown	Yes, Simcom	Yes	Unknown	The MU-2 is a safe airplane, proper pilot training is essential.
34	Pilot	several	Unknown	Yes	Yes	Unknown	Com Pilot, CFII, CE-500 rated. Nothing wrong with airplane. Training, Training, Training!
35	Owner/Pilot	2	250	Yes, Simcom	Yes	Unknown	Lawyer, Com Pilot CFI, BE58 & C-90. MU-2 Excellent airplane, feel it meets FAA Certification standards.
36	Operator	17	10500	Unknown	Yes	Yes	Very reliable and straight forward airplane. Properly trained pilots and mechanics is key to safe operation.
37	Owner/Pilot	3.5	7000	Yes, Howell Enterprises	Yes	Yes	A fantastic aircraft. "drivers" will NOT do well in it. Properly trained pilot and mechanics is a must.
38	Owner/Pilot,10000 TT ATP, C-500	Unknown	1800	Yes, Howell Enterprises	Yes	Yes	Not a forgiving airplane and must have a well-trained pilot. Very safe when properly trained.
39	Owner/Pilot, ATP, CFII	1	Unknown	Yes, Howell Enterprises	Yes	Unknown	Pure joy to fly. Fantastic single engine performance. Initial and recurrent training a key ingredient.
40	Owner/Pilot	Unknown	Unknown	Unknown	Yes	Unknown	Good pilot training is essential

Appendix 5 (Continued)

Table 2 (Continued)

Summary of ACS Responses (Continued)

41	Owner/Pilot	4	Unknown	Yes	Yes	Yes	Recommend training. Airplane is perfectly safe, very predictable and reliable.
42	Owner/Pilot, 7900 TT.	Unknown	1300	Yes, FSI	Yes	Unknown	Considers himself an average pilot has no problem with the airplane. Solid stable airplane.
43	Owner/Pilot	10	1300	Yes, FSI, Simcom	Yes	Yes	Never a controllability problem. Airplane is high performance
44	Owner/Pilot, 4000 TT. ATP.	1	800	Yes, Howell Enterprises	Yes	Unknown	Accidents are caused by complacency and lack of currency and continued training.
45	Owner/Pilot, 8000 TT Ck Airman	Unknown	2000	Unknown	Yes	Unknown	Stall characteristics, general handling, engine out handling is good.
46	Pilot, Mil F-15	8	3500	Unknown	Yes	Yes	High performance twin that requires good maintenance and well-trained pilot.
47	Owner	4	Unknown	Unknown	Yes	Yes	MU-2 flight characteristics consistent & inherently stable thru felt envelop.
48	Pilot	Unknown	Unknown	Yes, Simcom	Yes	Yes	Flies like a Lear Jet with props. No controllability problems, very stable easy to fly. Pilot for Sheriff's Dept.
49	Operator/Pilot	9	1000	Yes, Simcom	Yes	Yes	European operator. No problems with airplane including engine out operation. Don't blame airplane for bad pilots.
50	Operator/Pilot, Lear 36	10	2000	Yes, FSI	Yes	Yes	Extensive explanation safe single engine ops and history of the MU-2
51	Owner/Operator	35	Unknown	Unknown	Yes	Yes	Accidents center around issues of training or lack thereof. Largest MU-2 Service Center.

Appendix 5 (Continued)

Table 2 (Continued)

Summary of ACS Responses (Continued)

52	Owner/Pilot	8	Unknown	Yes	Yes	Yes	Training is essential, great airplane unfairly blamed for poor piloting and maintenance.
53	Pilot/135 ops	3	Unknown	Yes, Simcom	Yes	Yes	Strong safe aircraft when properly maintained and flown.
54	Pilot, CFII, typed G2, G3	45	17000	Unknown	Yes	Yes	Great airplane. Accidents caused by poor pilot judgment. Flew MU-2 for Icing tests at Edwards AFB.
55	Pilot, 5000TT ATP	Unknown	225	Yes, FSI	Yes	Unknown	MU-2 handles like a Lear 24, performs as stated in the AFM. Good training cannot be over emphasized.
56	Owner/Pilot, BE-55, AeroStar, 5000 TT	Unknown	650	Yes, Howell Enterprises	Yes	Yes	Completely trust this aircraft. Very stable IFR, performs well in icing.
57	Owner/Pilot, 1700TT, Aerostar	4	300	Yes, Howell Enterprises	Yes	Yes	Airplane is excellent. Poorly trained pilots are the problem.
58	Owner/Pilot, 8000TT, BE-99, Saab 340	Unknown	200	Yes, Howell Enterprises	Yes	Unknown	MU-2 requires proper flight and emergency training. I carry my family in this aircraft. No unusual quirks/handling
59	Owner/Pilot, 30000 Part121	Unknown	350	Yes, Howell Enterprises	Yes	Yes	Airplane is fine, no unusual flight characteristics other than those an MU-2 pilot can train for.
60	Pilot, aircraft sales	25	1500	Unknown	Yes	Yes	High wing loading, fly by the numbers. Not a "seat of the pants" airplane. Lear Jet with propellers
61	Pilot/operator, BE-58, C402/404	8	Unknown	Yes, FSI, Simcom	Yes	Unknown	Emergencies are non-event (engine out) with proper training. Handles bad weather better than others due to high wing loading
62	Pilot	5	2000	Yes, Simcom	Yes	Yes	Airplane is NOT the problem. Airplane performs well in all weather, no loss of control problems.

Appendix 5 (Continued)

Table 2 (Continued)

Summary of ACS Responses (Continued)

63	Pilot/135 ops	20	Unknown	Yes	Yes	Yes	No problems with the airplane. Part 135 Pax service. 20,000 hrs. accident free operation.
64	Owner/Pilot	9	1000+	Unknown	Yes	Unknown	Pilot training required. Airplane is not the problem.
65	Owner/Pilot, Mil F-102, C-525SP	18	2000	Unknown	Yes	Yes	ABSOLUTELY NOTHING WRONG WITH THE MU-2. Require pilot training.
66	Pilot, 4000 TT, BE-90, 58,401,c421 Merlin	4	400+	Yes, Simcom	Yes	Unknown	Airplane fully controllable about all axes in all flight regimes including engine out. C421 requires more pilot attention.
67	Operator, Ret Navy pilot	5	500 per year	Unknown	Yes	Unknown	Experienced loss of engine. No problem . Proper training is vital.
68	Owner/Pilot	5	Unknown	Yes	Yes	Yes	No problems. Very good success, low maintenance and very dependable.
69	Owner/Pilot	4	Unknown	Yes	Yes	Unknown	Aircraft handles predictably during emergency maneuvers.
70	Owner/Pilot, 12000 TT, Mil, BE58, C421	10	Unknown	Yes	Yes	Yes	MU-2 is safe to operate. Formal pilot training is answer.
71	Owner/Pilot	Unknown	Unknown	Yes	Yes	Unknown	Safe and reliable if flown by a well trained pilot.
72	Owner/Pilot	4	250	Yes	Yes	Yes	Good airplane. Engine out less of an event than that of a B-58. Training provided is very good.
73	Pilot	Unknown	1000	Unknown	Yes	Unknown	Good airplane. Metro III more demanding.
74	Pilot	15	2200	Yes	Yes	Unknown	Require pilot training. Airplane is great, handles better, more stable than Cheyenne or King Air in adverse weather.

Appendix 5 (Continued)

Table 2 (Continued)

Summary of ACS Responses (Continued)

75	Owner/Pilot	15	1600	Yes	Yes	Unknown	Never found the airplane to be unsafe. Training seems most critical factor in MU-2 safety.
76	Owner/Pilot	5	800	Yes	Yes	Unknown	MU-2 is not the problem. Inexperienced and poorly trained pilots are.
77	Owner/Pilot	2	416	Yes, Howell Enterprises	Yes	Unknown	Airplane has no operational faults that could cause loss of control. Training is important.
78	Owner/Pilot, 3500 hr in Navy A-6	9	Unknown	Unknown	Yes	Unknown	Exhibits no unsafe or undesirable flight characteristics. Pilots need proper hands-on training.
79	Owner/Pilot	10	Unknown	Yes, Simcom	Yes	Unknown	No loss of control experiences. Requires proper training.
80	Pilot, 13000 TT, Falcon 10,Westwind	20	7000	Yes, Howell Enterprises	Yes	Unknown	No control problems with this aircraft. Must be flown properly and this takes good training.
81	Owner/Pilot	1	200	Yes	Yes	Unknown	See no control problems with the MU-2. Can be flown safely with reasonable discipline and training.
82	Owner/Pilot, BE-90, 200, 690A	3	Unknown	Yes	Yes	Yes	No more challenging than other turboprops. Safe when operated properly.
83	Owner/Pilot	12	Unknown	Yes	Yes	Unknown	High workload airplane. Requires good skills and training.
84	Owner/Pilot	9	1000	Yes, Simcom	Yes	Yes	Problems with the MU-2 are inexperienced pilots and poor maintenance. Training corrects this.
85	Owner/Pilot, 2500 TT, Aerostar	Unknown	30	Yes	Yes	Unknown	Casual pilot can get into trouble. Proper training will correct this.

Appendix 5 (Continued)

Table 2 (Continued)

Summary of ACS Responses (Continued)

86	Owner/Pilot	10	1500	Yes, Howell Enterprises	Yes	Unknown	Believes in the MU-2 for family use. FAA should require training.
87	Pilot, 6000TT, C-411, BE-58, Aerostar	11	1000	Yes, Howell Enterprises	Yes	Unknown	Training makes the difference between safe and unsafe.
88	Pilot, 20000TT,	Unknown	10000	Yes	Yes	Unknown	Believe factory approved training should be required.
89	Operator	Unknown	Unknown	Unknown	Yes	Unknown	Airplane exposed to worst weather because of Check Hauling Ops. Need a well-trained crew.
90	Owner/Pilot, 30000TT, C-421, B-55	Unknown	600	Yes	Yes	Unknown	Proper training should be mandatory for this HIGH performance aircraft. Airplane is not the problem.
91	Owner/Pilot, Lear	6	700	Yes, Howell Enterprises	Yes	Unknown	Flown all weather conditions and airplane is safe. Training should be required.
92	Pilot/135	30	2000	Yes	Yes	Unknown	Pilots have to be professionally trained.
93	Owner/Pilot	1	200	Yes, Simcom	Yes	Unknown	I find no problems flying the aircraft because I receive proper training.
94	Owner/Pilot, 2300TT	Unknown	1000	Yes, FSI, Simcom	Yes	Unknown	Training is necessary and highly recommends MHI's PROP seminars.
95	Dir of Maint/135	20	Unknown	Unknown	Yes	Yes	Have gained valuable experience thru the years & established proven maintenance procedures and training.
96	Operator	Unknown	Unknown	Unknown	Yes	Yes	Using properly trained pilots and mechanics have had many years of safe, reliable operation. Training
97	Owner/Pilot, 12000TT	6	1200	Yes	Yes	Unknown	US aerobatic team, MU-2 is for family use, Nothing wrong with MU-2.

Appendix 5 (Continued)

Table 2 (Continued)

Summary of ACS Responses (Continued)

98	Owner/Pilot	5	2000	Unknown	Unknown	Unknown	Problems are pilot error
99	Pilot, F-15, MD-80	Unknown	Unknown	Unknown	Unknown	Unknown	Florida Air Nat Guard pilot. MU-2 has no aerodynamic problems, must be flown properly.
100	Pilot	1	650	Unknown	Yes	Yes	Flown and maintained properly the MU-2 is as safe or safer than many other airplanes or similar type.
101	Pilot	4	600	Unknown	Unknown	Unknown	Have great confidence in the airplane and its stability when properly flown.
102	Dir of Maint/135	Unknown	Unknown	Yes	Yes	Yes	MU-2 astonishingly well-engineered. Highly regard factory training and seminars. MHI & Honeywell training is outstanding and successful.
103	Owner/Pilot	10	Unknown	Yes	Yes	Unknown	Very successful 10 years of operation. Reliable/stable airplane.
104	Owner/Pilot	2	450	Unknown	Unknown	Unknown	The plane has performed unbelievably.
105	Operator/91	12	1000	Unknown	Unknown	Unknown	Have found the MU-2 highly reliable, stable and safe to operate.
106	Owner/Pilot	14	Unknown	Yes	Yes	Yes	MU-2 is extremely reliable have had great success. Pilots attend recurrence training.
107	Pilot	20	8000	Unknown	Unknown	Unknown	No problems or loss of control, Airplane extremely safe, efficient and pleasure to fly.
108	Pilot, ATP, Turbojet rated	14	Unknown	Unknown	Unknown	Unknown	MU-2 is safe to fly. Pilot must pay attention to detail and fly the airplane. Flt characteristics are superb.

Appendix 5 (Continued)

Table 2 (Continued)

Summary of ACS Responses (Continued)

109	Pilot	7	1300	Yes, FSI	Yes	Unknown	Encountered no problems with the airplane. Untrained or minimally trained pilots crashed the airplane.
110	Pilot, 14000TT, Mil high perf.	15	9000	Unknown	Yes	Yes	Mu-2 better than other similar twins. Use recurrent training. Pilots need proper training.
111	Pilot/Chief Insp.	Unknown	Unknown	Unknown	Yes	Yes	45 years is aviation as pilot, mechanic. Great respect for MU-2. Pilots and mechanics must have proper training.
112	Chief pilot, 8500TT	15	4400	Unknown	Yes	Yes	Feels the airplane is solid and very capable. Pilots must understand the airplane.
113	Pilot, 5000TT	30	5000	Unknown	Unknown	Unknown	Nothing unsafe about the MU-2
114	Owner/Pilot, 13000 TT, Mil A-6	Unknown	Unknown	Unknown	Unknown	Unknown	Handling is excellent, fly the airplane properly.
115	Owner/Pilot, 1200 TT	Unknown	Unknown	Unknown	Yes	Unknown	Supports pilot training.
116	Pilot, 5900 TT,	23	3790	Yes, Simcom	Yes	Yes	Comments on value of formal training.
117	Owner/135,	15	20870 hrs of ops	Yes	Yes	Yes	15 years accident and incident free. Uses in-house training, but pilots also get annual professional training.
118	Operator/Pilot	33	Unknown	Yes, Simcom	Yes	Unknown	32000 hr pilot. Design features of the airplane are handled by training. Training should be required by FAA
119	Owner/Pilot, 5000TT, B35, B58	8	725	Yes, Howell Enterprises	Yes	Unknown	Transitioned from Beech Baron, Airplane has different characteristics that training addresses. Require specific t raining. Good airplane and must be flown properly.

Appendix 5 (Continued)

Table 2 (Continued)

Summary of ACS Responses (Continued)

120	Dir Ops/135	15	Unknown	Unknown	Yes	Unknown	Airplane is safe. Pilot must be trained, current and must know the limits and fly by them.
121	Owner/Pilot	Unknown	Unknown	Unknown	Unknown	Unknown	Airplane is not the problem. Need pilot training.
122	Pilot, 20000TT,	Unknown	2000	Yes, Howell Enterprises	Yes	Unknown	Never experienced problem with airplane. Safe as any other plane. Recommend training
123	Pilot, 3000TT, B-17, B-25, F4U, C400	20	1500	Yes, Howell Enterprises	Yes	Unknown	MU-2 has aspects that need to be understood and respected. Recommend training
124	Owner/Pilot	5	Unknown	Unknown	Yes	Unknown	Highly recommends MHI seminars and states emphasis should be on pilot training.
125	Owner/pilot	2	Unknown	Yes, Howell Enterprises	Yes	Yes	High confidence in airplane states MU-2 is like flying his L-39 jet. Believes training and recurrent is a must.
126	Owner/Pilot	8	Unknown	Yes, Howell Enterprises	Yes	Unknown	Transition from Twin Bonanza, believe the airplane to be good. Must receive proper training.
127	Pilot	Unknown	Unknown	Yes	Yes	Yes	Mitsubishi Co. employee, 40 yrs, many hours. Does not fly EXACTLY like Cessna or Beech. Flies better. Has characteristics that must be learned. Good predictable airplane.

Appendix 5 (Continued)

Table 2 (Continued)

Summary of ACS Responses (Continued)

128	Pilot, ATP 8500TT	1	Unknown	Yes, Simcom	Yes	Yes	MU-2 has low cost of operation making it attractive to low cost operators. Airplane requires strict training for pilots, mechanics, and implementation of all technical bulletins.
129	Pilot, Air carrier CK airman	1	Unknown	Unknown	Yes	Yes	Airplane requires "differences" training from other similar airplanes. No problems encountered. 7500 hr. Lear pilot.
130	Operator, 8500 TT, 5000 TT TPE331	25	Unknown	In-house	Yes	Yes	Operates 8 MU-2s, 42000 hrs accident free. Professional training should be required
131	Pilot	Unknown	1000	Yes	Yes	Unknown	Part 91, second MU-2, high confidence, flies family in airplane. Fly MU-2 like light twin and you will be in trouble.
132	Pilot, A-90, B-200	Unknown	Unknown	Unknown	Yes	Yes	Great airplane. Requires a level of training above that of the average small airplane.
133	Pilot	9	Unknown	Yes, Howell Enterprises	Yes	Unknown	Absolutely no control problems with the MU-2. Operate 2 MU-2s. Proper training required due to high performance.
134	Pilot	1	120	Yes, Simcom	Yes	Unknown	FAA should focus on training and not the airplane.
135	Pilot, 17000TT, BE-400	Unknown	Unknown	Yes	Yes	Yes	Mitsubishi Demo pilot for many years. Strongly believes in PROP seminars and type training should be required.
136	Pilot, 15000TT, Lear, CL-600, DA10	Unknown	Unknown	Yes	Yes	Yes	5000 hr with TPE331 eng. MU-2 good with no loss of control issues. MU-2 is Jet with props. Must have proper training.

Table 2 (Continued)

Summary of ACS Responses (Continued)

137	Owner/pilot	Unknown	500	Yes, Howell Enterprises	Yes	Unknown	Examples of adverse conditions where pilot followed training and had no problems. Recommends hands-on training
138	Pilot/135	6	4000	Unknown	Yes	Yes	Proper initial training and continued refresher courses are imperative.
139	Owner/operator	20	2500	Unknown	Yes	Yes	Boeing rated. Flies family. Had one engine fail. Non-event. Insure pilot/mechanics have proper training.
140	Owner/Pilot	9	1000	Unknown	Yes	Yes	Safe operating airplane. Pilot must be well trained.
141	Owner/Pilot	several	Unknown	Yes	Yes	Unknown	Safe, very reliable, solidly built, does not fly like a Cessna, No loss of control issues. Take annual training.
142	Pilot	17	6000	Unknown	Yes	Unknown	Any concealed or otherwise sinister trait or characteristics has failed to materialize. Not a Cessna - need training.
143	Owner/operator, 8000 TT	many	800	Yes	Yes	Unknown	No question MU-2 requires more pilot attention. Like a Lear Jet, needs discipline. Training is imperative.
144	Operator/Pilot, 20000TT	10	7000	Yes, Howell Enterprises	Yes	Yes	Air Ambulance, 3 eng shutdowns, 1 fail, non-event because of training. No control issues. Truly a great airplane. Strongly feel that proper initial and recurrent pilot and maintenance training is key to MU-2B safe operation.
145	Pilot, 8000 TT, B-737	Unknown	2000	Yes	Yes	Unknown	MU-2 has characteristics that are easily manageable by receiving proper training.

Appendix 5 (Continued)

Table 2 (Continued)

Summary of ACS Responses (Continued)

146	Owner/Pilot, 7000TT	26	2100	Yes	Yes	Unknown	MU-2 for business/personal use. Very safe aircraft, nothing wrong. Get annual training.
147	Operator	35	Unknown	Yes	Yes	Unknown	FAA should check maintenance, pilot qualifications, pilot/mechanic training and medical on accident invest.
148	Owner/Pilot	Unknown	Unknown	Unknown	Yes	Unknown	Losses of control accident are cause by poorly trained pilots. Proper training plus proper mandatory recurrent required.
149	Owner/Pilot, 8000 TT	30	4000	Yes	Yes	Unknown	Never experienced loss of control with this airplane. Attends training. MU-2 is safe operated properly.
150	Pilot	Unknown	1400	Unknown	Yes	Unknown	No control problems, well-designed airplane, initial and recurrent training is necessary, maintain proficiency.
151	Operator	many	Unknown	Unknown	Yes	Yes	With proper training and maintenance this is one of the safest turboprops in the industry.
152	MU2 Owner & Pilot Assoc.	Unknown	Unknown	Unknown	Yes	Yes	
153	Pilot, 6000TT, C-560, CFII/MEI	1	200	Yes, McDonnell	Yes	Unknown	Extremely stable, consistent and trustworthy platform, robust icing capability, Must understand airplane.

Appendix 6

Familiarization Flight Report
Prepared September 2005

A. Summary

Two Federal Aviation Administration (FAA) test pilots each flew a familiarization flight, for approximately two hours, in an MU-2B-60 on September 7, 2005.Each pilot flew just over an hour. The purpose of the flight was to get a feel for the flight characteristics of the MU-2B and investigate some of the critical areas of operation within safety limits.

Prior to this flight we reviewed the 1984 Special Certification Review (SCR) and the 1997 Fact Finding Focused Special Certification Review (FFFSCR). The thoroughness of both reports allowed us to focus this effort on single engine climb and low speed handling characteristics. Both pilots found that the airplane can be safely operated and that it appeared to meet all of the certification requirements that were a concern. It was evident during the initial climb that, even though this airplane met all certification requirements, it has characteristics more like turbojets. Pilots operating the MU-2B need to have specialized training to respect these characteristics. Service history indicates that these turbojet characteristics are not unsafe if pilots have airplane specific training to recognize these characteristics.

Finally, flight-test personnel reviewed select documents from the original U.S. Type Certification validation program to ensure that the airplane underwent a full certification program. An FAA flight-test pilot was heavily involved in every flight aspect of the MU-2B certification program. The documents clearly show that the airplane was thoroughly evaluated and complied with the applicable flight requirements of Civil Aviation Regulation (CAR) 3, including the special conditions.

B. Discussion

The MU-2B is a high performance turboprop twin, certificated to CAR 3 plus special conditions applicable to all part 23 turboprops of that era. It is a very capable airplane in that it has Short Take-Off and Landing (STOL) capability when utilizing the full 40-degree full-span, slotted, fowler flaps. On the other end of the spectrum, the airplane is very fast and capable of cruise speeds in excess of 250 knots, which is faster than most comparable turboprops.

The MU-2B is capable of higher and lower speed operation than most comparable turboprop twins. The engineering tradeoff for this capability is an airplane that is less tolerant of pilot induced mistakes. The airplane must be flown using the procedures in the Airplane Flight Manual (AFM).

C. Familiarization Flight

The familiarization flight was conducted just under maximum gross weight and about mid to aft center of gravity (CG). Each test pilot flew just over an hour and logged a takeoff and landing.

During the flight, the airplane was flown at elevated g-levels, in steep turns, and slow flight. Stalls were done by both pilots in “clean” and “dirty” configurations and the airplane would have passed the current certification requirements. Stalls were conducted with near idle or zero thrust power settings.

Simulated single-engine failures were evaluated during takeoff and the aircraft demonstrated adequate climb capability and controllability provided the airplane was flown at the recommended pitch attitude (provided by the MHIA Pilot-in-Command) needed to capture the recommended speeds and configured for single-engine climb in accordance with the AFM. It should be noted that the certification basis of the airplane does not require single-engine takeoff climb performance.

Static (Vmc) was evaluated and AFM speeds were confirmed.

Both pilots noted that this is a higher performance airplane than most other part 23 airplanes in terms of high cruise speed and Short Take-Off and Landing (STOL) capability. Not unlike other turbo propeller airplanes, the single-engine climb performance in the takeoff climb segment is not guaranteed and the airplane's capability for continued flight may be limited by weight, atmospheric conditions, and the pilot's ability to respond accordingly to the condition. The airplane does have specific design characteristics, i.e., spoilers for roll control, trimmable full-span flaps, drag rise during gear retraction, that require special training as to the criticality of following approved procedures to operate the airplane safely.

Appendix 7

Meetings Held with MU-2B Community

During this safety evaluation, the FAA invited comments from several segments of the MU-2 community to better understand the perceptions relating to pilot training and operation of the airplane. We took part in several meetings with these groups with MU-2B owners, operators, training providers, various aviation industry groups, as well as Mitsubishi Heavy Industries of America (MHIA), and the Japan Civil Airworthiness Board (JCAB).

During these meetings, all participants agreed that something needed to be done to improve the safety record of the MU-2B. Everyone supported mandatory type specific recurrent standard training for pilots and maintenance personnel of MU-2B airplanes. Everyone also agreed the Airplane Flight Manuals (AFM) and the Pilot Operating Handbooks (POHs) needs reviewing and revising.

The FAA took informal notes at each of the meetings, which are summarized below. A note of particular importance is that these notes include comments made by individuals attending these meetings and may not be entirely consistent. Further, FAA gave more credence to comments that were consistently repeated by different participants at different meetings. If a single participant made a comment and others did not repeat the same comment, it was less likely to be followed up on than a consistent comment made by many. Therefore, these notes are simply a summary compilation of comments made by many individuals during several meetings and are not intended to provide FAA views on these issues.

A. Notes from the Meeting with MU-2B Training Providers held on October 3, 2005

(1) Meeting Notes:

One of the trainers will not provide training to 14 Code of Federal Regulations (CFR) part 135 operators - stating that part 135 operators do not give the aircraft the respect it deserves and are always rushed to complete training. This trainer also states that 14 CFR part 91 operators are willing to take the time for proper training. Two other trainers confirmed they do little training for 14 CFR part 135 operators. Most of their training is also for 14 CFR part 91 operators. One trainer provides training for a single 14 CFR part 129 Air Carrier.

One training provider identified engine knowledge as the weakest subject for most students. All agreed that you need experienced MU-2B pilots to be effective in teaching in the aircraft.

(2) Identifying Best Practices

(i) Pilot Operating Handbook (POH)/Airplane Flight Manual (AFM)

The trainers agreed that the AFM needs revision and "clean-up", ensuring consistency with any new training curriculum developed. Several specific items and procedures were identified as needing correcting. One participant commented that not all pilots have the latest AFM revisions.

(ii) Normal and Emergency Procedures
Trainers described their teaching techniques for normal, abnormal, and emergency procedures. There was no consensus among the trainers on the best techniques. Two of the trainers teach techniques that are substantially different to what is published in the POH/AFM. One teaches techniques that are similar to those published but not identical.

All participants felt the aircraft performed well on one engine when flown correctly. Everyone agreed that emergency techniques used for other light turbine aircraft were detrimental when applied to the MU-2B. All teach single-engine instrument flight rules (IFR)/visual flight rules (VFR) approaches. None of the participants will teach a single engine "go-around" in the actual aircraft for safety reasons. One teaches this technique in a flight training device (FTD) only. All agreed that it was dangerous to change flap setting while in a turn.

(iii) Checklists
All agreed there would be a benefit for a standardized laminated cockpit checklist. Since there isn't one, the users of the aircraft have created their own checklists.

(iv) Maintenance Training
Before instructing in an owner's aircraft, two of the trainers will do a maintenance "status sheet" to check fuel flows, temps, torque, etc. Many problems are identified during this inspection with incorrect rigging being the most common. There was agreement that flight idle fuel flow settings were chronically incorrect. Critical maintenance items identified were: torque sensors, fuel controller, gearbox drive assembly, propeller couplings, and prop balancing. All agreed that fuel flow flight idle settings and rigging, including proper blade angle settings, are critical to safe operation of the aircraft.

There were also complaints about the currency of the maintenance manuals. All agreed the MU-2B requires specialized maintenance training.

(3) Other Issues and Solutions

According to the trainers, most of the pilot workload issues are related to the need to constantly trim the aircraft. Also, there may be some confusion about the various airworthiness directives (AD) related to icing training, which may mean not all who need to comply are. Not all trainers believe the video mandated in one of the ADs is an effective training technique. The trainers explained that it is important to communicate to the pilots that the MU-2 flies differently than other light twins.

Insurance companies have become the safety regulators for the MU-2B. This is because they can require professional training for 14 CFR part 91 operators, though they have less control over 14 CFR part 135 operators. Many insurance companies will require:

- A minimum of 25 hours of MU-2B training (up to 100 hours).
- A sign-off from an MU-2B instructor showing the pilot has a satisfactory skill level.
- Satisfactory completion of an MU-2B training course.
- Annual recurrent training.

All agreed the aircraft requires type specific recurrent pilot and maintenance training.

B. Notes from the Meeting with 14 CFR part 129 and 135 Operators of the MU-2B held on October 13, 2005

(1) Meeting Notes:

This meeting included commercial operators with a wide range of experience as follows:

- Participating pilots had from 15 to 35 years experience in the MU-2B.
- Fleet size of the operators ranged from 1 to 14 aircraft.
- Annual hours flown by the operators ranged from 450 to 8,000 hours.

(2) Identifying Best Practices

(i) Canadian vs. U.S. Operations

Two 14 CFR part 129 Foreign Air Carriers participated in the meetings. Both were from Canada. A discussion was held about the differences in their operations compared to the differences from those in the United States. The Canadians have not seen the same increase in accidents as is occurring in the United States. One significant difference in operation is the Canadians exclusively operate the aircraft with a two-pilot crew. All Canadian crews receive type specific pilot training – which has already been standardized. Additionally, their crews only fly the MU-2B - they are not assigned to any other aircraft. The Canadians explained their standard operating procedures. As an additional note, all the Canadian aircraft are equipped with the ice detection equipment required by an airworthiness directive (AD) They said the equipment works well.

(ii) Pilot Operating Handbook (POH)/Airplane Flight Manual (AFM) requirements

Like the training providers all agree, the POH/AFM needs revising. The Canadian operators stated the AFM was reissued in 1987. At that time, they believe a lot of important information about the aircraft systems was removed and should be put back in.

(iii) Normal and Emergency Procedures

The Canadian operators did not completely agree on the best techniques. There was more agreement on how to respond to an engine failure. The group unanimously agreed that flaps 40° landings should be prohibited. The operators identified ways to increase stall margins and improve lower speed maneuverability.

(iv) Checklists

The participants agreed that the AFM is inadequate in addressing emergency checklists. For that reason, they have created their own (unapproved) checklists to fill this need. All agree that a standardized checklist should be incorporated.

(v) Service Bulletins (SBs), Airworthiness Directives (ADs), and Alternative Methods of Compliance (AMOC)

Some operators suggested that certain SBs should be mandated by AD. Further they believe that certain ADs requiring one-time inspections should be changed to repetitive inspections and that some regular inspections should be incorporated into the maintenance manual. The operators believe that the icing video required by AD needs wider distribution. The also states that the icing ADs and associated AMOCs are easily misinterpreted.

(vi) Maintenance Issues/Training

There was consensus that type specific maintenance training should be mandatory. It was stated that only about 30 percent of the part 135 operators use service centers. All part 135 maintenance providers need more and better MU-2B product support information than they currently have. MU-2B specific maintenance is critical to the safe operation of the MU-2B. The operators discussed the implications of doing certain maintenance incorrectly, as well as identifying critical items that warrant special attention. They also identified some design changes that could enhance safety.

(3) Potential Solutions to the MU-2B Accident Rate

These groups of operators agree that there is a need for mandatory type specific pilot and maintenance training. Aircraft systems' training also needs to be expanded. Flight training, with an increased emphasis on single-engine flight capabilities and emergency procedures, is key. Realistic training scenarios need to stress not only the correct procedures when flying a single-engine approach, but the entire process from the start of the emergency to its conclusion.

Another area that is critical to this group is the availability of a manufacturers approved checklist for both Normal and Emergency procedures.

Some participants in this meeting agree that consideration should be given to two-pilot crews or the addition of a working autopilot for single pilot operations in IFR conditions.

(4) Process for Delivering Best Practices to the Operators

All part 135 operators in attendance supported the concept of creating a Special Federal Aviation Regulation (SFAR) to mandate recurrent type specific pilot and maintenance training in attendance. They preferred an SFAR to a type rating.

C. Notes from meeting with 14 CFR part 91 Operators of the MU-2B and Special Interest Groups held on October 18, 2005

(1) Identifying Best Practices

(i) Pilot Operating Handbook (POH)/Airplane Flight Manual (AFM) Requirements
Part 91 operators consistently agreed with the operators in earlier meetings that the AFM and POH need revising and that certain information removed in an early revision should be reinserted.

(ii) Normal and Emergency Procedures
This group was not concerned with single engine operations. They felt that, if flown properly, the aircraft performed well with one engine. Many suggested delaying rotation to gain speed and they leave the flaps alone at low altitudes until about 120 knots. There was disagreement, however, about flap settings for normal take-offs and landings.

(iii) Checklists
Like part 129 and 135 operators, part 91 operators see a need for a manufacturer provided standardized checklist for the MU-2B.

(iv) Service Bulletins (SBs), Airworthiness Directives (ADs), and Alternative Methods of Compliances (AMOCs)
These operators also agree that the icing video AD associated AMOCs are confusing, especially the recurrent requirements. A suggestion was made to incorporate the icing AD and associated AMOCs into a standardized training program. Like operators in earlier meetings, some felt that certain SBs should made into ADs, that certain one-time inspections should be done repetitively, and require some high-failure items to be replaced.

(v) Maintenance Training

This group also agrees that specialized maintenance training should be made mandatory. This group discussed those maintenance items that are critical to the safe operation of the MU-2B. The group stated that part 91 owner/operators do not face the same maintenance issues as other operators because they primarily use Mitsubishi Heavy Industries (MHI) approved service centers for aircraft maintenance. However, they do believe that part 135 operators need good in-house maintenance training programs and increased maintenance surveillance. To accomplish this, it was suggested for the FAA Principal Maintenance Inspectors to get specialized maintenance training.

(vi) Potential Solutions to the MU-2B Accident Rate
These operators believe the MU-2B is more difficult to fly than other aircraft in their class. They state the MU-2B demands constant attention. Pilots need to be disciplined, standardized, and attend recurrent flight training. The same goes for maintenance personnel. They also mentioned the possible negative transfer from other aircraft experience to this aircraft and that the MU-2B is not as forgiving.

The participants of this meeting identified that the training currently available is conflicting and needs to be standardized. They also state that the training program should apply to all users of the aircraft (part 91, part 129, and part 135 operators). They agree that most of the initial training and some of the recurrent training should be done in the aircraft. Part 91 operators believe that we need to look at the maintenance and pilot training instead of the aircraft. However, they did identify certain aspects of the airplane that, if changed, could enhance safety.

(vii) Process for Delivering Best Practices to the Operators

There were strong opinions voiced that opposes AD action on the pilot, i.e. using an AD to mandate training. Most of the participants support the use of an SFAR to mandate type specific recurrent pilot and maintenance instead of an AD.

D. Notes from the meeting with the Japan Civil Airworthiness Board (JCAB), Mitsubishi Heavy Industries of America (MHIA), Mitsubishi Heavy Industries, Inc. (MHI), and Turbine Aircraft Services (TAS) held on October 19-20, 2005

(1) Potential Solutions to the MU-2B Accident Rate

The JCAB and Mitsubishi believe the cause of increasing accidents is due to lack of training. Like the operators in other meeting, they agree that mandatory training with a demonstration of skills should be required

During the October 19-20, 2005 meeting, Mitsubishi Heavy Industries of America (MHIA) indicated that most of the accidents since 1994 in the MU-2B have been with pilots who had not attended or not completed a Mitsubishi Heavy Industries, Inc. (MHI) recognized pilot training program (2) Pilot and Maintenance Training

MHIA stated they support a Special Federal Aviation Regulation (SFAR) to require type specific pilot training. MHIA agreed to develop a standardized training program for FAA approval. MHIA needs more time to develop and finish the maintenance training.

(2) Check Lists

The lack of a checklist was discussed, including operator desire for a standardized manufacturer developed checklist. MHIA agreed to take this into consideration. (Following the meeting they agreed to provide such a checklist for FAA approval.)

(3) Service Bulletins (SBs), Airworthiness Directives (ADs), and Alternative Methods of Compliance (AMOCs)

MHIA expressed concern with FAA's icing AMOCs to the MU-2B ADs. They asked us to review the JCAB issued ADs (TCDs) to ensure we have addressed those issues. They also discussed certain changes that could enhance safety.

(4) Automation/ Design Changes

The FAA shared information gathered during previous meetings. Some of the issues already have available solutions. For example, there is already a Supplemental Type Certificate (STC) that provides automated aural call-outs.

(5) Flight Standardization Board (FSB)

The FAA discussed their desire to conduct an FSB on the airplane to evaluate training proposals and identify specific issues that warrant FAA attention. MHIA welcomed the FAA to fly their aircraft.

(6) Process for Delivering Changes to the Operators

After discussing ways to mandate training, this group also agreed that an SFAR might be the best course of action. MHIA stated that they strongly support an SFAR to mandate pilot training. Further, the icing video, which may not be viewed as required, could be incorporated into the training syllabus.

(7) Follow up actions:

(i) Mitsubishi committed to the following actions:

- Propose a standardized pilot training program by 11/30/05
- Research possibility of upgrading simulator to a higher standard (Currently level 5 will look to 6)
- Work with SIMCOM over the next 18 months to expand maintenance training program, and maintenance video program
- MHIA will visit 14 CFR part 135 operators to offer immediate assistance with any safety enhancements through:
  - ✓ Assistance with maintenance issues.
  - ✓ Assistance with maintenance training through MU-2 vendors, for systems training.
- Full cooperation on the FSB providing both a long and short body airplane as well as providing safety pilots.
- Distribution of service news, encouraging to a) Operate according to the latest AFM. b) Use genuine parts. c) Perform a careful review of their operating procedures and current aircraft status. d) Promote simulator training.
- Proceed with plans to present a Safety seminar at NBAA based on independent review of MU-2 accidents.
- Proceed with an STEC autopilot program.
- Consider other action items after FAA complete their review.
    - ✓ Present candidates:

    - Consider adding an airspeed and bank angle to the aural warning system STC for pilot workload improvement.
- MHIA will look into the landing gear & CB issue & identify which models this affects after they receive our report.

(ii) FAA committed to the following actions:

- Continue with open communication as the law allows.
- FAA to send letter to MHIA requesting support for the FSB.
- FAA to research using or approving SimCom’s level 5 Flight Training Device (FTD) to a level 6
- FAA to reevaluate the ADs and AMOCs on icing.

Appendix 8

Honeywell TPE331 Series Engine Service Difficulty Review

The Honeywell TPE331-25A engine was first certified on the MU-2B aircraft on February 25, 1965. Over the years, this engine and its derivatives were installed on approximately 1,614 MU-2B type aircraft. The TPE331 series engine has been installed in over forty-five different aircraft configurations to date. There are approximately 11,300 engines produced for this market.

The Federal Aviation Administration (FAA) has determined that the SDR reporting system is not as effective as intended. There is a lack of engine and aircraft data and it is possible that failures exist that are not being reported. With this understanding, the FAA met with various industry partners including operators, trainers and service center owners (jointly referred to as "the User") during several meetings to discuss perceived service difficulties, service bulletins (SBs), airworthiness directives (ADs), and alternative method of compliance (AMOCs). Below are some user comments focused on the MU-2B aircraft design equipped with the Honeywell TPE331 series engine. The FAA has investigated these comments with assistance from Honeywell.

(1) User comment regarding "journal bearings"

Comment: A Honeywell SB, which recommends changing the journal bearing in the high-speed pinion to a roller bearing, should be reviewed. This SB allows you to eliminate the oil line by replacing the journal bearing with a roller type bearing. The oil supply line is prone to cracking, and when severe enough, cuts off lubrication to the journal bearing. When this happens, the bearing will fail within five seconds. When the journal bearing fails, it decouples the propeller from the engine but the pilot has no indication of the failure on the gauges. Although a failure of some sort may be detected, the actual nature of the failure may not be determined.

FAA perspective: On November 30, 2005, the FAA reviewed the journal bearing and oil supply tube service issue with Honeywell. The data presented to the FAA showed one in-flight shutdown (IFSD) in the past ten-years attributed to the journal bearing oil supply tube. Possible indications may be low and fluctuating oil pressure, torque indication fluctuations, an uncommanded engine shutdown, and a likely asymmetric thrust condition for the aircraft. The journal bearings are in the high-speed pinion assembly, which comprises the first stage of reduction gearing to the propeller shaft. Loss of drive to the propeller would be evident during engine operation as a power loss with associated asymmetric thrust on a twin-engine airplane. The journal bearing failure mode has been identified, Honeywell has released design improvements by SB TPE331-72-0092, initial issue, dated December 9, 1974, and the FAA has mandated AD 76-16-01 to reduce the number of oil tube failures. Based on current data reviewed and the low fleet risk of IFSD for this cause, the FAA has determined that no TPE331 unsafe condition exists relative to the journal bearing.

(2) User comment regarding "propeller shaft couplings"

Comment: The propeller shaft couplings in the 1591 gearbox (slow turning engines) are prone to failure. There were 3 accidents, Napa CA, Woodlands TX, and Conroe TX, where propeller shaft coupling failures could be a contributing factor in the accident. There is a SB allowing conversion to a more reliable coupler. This SB should be reviewed.

FAA perspective: The FAA review found that the National Transportation Safety Board (NTSB) had determined that two accidents have involved propeller shaft coupling failures. One accident occurred in Rapid City, SD, in February 1990, and the other in Woodlands, TX, which originated in Conroe, TX, in May 2001. Additionally, Honeywell's data showed one MU-2B TPE331-10 basic IFSD in the past ten-years attributed to the propeller shaft coupling. The FAA determined that the propeller shaft coupling did not contribute to the NAPA TX accident.

The SB history for the propeller shaft coupling was reviewed. SB TPE331-72-0873, issued May 20, 1993, introduced a redesigned coupling, part numbers (P/Ns) 3107092-1 (reworked part) and 865888-10 (new part). Those propeller shaft couplings manufactured prior to the SB release may experience cracks at the corners of the lubrication slots that may result in coupling fractures, resulting in a sudden loss of drive to the propeller shaft and feathering of the propeller. Subsequent to a propeller shaft coupling failure, the engine is designed to run at speeds between the propeller governor set point and the overspeed governor set point (104-105%).

Propeller shaft coupling accident data that was received from the NTSB and pilot interviews were useful in assisting the FAA investigation. Coupling shaft reliability data and seven material analyses have been reviewed and a system safety assessment has been completed. Based on current data received and the FAA TPE331 engine system safety assessment, no unsafe condition exists relative to the propeller shaft coupling.

(3) User comment regarding "torque sensors"

Comment: Certain torque sensors seem to fail too frequently. These sensors include P/N 3101726-1 and -2 torque sensors and other older configurations. The original time between overhaul (TBO) of the TPE engine was 3,600 hours. The engine TBO was eventually increased to 5,400 hours. This increase didn't consider that these older torque sensors were not designed to be in service for 5,400 hours. Some users recommended that the more durable P/N 3101726-3 torque sensor replace the older configurations, P/Ns 3101726-1 and -2. Since the TBO has been extended to 5,400 hours, the compliance time in this SB should be reviewed.

FAA perspective: It has been FAA policy to review all SBs that authorize a TBO increase. Such a review will consider the engine's service history prior to SB release. Also, Honeywell authorized TBO extensions are generally predicated on incorporation of certain SBs, prior to the implementing the new TBO. For example, since 1997, Honeywell has recommended (by SB) the installation of P/N 3101716-3 torque sensor for the TPE331-5, -6, and -10 series engines in order to qualify for the 5000, 5400, 6000, and 7000 hour TBO and 7000 hour Continuous Airworthiness Maintenance (CAM) program.

During the FAA evaluation, it was determined that the hydraulic torque sensor gear assembly contains idler gears and bearings that drive the oil pump, gearbox oil scavenge pump, fuel pump, and fuel control. Idler bearing malfunction may result in an uncommanded engine shutdown due to possible loss of drive to the fuel pump. Honeywell SB TPE331-72-0555, first issued July 1, 1988, released hydraulic torque sensor gear assembly, P/N 3101726-3, which has more durable idler bearings.

The IFSD rate for all hydraulic torque sensor gear assemblies over a 30-year period is nearly the same for engines on MU-2 aircraft as for engines on all other aircraft types.
Based on current data reviewed for the various torque sensors still in service the FAAs system safety assessment indicates that no unsafe condition exists relative to the torque sensors, as the rate of failure and IFSD are very low.

(4) User comment regarding "fuel control bellows"

Comment: One user stated that a certain Honeywell service bulletin allows leakage of the fuel control bellows, which can lead to a possible unsafe condition of fire.

FAA perspective: After review of the existing reported problem, FAA and the engine OEM believe that there is insufficient data to identify any service difficulty. The FAA is not aware of any Honeywell SB that allows fuel leakage as reported. Clarification and specifics from the commenter would be needed to investigate further. It is possible that the user comment was addressing a pneumatic leakage of the compressor air pressure bellows. This problem results in higher than desired fuel flows, not a fuel leakage.

(5) User comment regarding "a proposed engine 100 hr oil analysis"

Comment: There needs to be a 100-hour gearbox oil sampling for gearbox service life. Currently, service life extension from 3,600 hours to 5,400 hours only requires a gearbox inspection at 3,600 hours. Inspections at 3,600 hours often reveal a lot of metal. This user suggested that more frequent, mandatory oil inspection as a possible solution.

FAA perspective: The Spectrographic Oil Analysis Program (SOAP) program offered by Honeywell is valuable engine maintenance tool and applies to more than the MU-2B. Operators are not required to use the program. The FAA has not established that there is existing data that shows a gearbox safety concern that would require short interval SOAP inspections. The FAA supports good maintenance practices for all operators, but only issues mandatory action when there is a known safety of flight concern.

(6) No User comment regarding "TPE331 Turbine wheel"

Even though no user comments were received for the TPE331 turbine wheel failures, FAA added the action item because failures of the TPE331 turbine wheels have resulted in uncontained failures. Therefore, the FAA is considering AD action that affects the TPE331 engine turbine wheels for special-use operators. This would propose a new method of counting cycles based on mission cycle surveys and analysis.

(7) User comment regarding "propeller governor high setting"

Comment: Propeller governor high setting is important in developing rated thrust at takeoff. Certain operators are seeing many propeller governors that are improperly set. This results in only getting 98% RPM instead of full power, which restricts blade angle. This may possibly be a maintenance and/or pilot issue.

FAA perspective: The maintenance manual provides the approved rigging of the engines. Some operators have set the engines and propellers at a non-approved setting. Proper rigging is critical to the engine, and requires a high level of expertise to do correctly. The mechanics that work on the engines of all aircraft should be very familiar with the rigging and installation requirements. The TPE331 engine maintenance manual specifies the propeller governor static takeoff setting (prop governor high setting) is 99.0% to 101.0% RPM. The stabilized in-flight engine RPM with the speed lever in the takeoff position is 100% to 101%; and the minimum in-flight cruise setting (prop governor low setting) is 96.0% RPM. The engine maintenance manual for some TPE331-6 engines additionally specifies the static minimum setting of the propeller governor (prop governor low setting) at 94% to 95% RPM. The FAA has not established that there is existing data that shows a prop governor safety concern. The FAA supports good maintenance practices for all operators, but only issues mandatory action when there is a known safety of flight concern.

(8) User comment regarding the spline drive between the Woodward fuel control unit (FCU)

Comment: The spline drive failure between the Woodward FCU and the fuel pump can cause the engine to go to overspeed unless the fuel control is modified. While a service bulletin already exists to modify the fuel control, the modification is not mandatory and some operators may not exercise the option to have the fuel control modified. Some special emphasis should be placed on getting this modification of the fuel control.

FAA perspective: If the spline drive fails and the engine goes to overspeed and produces relatively high thrust, the pilot could be confused because, in this case, the good engine would appear to be at a relatively lower power setting. The FAA concurs that this may present an unsafe condition and is considering AD action to mandate the use of a modified FCU on TPE331 engines based on the failure rate and consequences of failure.

Appendix 9

Draft Copy of the FSB Report

FLIGHT STANDARDIZATION BOARD

Mitsubishi Heavy Industries America, Inc.
MU-2 Flight Review

Type Certificate Data Sheet Numbers

A2PC
&
A10SW

Recommended by:________________________Date:
Johnathon A Vetter
FSB Chairman

Approved by:____________________________Date:
Walter J Hutchings
Manager, Kansas City Aircraft Evaluation Group
MKC-AEG

Coordinated by:__________________________Date:
Tom Toula
Manager, Air Transportation Division
AFS-200

REVISION RECORD

Revision	**Sections**	**Date**	**Chairman**
Original	All	12/16/2005	John Vetter

CONTENTS

1. PURPOSE AND APPLICABILITY

1.1 Purpose

The Mitsubishi Heavy Industries Model MU-2 Flight Standardization Board (FSB) convened to evaluate proposed training, checking, and currency requirements for pilots operating the MU-2 aircraft. This FSB was convened as part of a Safety Evaluation of the MU-2 aircraft undertaken in July 2005. The FSB evaluated operating characteristics and techniques to propose training, checking and currency requirements applicable to the MU-2 aircraft. The objectives of the FSB were to:

- Review aircraft procedures for consistency and effectiveness.
- Identify training, checking and currency requirements necessary to improve the safety of operating the MU-2 aircraft.
- Evaluate the complexity of the MU-2 to determine if a pilot, with or without training, can safely operate the aircraft in all certificated operating conditions.
- Identify if any unique requirements exist for MU-2 operation.
- Describe acceptable training program and training device characteristics.
- Establish checking and currency standards for MU-2 operation, if required.

1.2 Applicability

All models of the MU-2 were evaluated in conjunction with this report, including several modifications to the MU-2 that were available at the time.

In accordance with existing FARs, the provisions of this report apply to all operations of all models of the MU-2. This report is also applicable to all training and checking conducted in the aircraft, as well as the currency and experience provisions. This report is effective until amended, superceded or withdrawn by subsequent revision.

2. AIRCRAFT DETERMINATION (AMEL)

2.1 Background

In conducting its evaluation of the MU-2 the Board utilized the evaluation process outlined in Advisory Circular AC 120-53 and the Common Procedures Document for Conducting Operational Evaluation Boards (JAA, TCCA, FAA, 10 June 2004). The Board evaluated the MU-2 design and operating characteristics in the Areas of Operation required for a Commercial Pilot - Multiengine Instrument Rating by the Practical Test Standard (PTS). For the purpose of design and operating characteristics the MU-2 falls within the Small Multiengine Aircraft Group (AMEL), Turbo-Propeller.

The FSB requested and received a proposed MU-2 training program from Mitsubishi Heavy Industries America, Inc (MHIA). FSB members completed ground school inclusive of all models of the MU-2 aircraft. A Level 5 MU-2 Flight Training Device was utilized for procedural training and checklist review including a LOFT scenario with Normal, Abnormal and Emergency Procedures. Flight training was conducted in four different models of the MU-2 selected to be representative of the entire MU-2 fleet. The training was consistent with that proposed by Mitsubishi Heavy Industries America, Inc. (MHIA) and provided under the supervision of MHIA. The MHIA Training Program was modified throughout the FSB process so that at the conclusion of the FSB the MHIA Training Program complies with the FSB recommendations.

A modified T2 test was conducted for the Areas of Operation required by the Practical Test Standard for Commercial Pilot - Multiengine Instrument Rating. The T2 was modified to incorporate testing of both the aircraft and the Flight Training Devices available at the time of the FSB. T3 and T5 tests were conducted to validate proposed training, checking and currency. The testing also included workload analysis to determine if the MU-2 design is consistent with acceptable pilot workload for a single pilot with adequate training.

2.2 Determination of Type Rating

The FSB has identified Level E training, checking and currency for the MU-2 aircraft. Level E requirements are normally eligible for designation of a Type Rating. However, current regulatory requirements for a single pilot type rated aircraft are not adequate to address training, checking and currency necessary for safe operation. The FSB recommends implementation of a single standard for training, checking and currency for the MU-2. Regulatory changes to type rating requirements or special regulatory measures are needed. Timely implementation of a single standard of training, checking and currency to all MU-2 operations, including Part 91 operations, is necessary to achieve safety.

The Board determined the MU-2 met the Advisory Circular 120-53 criteria for Level E differences in the following Areas of Operation:

2.2.1 Takeoff and Landing

Takeoff and landing characteristics for the MU-2 are affected by the position of the landing gear relative to the aircraft's center of gravity. Standard crosswind techniques apply to the MU-2 but the flight characteristics differ in crosswind operations due to a combination of landing gear positioning, center of gravity and spoiler control. Proper techniques to control crosswind roll and weight shift on the landing gear are necessary to stabilize directional control. These takeoff and landing characteristics are most prominent in the short body MU-2 models. In a crosswind the direct nose wheel steering requires the rudder to be centered when the nose wheel touches down. Options for Flaps 5 and Flaps 20 takeoff configurations need to be trained and characteristics for each understood when selecting the appropriate configuration. The combination of all of these factors and the need to use care with propeller control to maintain stable directional control on landing is best trained in the aircraft. Level E training applies.

2.2.2 Performance, Steep Turns and Stalls

An accelerated stall maneuver is recommended as a special maneuver (Special Flight Characteristics) for the MU-2 aircraft. The design of the MU-2 wing utilizes a full-span flap that results in variable wing loading. With this characteristic, pilot awareness of configuration, speed, bank angle and stall margin is critical. At a safe altitude, the aircraft is configured clean and trimmed at 115 KIAS. The aircraft then begins entry toward a 60 degree bank turn. Stall warning (stick shaker) will normally be detected prior to 40 degrees of bank, depending on weight, and the aircraft is recovered to straight and level flight using bank, power and pitch. Level E differences apply to this maneuver.

2.2.3 Emergency Operations

All One Engine Inoperative Training Maneuvers must utilize the manufactures recommendation for zero thrust applicable to the MU-2 model being operated.

Engine Failure During Takeoff - Takeoff Continued.

The AFM procedure for engine failure on takeoff for the MU-2 requires pilot decision making during the event. This event requires pilot proficiency with the MU-2 aircraft and knowledge of the MU-2 aircraft operation. Consideration of landing gear position and transit, flap positions, available runway remaining, acceleration versus climb performance, rudder forces, use of trim aileron to eliminate roll spoiler drag and Beta Follow-Up are areas requiring training. The combined knowledge and skill needed to safely operate the MU-2 in this Area of Operation requires Level E training.

Engine Failure after Liftoff with Runway Remaining

The AFM checklist and procedure for engine failure on takeoff for the MU-2 requires pilot decision making during this event. In the event the aircraft is unable to climb with one engine inoperative and there is available runway, the maneuver for returning to the runway must be trained. The landing gear remains extended for this maneuver. Adequate runway must be available for safe completion of this maneuver. Level E training applies to this maneuver.

One Engine Inoperative Maneuvering / Loss of Directional Control

The Private and Commercial Practical Test Standard maneuver for Vmc demonstration is best accomplished using a One Engine Inoperative Maneuvering profile. The One Engine Inoperative - Loss of Directional Control maneuver is best trained and accomplished using early recognition and recovery techniques. Seat position and rudder travel should be emphasized during this maneuver. Rudder blocking by the instructor is encouraged to produce loss of directional control at Vmc plus 10 knots because early recognition and recovery is the primary objective for this maneuver. The FSB recommends the maneuver be accomplished at a safe altitude in a Flaps 20 takeoff configuration. Trim the aircraft to 120 knots in level flight with one engine set at zero thrust. Apply takeoff power to the other engine while increasing pitch to cause a deceleration rate of 1 knot per second. Recover to straight and level flight at first indication of the loss of directional control. Level E training applies to this maneuver.

Approach and Landing with One Engine Inoperative

Flight characteristics and performance of the MU-2 aircraft operating with one engine inoperative requires adherence to the AFM procedures for safe operation. Airspeed maintenance is paramount to the safe completion of the maneuver. With one engine inoperative the aircraft has slow acceleration from a deteriorated airspeed in landing configuration requires vigilant airspeed management throughout the maneuver. Aircraft configuration is selected to minimize drag prior to the point where landing is assured and final descent is initiated. Coordinated flight and roll trim management are essential to maximize one engine inoperative performance. Level E training applies to this maneuver.

<u>2.2.4 Multiengine Operations</u>
All One Engine Inoperative Training Maneuvers must utilize the manufacturer's recommendation for zero thrust applicable to the MU-2 model being operated.

Instrument Approach – One Engine Inoperative

Conduct of instrument approach procedures in the MU-2 aircraft with one engine inoperative requires pilot decision-making, approach planning and proficient adherence to AFM operating procedures. The preferred one engine inoperative instrument approach procedure is the Precision Approach. The Precision Instrument Approach provides the most stable approach procedure and least deviation from normal operating procedures for the safest operation. AFM compliance with Flaps 20 only when landing is assured is required to maximize available performance. Level E training applies to this Area of Operation.

<u>Non-Precision Approaches</u>
The Straight in Non-Precision Approach is acceptable when necessary with one engine inoperative. Selection of Flaps 5 at the FAF is recommended per the AFM and the decent is planned to preclude extensive maneuvering upon reaching MDA with consideration given to aircraft weight and density altitude to maintain MDA. One Engine Inoperative Circling Approach should be conducted only when absolutely necessary and must be trained if utilized. For all Non-Precision approaches, landing gear extension and Flaps 20 should be selected only when landing is assured and descent from MDA for landing is initiated. Adherence to configuration and speeds prescribed by the AFM is necessary for safe operation. Level E training applies to this Area of Operation.

<u>2.3 Conclusion</u>
The Board recommends the MU-2 aircraft be trained at Level E for Initial Qualification and Level C for Recurrent and Requalification Training.

3. MASTER REQUIREMENTS (Including MCR, MDR and ODR)

3.1 Master Common Requirements

- Landing Minima Category for the MU-2 is normally Category "C".
- Normal "Landing Flap Setting" is Flap 20 or Flap 40.
- Normal "Takeoff Flap Setting" is Flap 5 or Flap 20.
- "No Flap Landing". Training and checking for the MU-2 requires demonstration of "No Flap" landings. "No Flap" approach and landing procedures include Flaps 0 and Flaps 5.

3.2 Areas of Special Interest and Emphasis

The FSB has determined that certain aspects of pilot knowledge, skills and abilities must be emphasized and evaluated during the training and checking process for the MU-2.

- Accelerated stall awareness and training maneuvers with emphasis on configuration management. Awareness of the margin to stall in all flight operations and configurations should be emphasized throughout training.
- Vmc awareness and early recognition should be trained and checked. Minimum airspeeds for one engine inoperative must be emphasized in all configurations.
- Air speed management and recognition of airspeed deterioration below AFM recommended speeds and recovery methods must be emphasized throughout training and checking.
- Knowledge of icing conditions and encounters must be emphasized throughout training and checking including; equipment requirements, certification standards, minimum airspeeds, use of autopilot and other AFM procedures. This information should conform to the standard of training set out by the Icing Training Video established for AD compliance for the MU-2
- Knowledge of certification standards for aircraft performance, both All Engine and One Engine Inoperative operations, should be emphasized as essential for decision-making regarding aircraft operation.
-

3.3 Master Difference Requirements Tables

This Master Difference Requirements table indicates the required level of Training/Checking/Currency for MU-2 crewmembers.

Master Requirements for all models MU-2 Initial and Transition Training, Checking and Currency are E/E/E respectively.

Master Requirements for all models MU-2 Recurrent and Requalification Training, Checking and Currency are C/D/E respectively.

Appendix 9 (Continued)

Master Differences Requirements for within the MU-2 models are the following table.

TO FROM	B, D 2B 2B-10	F 2B-20 (short)	G 2B-30 (long)	K (short)	J (long)	M (short)	L (long)	P (short)	N (long)	Solitaire 2B-40 (short)	Marquise 2B-60 (long)
B, D 2B 2B-10	//	B/B/B	B/B/B	B/B/B	B/B/B	B/B/B	B/B/B	B/B/B	B/B/B	B/B/B	B/B/B
F 2B-20 (short)	B/B/B	//	B/B/B	B/B/B	B/B/B	B/B/B	B/B/B	B/B/B	B/B/B	B/B/B	B/B/B
G 2B-30 (long)	B/B/B	B/B/B	//	B/B/B	B/B/B	B/B/B	B/B/B	B/B/B	B/B/B	B/B/B	B/B/B
K 2B-25 (short)	B/B/B	B/B/B	B/B/B	//	B/B/B	A/A/A	B/B/B	B/B/B	B/B/B	B/B/B	B/B/B
J 2B-35 (long)	B/B/B	B/B/B	B/B/B	B/B/B	//	B/B/B	B/B/B	B/B/B	B/B/B	B/B/B	B/B/B
M 2B-26 (short)	B/B/B	B/B/B	B/B/B	A/A/A	B/B/B	//	B/B/B	B/B/B	B/B/B	B/B/B	B/B/B
L 2B-36 (long)	B/B/B	B/B/B	B/B/B	B/B/B	B/B/B	B/B/B	//	B/B/B	B/B/B	B/B/B	B/B/B
P 2B-26A (short)	B/B/B	B/B/B	B/B/B	B/B/B	B/B/B	B/B/B	B/B/B	//	B/B/B	B/B/B	B/B/B
N 2B-36A (long)	B/B/B	B/B/B	B/B/B	B/B/B	B/B/B	B/B/B	B/B/B	B/B/B	//	B/B/B	B/B/B
Solitaire 2B-40 (short)	B/B/B	B/B/B	B/B/B	B/B/B	B/B/B	B/B/B	B/B/B	B/B/B	B/B/B	//	B/B/B
Marquise 2B-60 (long)	B/B/B	B/B/B	B/B/B	B/B/B	B/B/B	B/B/B	B/B/B	B/B/B	B/B/B	B/B/B	//

Note: STC’s for EFIS Systems in the MU-2 require Level D Differences for training, checking and currency.

3.4 Operator Difference Requirement Tables

ODR tables are used to show operator compliance methods. Sample ODR tables are available for MU-2 Initial Requirements and for MU-2 Model differences. Any additional ODR requirements must be based on the above MDR Table. Coordination with the Kansas City Aircraft Evaluation Group should occur for any additional ODR Tables proposed by an operator.

4. FSB SPECIFICATIONS FOR TRAINING

The FSB recommends annual (12 month) training for the MU-2 aircraft. This annual training requirement must be met with an FSB compliant FAA Approved Training Program for all MU-2 operations. The FSB compliant FAA Approved Training program must comply with the recommendations of this report and include a completion standard evaluation.

4.1 Training Requirements

The MU-2 is a single pilot aircraft. No training credit is given for Second in Command Training (no credit for right seat in FTD). Upgrade Training is not applicable.

Initial / Transition Training: Applies to any pilot without documented MU-2 pilot operating experience within the last two years.

Requalification Training: Applies to any pilot with documented MU-2 pilot operating experience in the last two years but does not have documented training on an FSB compliant FAA Approved Training Program for the MU-2 to meet eligibility for Recurrent Training.

Recurrent Training: Applies to any pilot who completed and documented training on an FSB compliant FAA Approved Training Program for the MU-2 in the last 12 months and is MU-2 current in accordance with this report. Training completed the month before or after the month it is due is considered completed in the due month.

Differences Training: Applies to any pilot who operates more than one MU-2 model. Required Ground Training subjects are in accordance with differences between applicable models of the MU-2 to be operated.

4.1.1 Ground Training Program Hours

Initial / Transition: 20 hours
Requalification: 12 hours
Recurrent: 8 hours
Differences Training at Level B: 1.5 hours for 2 models, 3 hours for more than 2 models.

All FAA Approved Training Programs must include ground instruction in the following:

- All applicable aircraft systems modules by ATA subjects.
- Weight and Balance.
- Aircraft Performance.
- MU-2 Icing Training consistent with Icing Training Video for AD compliance.

- Controlled Flight Into Terrain (CFIT) training according to FAA guidelines.
- Cockpit Resource Management/Single Pilot Resource Management (CRM/SPRM).

<u>4.1.2 Flight Training Program Hours</u>
Initial / Transition: 16 hours with a minimum of 6 hours of Level E training.
Requalification: 8 hours.
Recurrent: 6 hours when no checking is required for Part 91,
4 hours when subsequent checking is required for Part 135.
All FAA Approved Training Programs must include Flight Training in the following:

- All maneuvers applicable for Commercial Multiengine Instrument PTS for instrument rated pilots. Maneuvers applicable for Commercial Multiengine PTS for non-instrument rated pilots.
- All specific maneuvers identified in Sections 2.2.1 through 2.2.4 of this report (Level E Training).
- All Training Maneuvers must be consistent with the most Current FAA Approved AFM procedures (latest revision) and AFM compliant checklists
- Training in the use of the autopilot, if installed
- Icing Awareness Training applicable to the MU-2
- CFIT procedures and CRM/SPRM procedures

5. FSB SPECIFICATIONS FOR CHECKING

14 CFR Part 91 operations of the MU-2 are not subject to checking requirements.

Checking for the MU-2 is in accordance with current regulations of 14 CFR 135.

The MU-2 is considered a separate type of aircraft as described in 14 CFR 135.293(b) for the purpose of recurrent testing. Twelve month testing currency applies to the MU-2 exclusively for compliance with FAR 135.293.

6. FSB SPECIFICATIONS FOR CURRENCY

Landing currency requirements of FAR 61.57 must be maintained in the MU-2 aircraft exclusively. Landings in other AMEL aircraft will not be credited for landing currency in the MU-2 aircraft. Landings in either short or long body MU-2 aircraft may be credited toward landing currency in both model groups.

Instrument experience to satisfy FAR 61.57 is not MU-2 exclusive provided the FSB compliant FAA Approved Training is completed satisfactorily to the Commercial Pilot - Multiengine Instrument PTS.

Satisfactory completion of a Flight Review to satisfy FAR 61.56 is valid for operation of an MU-2 only if that Flight Review is conducted in an MU-2. The Flight Review must include training in Areas of Operation identified in Sections 2.2.1 through 2.2.4 of this report and be given by an MU-2 qualified instructor meeting the minimum experience level established within this report for aircraft instruction.

7. AIRCRAFT REGULATORY COMPLIANCE CHECKLIST

A Compliance Checklist has not been included in this report due to the extensive operating experience of the Mitsubishi MU-2 fleet.

Proving tests to satisfy FAR 135.145 should be conducted in accordance with FAA Order 8400.10, Volume 3, Chapter 9.

8. FSB SPECIFICATIONS FOR SIMULATORS AND DEVICES

Requests for device approval should be made in accordance with FAA procedures.
Credit for flight training in an approved Flight Training Device (FTD) is allowed in accordance with the Commercial Pilot - Multiengine Practical Test Standards except where this report is more restrictive. An MU-2 aircraft may be used for all levels of training, checking and currency.

Level C Flight Training and Checking specified in this report must be conducted in an approved Level 5 FTD. In addition to Level 5 FTD basic requirements, the FTD must be representative of the MU-2 aircraft with MU-2 cockpit controls and a visual system as a minimum. Any higher approval FTD or Simulator may be used provided it has MU-2 cockpit controls and a visual system.

Level D Flight Training specified in this report must be conducted in an approved Level 6 FTD with a visual system as a minimum or an approved simulator.

Level D Checking specified in this report must be conducted in an approved Level 7 FTD with a visual system as a minimum or an approved simulator.

Level E Flight Training and Checking specified in this report may be conducted in an approved Level C or D Simulator, or in the actual aircraft.

There was no approved Level 6 or 7 FTD, or simulator in existence at the time of this FSB meeting. The FSB was able to evaluate an approved Level 5 FTD with MU-2 cockpit controls and a visual system for training in maneuvers and procedures for the MU-2. The training credit allowed for Level C training and checking in this report is based on the demonstrated ability of the particular Level 5 device to accomplish effective training and is the foundation for the specific additional requirements imposed in this report for Level 5 FTDs.

9. INSTUCTORS, CHECK AIRMEN AND EXAMINERS

Instruction given for the MU-2 must be consistent with manufacturers recommendations and comply with latest FAA Approved AFM procedures and AFM compliant checklist.

Flight Instructors must be qualified and current in the MU-2 aircraft consistent with this report. Flight Instructors for FTD and Simulator instruction must receive instructor training consistent with the Initial and Transition Training requirements of this report.

To provide instruction in the aircraft, Flight Instructors must have a minimum of 2000 hours total time, 1000 hours of multiengine time and 500 hours PIC in the MU-2. 100 hours of MU-2 PIC experience must be within the last 12 months.

For the purpose of checking, FAA Aviation Safety Inspectors, Designated Pilot Examiners, Training Center Evaluators and Check Airmen must have completed appropriate qualification in the MU-2 aircraft in accordance with this report. Examiners and Check Airmen must have 100 hours PIC in the MU-2 and maintain currency in accordance with this report.

10. MISCELLANEOUS RECOMMENDATION

The FSB recommends that all MU-2 operations be conducted with standard Normal, Abnormal and Emergency checklists in user-friendly format consistent with the latest FAA Approved Aircraft Flight Manual.

To support the Takeoff Procedures in the standard checklist procedures, the FSB recommends MHI publish climb/descent performance data for both Flaps 5 and Flaps 20 takeoffs with the landing gear retracted. This would provide essential information to assist the pilot in deciding whether or not to continue a takeoff after experiencing an engine failure after liftoff.

The FSB encourages all single pilot IFR operations be conducted with an autopilot. The Work Load Analysis conducted by the FSB during training and the LOFT scenario demonstrated that workload was significantly reduced during transition phases of flight through the effective use of an autopilot.

The FSB recommends for single pilot IFR operations using an autopilot, compliance with current Airworthiness Directives for installation of Trim in Motion Warning and Autopilot Disconnect systems. The Trim in Motion Warning and Autopilot Disconnect are useful warning indications and speed awareness tools for the pilot apart from icing conditions.

11. APPLICATION OF FSB REPORT

All MU-2 aircraft operations are subject to the provisions of this report. This report becomes effective when given final approval by the FAA.

All training and checking for the MU-2 aircraft must be conducted in accordance with an FAA Approved Training Program that complies with all provisions of this report for the MU-2 aircraft. All FAA Approved Training Programs must incorporate the latest FAA Approved AFM

Procedures, AFM compliant checklist and manufacturer's recommendations for training maneuvers.

12. ALTERNATE MEANS OF COMPLIANCE

Alternate means of compliance to requirements of this report must be approved by the FSB. If alternate compliance is sought, operators must show that the proposed alternate means provides an equivalent level of safety to the provisions of AC 120-53 and this FSB report. Analysis, demonstrations, proof of concept testing, differences documentation or other evidence may be required.

12.1 Equivalent Safety

Significant restrictions may apply in the event alternate compliance is sought, and the reporting requirements may be increased to ensure equivalent safety. FAA will generally not consider relief through alternate compliance unless sufficient lead-time has been planned by an operator to allow for any necessary testing and evaluation.

12.2 Interim Programs

In the event of clearly unforeseen circumstances in which it is not possible for an operator to comply with MDR provisions, the operator may seek an interim program approval rather than a permanent alternate compliance method. Financial arrangements, scheduling adjustments and other such reasons are not considered "unforeseen circumstances" for the purposes of this provision.

Appendix 10

MU-2 Flight Standardization Board (FSB) - Aircraft Certification Report

Flight Operations and Results

December 5th thru the 15th, 2005

Introduction

FAA Aircraft Certification Service flight test specialists supported Flight Standards Service (AFS) flight operations during an AFS Flight Standardization Board (FSB) for the Mitsubishi MU-2B. The objective of the FSB was to evaluate the MU-2B series airplanes for training, flight checking, and currency requirements using the proposed Mitsubishi Pilot training program. Additionally, an Engineering Research Psychologist from the Office of Aerospace Medicine (AAM) evaluated whether the proposed pilot training program would effectively reduce pilot workload and workload-induced stress. Because of the accident history of this airplane, Aircraft Certification Service (AIR) flight test specialists supported this effort. AIR was tasked to evaluate the proposed training and operating procedures to ensure they provide an adequate margin of safety within the approved aircraft envelope.

Discussion

The first four flights were familiarization flights, two for each test pilot. The familiarization flights looked at key maneuvers in the flight training curriculum. Flights in both the long and short body airplanes allowed a look at possible airframe/ configuration differences. This approach provided an advanced look at areas that might need closer investigation. Since the airplanes had to remain in normal category, we were only able to get close to max gross weight and a nominal cg. The short body gross weight is lower than the gross weight of the long body so it has a higher power-to-weight ratio. Maneuvers requiring power were done in the short body. Conversely, maneuvers done power-off and single-engine were done in the long body with the higher gross weight.

The flight test team, based on the familiarization flights, determined that they should look at five specific areas.

- ***Wings level stalls (power on/power off)* –** Stalls were investigated for stall handling characteristics and margin between stall warning (stick shaker) and aerodynamic stall. Tests and test conditions are presented in Table 2 of this appendix. The test objective was to determine that the test aircraft as presented to the FSB was representative of type design. Both the short and long models were investigated. In all cases, the airplane's stall characteristics represented type design data as indicated by adequate margin between stall warning and aerodynamic stalls and acceptable stall handling characteristics. Aerodynamic stalls with OEI were not evaluated. Current type certification standards do not require stall with OEI and the increased risk of conducting such stalls was outside the scope of this evaluation.

- ***Accelerated stalls (power on/power off)*** **–** The same test scope and objectives as for power-off stalls was used for accelerated stalls. At all test conditions, the accelerated stall characteristics represented type data in that adequate stall warning margin and acceptable stall handling characteristics was provided.
- ***Minimum Speed Evaluation*** **–** The test objective was to determine a safe speed to intentionally render an engine inoperative. Static and dynamic maneuvers were performed under various test conditions shown in Table 3 of this appendix. Based on handling characteristics, the highest minimum speed for all models series airplanes was 115 knots. This airspeed represents the minimum speed for handling characteristics only; it does not imply adequate single engine climb performance. Based on the manufacturer’s recommended safe speed of 125 knots, there is an acceptable safety margin between the recommended speed and the speed determined by flight test.
- ***Maneuvering margins*** **–** The test objective was to determine if adequate margin existed between normal maneuvering speeds at various aircraft configurations and stall warning or any other sign of impending stall. Normal maneuvering also included maneuvers with one-engine-inoperative (OEI). Test conditions and configurations are presented in Table 4 of this appendix. No indication of stall warning or other indications of impending stall were noted.
- ***OEI performance*** **–** OEI climb performance was checked for acceptability against the training procedure for OEI circling approach. The approaches were flown per the training with gear-up and also with gear-down. The gear-down approaches were flown specifically to look at single-engine performance and excess available thrust margins. Typically, the landing gear is extended at the final approach fix to get the airplane configured for the approach and landing. Configuring early in the approach allows the pilot to fly a stabilized approach all the way to short final. The procedure for the MU-2B specifically requires that the landing gear remain up until the landing is assured. The manufacturer has elected to use this procedure for training and operations to provide additional OEI thrust margins until landing is assured. It was determined during the evaluation that the manufacturer’s procedure provides the highest level of safety.

Conclusions

The MU-2B is a capable, high-performance airplane that demands that pilots have high-quality, airplane-specific training. This training is beyond what is typically required by non-type rated aircraft. When the airplane is flown per the MHI proposed training profiles, normal all-engine operations and OEI operation provides ample margins above stall warning during normal and accelerated maneuvers. Margins between stall warning and the aerodynamic stall for OEI operations were not evaluated.

With OEI, circling and missed approaches require an increased level of pilot skill. Pitch attitude and management of the airplane’s flight controls, plus gear and flap configuration are essential to obtaining appropriate airspeed and the resulting climb performance. Consideration should be given to adding an

Approved Flight Manual limitation, limiting the bank angle to 30 degrees for OEI operations. Consideration should also be given to restricting the airplane from performing OEI circling approaches and also for OEI missed approach procedures unless continuing the approach to landing could result in a greater hazard.

Consideration should be given to creating an AFM performance chart showing OEI takeoff climb performance at flaps 5 and gear down. This will allow the pilot to determine the OEI, flaps 5 takeoff climb performance capability prior to takeoff.

Table 1 - Flight Test Summary

Test	K	J	Solitaire	Marques
Airplane Details	-25 Short Body Ser# 260 N444FF -6 eng	-35 Long Ser# 645 N6469L -6 eng	-40 Short Ser# 411 N400PS -10 eng	-60 Long Ser# 794 N794MA -10 eng
Wings Level Stall				
Power Off	X			X
Power On	X	X		
Accelerated Stalls				
Power Off	X			X
Power On	X	X		
VSSE / Critical Engine	X			X
Maneuvering Margin	X			X
Climb Performance	X	X		

Appendix 10 (Continued)

Table 2: Test Conditions - Stalls

Test	Model[1]	Average Gross Weight (lbs)	Center of Gravity[2]	Trim Airspeed	Torque (%)	Angle of Bank (deg)	Flaps (deg)	Gear Position
Wings Level[3]								
Power On	-25	9420	Fwd	150	Zero thrust	0	Up	Up
				140	Zero thrust	0	5	Up
				130	Zero thrust	0	20	Down
				120	Zero thrust	0	40	Down
	-60	11,170	Fwd	150	Zero thrust	0	Up	Up
				140	Zero thrust	0	5	Up
				130	Zero thrust	0	20	Up
				120	Zero thrust	0	40	Up
Power Off	-25	9420	Fwd	150	50	0	Up	Up
				140	50	0	5	Up
				130	50	0	20	Down
				120	50	0	40	Down
	-60	11,170	Fwd	150	50	0	Up	Up
				140	50	0	5	Up
				130	50	0	20	Down
				120	50	0	40	Down

Appendix 10 (Continued)

Table 2: Test Conditions - Stalls (Continued)

Test	Model[1]	Average Gross Weight (lbs)	Center of Gravity[2]	Trim Airspeed	Torque (%)	Angle of Bank (deg)	Flaps (deg)	Gear Position
Accelerated[4]								
Power On	-25	9420	Fwd	150	Zero thrust	30L, 30R	Up	Up
				140	Zero thrust	30L, 30R	5	Up
				130	Zero thrust	30L, 30R	20	Down
				120	Zero thrust	30L, 30R	40	Down
	-60	11,170	Fwd	150	Zero thrust	30L, 30R	Up	Up
				140	Zero thrust	30L, 30R	5	Up
				130	Zero thrust	30L, 30R	20	Up
				120	Zero thrust	30L, 30R	40	Up
Power Off	-25	9420	Fwd	150	50	30L, 30R	Up	Up
				140	50	30L, 30R	5	Up
				130	50	30L, 30R	20	Down
				120	50	30L, 30R	40	Down
	-60	10,540	Fwd	150	50	30L, 30R	Up	Up
				140	50	30L, 30R	5	Up
				130	50	30L, 30R	20	Down
				120	50	30L, 30R	40	Down

Notes: 1 See Table 1 for type design
2 Relative to center of gravity limits for weight
3 Test conditions in accordance with 14 CFR Part 23.201
4 Test conditions in accordance with 14 CFR Part 23.203

Appendix 10 (Continued)

Table 3: Test Conditions – Minimum Speed Evaluation

Test	Model[1]	Flaps (deg)	Gear Position	Center of Gravity[2]	Average Gross Weight (lbs)	Left Engine	Right Engine	Minimum Airspeed (static)	Minimum Airspeed (dynamic)
Static/dynamic	-25	Up	Up	Fwd	11,030	Idle	MCP	95	107
		Up	Up	Fwd	11,030	MCP	Idle	97	107
		5	Up	Fwd	11,030	Idle	MCP	97	110
		5	Up	Fwd	11,030	MCP	Idle	100	110
		20	Up	Fwd	11,030	Idle	MCP	100	110
		20	Up	Fwd	11,030	MCP	Idle	97	110
		20	Down	Fwd	11,030	Idle	MCP	-	110
		20	Down	Fwd	11,030	MCP	Idle	-	110
		40	Down	Fwd	11,030	Idle	MCP	97	110
		40	Down	Fwd	11,030	MCP	Idle	100	110
	-60	Up	Up	Fwd	9210	MCP	Idle	105	115
		Up	Up	Fwd	9210	Idle	MCP	105	115
		5	Up	Fwd	9210	MCP	Idle	100	110
		5	Up	Fwd	9210	Idle	MCP	100	110
		20	Up	Fwd	9210	MCP	Idle	95	105
		20	Up	Fwd	9210	Idle	MCP	95	105
		20	Down	Fwd	9210	MCP	Idle	-	105
		40	Down	Fwd	9210	MCP	Idle	105	115

Notes: 1 See Table 1 for type design
2 Relative to center of gravity limits for weight
3 Maximum continuous power

Appendix 10 (Continued)

Table 4: Test Conditions – Maneuver Margins

Model	Airspeed (kias)	Flap (deg)	Left Engine	Right Engine	Bank Angle (deg)
-25 / -60 [1]	135	5	Zero thrust	MTP2	30L, 30R
	125	20	Zero thrust	MTP	30L, 30R
	140	5	MTP	MTP	40L, 40R
	130	20	MTP	MTP	40L, 40R
	150	0	Zero thrust	MTP	40L, 40R
	108	20	MTP	MTP	40L, 40R
	125	20 > 5	MTP	MTP	45L
	135	5 > 0	MTP	MTP	45L

Notes: 1 See Table 1 for type data
2 Maximum takeoff power

Appendix 11

Human Factors Report for the MU-2B FSB

This appendix is a summary of the findings of the human factors evaluations performed during the Flight Standards Board (FSB) for the MU-2B. This summary covers those activities that were directly requested by the board. Two general areas of evaluation were requested: (1) an evaluation of cockpit layout with regard to the activation and manipulation of specific controls and visibility of specific displays and (2) an evaluation of rated task loading throughout a proposed program of pilot training. The findings are derived from information obtained during on-site activities at SimCom in Orlando, Florida and at Turbine Aircraft Services, Inc., in Addison, Texas, during November and December of 2005.

Cockpit Layout

Cockpit layout was examined for placement of caution/warning indicators and system controls. These included: (1) beta lights, (2) fuel cut-off switches, (3) pressurization controls, and (4) oxygen system controls (for cockpit). An overview image of the instrument panel is shown in Figure 1 of this appendix with three of these four items labeled.

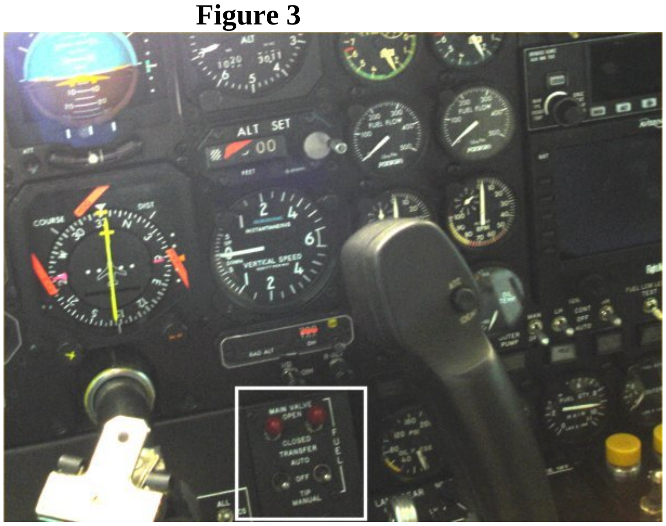
Figure 1

Figure 1. Overview of instrument panel showing location of fuel switches, beta lights and pressurization control.

Figure 2

Beta lights. Comment was made that the beta lights could be obscured from the pilot's view by the control yoke during some phases of operation. Examination of the indicators from the approximate pilot's eye position indicated that they could be obscured by the right side of the yoke under some circumstances (see Figure 2 of this appendix; photograph taken from approximately pilot's eye position). A repositioning would allow both lights to be seen at all times without requiring any head movement. However, as these lights are generally considered to be a confirmation of conditions, that would cause a significant aircraft performance change. It was determined that their positioning was not such that it would prevent them from being used to confirm that observed aircraft performance changes were or were not attributable to beta. The operational significance of this positioning needs to be discussed with AFS-820 and ACE-111. Figure 2. Beta lights from approximately pilot's eye position.

Figure 3



Fuel cut-off switches. The question had been raised as to whether it might be possible to accidentally activate the fuel cut-off switches (Figure 3). Examination of these switches showed that this was highly unlikely as the switches have detents and must be pulled out to be moved from one position to another.

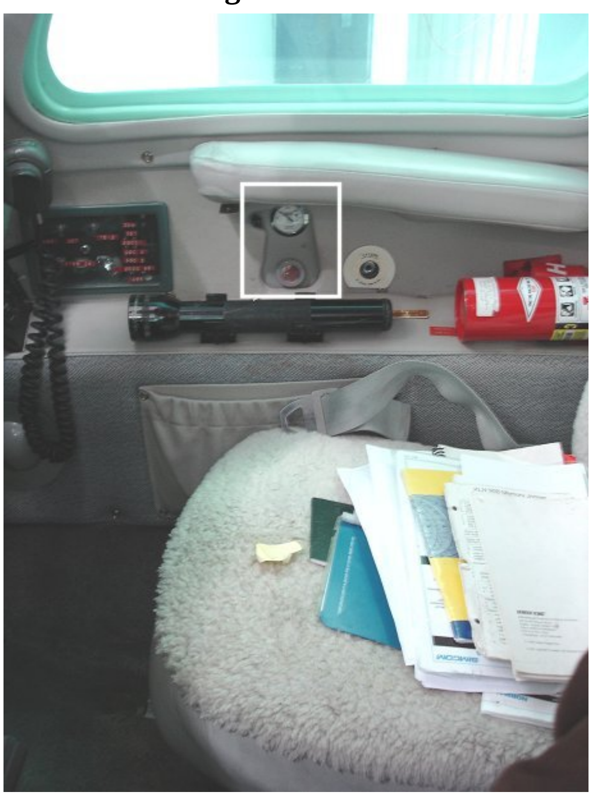
Figure 3. Fuel cut-off switches as seen from approximately pilot's eye position.

Figure 4

Pressurization controls. The question was raised concerning accessibility of the pressurization controls. This was examined using a pilot of moderate stature (5'7") with the seat positioned at arm's length (normal position for this pilot) from the instrument panel with the seat belt/harness on. The pressurization controls (Figure 4) were easily reached and manipulated from this seating position.

Figure 4. Pressurization controls as seen from approximately pilot's eye position.

Figure 5



Oxygen system controls, cockpit. The oxygen system control (Figure 5) was examined and determined to be at the extreme limit of reach for a pilot of this stature when wearing the belt and harness. However, the normal procedure calls for turning this valve on prior to departure, and it thus should not be necessary to access the control during flight.

Figure 5. Cockpit oxygen controls as seen from approximately pilot's eye position.

Rated task loading during training, longitudinal evaluation

The NASA TLX (Task Loading Index) scale was used to track the rated task loading experienced by pilots during their exposure to a standardized training program based on a collection of specific maneuver profiles. Note that the TLX uses ratings on six dimensions (mental, physical, time, effort, performance, and frustration) to determine how much loading was experienced (0 to 100%) on each scale, and then uses pair-wise comparisons between the factors to determine weights for producing an overall workload score. Tracking was begun during simulator trials and was carried through airplane-based training.

Individual pilots flew profiles for each session and marked task-load assessment forms either during the session (in the simulator) or immediately after the session while reviewing the flight via a videotape recording (aircraft). Their ratings were then processed using the NASA TLX PC-based data reduction program. Ratings were not available for all pilots and all sessions. Thus, findings are presented only for those pilots who completed at least four training sessions and essentially the complete training curriculum and for whom these rating data were completed.

Pilot 1 entered the process with more experience (more than 5,000 hours as PIC) than Pilot 2, both in twin-engine aircraft and twin-turbine aircraft, whereas Pilot 2 had less experience (about 2700 hours). Figure 6 depicts task-loading ratings across training sessions for two pilots. It is evident from these plots of averaged overall task loading that there was a systematic decrease from the initial session in the Flight Training Device (FTD) through the last session in the aircraft for each trainee. Thus, experienced task loading decreased to reasonable levels consistent with an increase in skill in operating the aircraft.

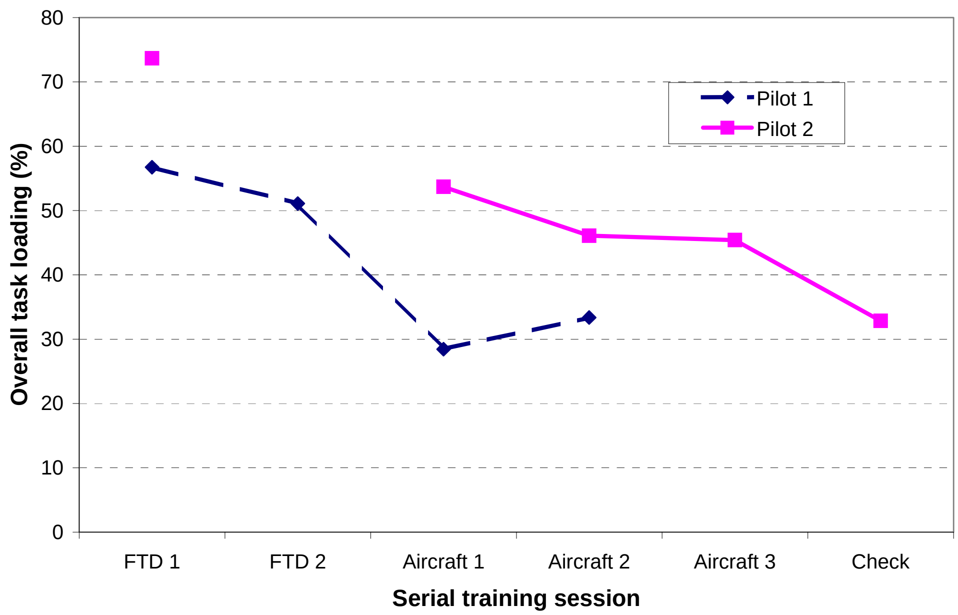


Figure 6 - Rated task loading, collapsed across profiles, for two pilots by training sessions.

Task loading was also examined by specific maneuvers that had been repeated across the training sessions to obtain a direct measure of how task loading on a specific profile benefited from the training.

Figure 7 presents data for Pilot 2 for Normal takeoff with 20 degrees slaps, steep turns with 20 degrees flaps, and engine failure on takeoff with 20 degrees flaps or 5 degrees flaps). Examination of each of the profiles indicates the same consistent reduction in workload across training sessions for each of the flight profiles.

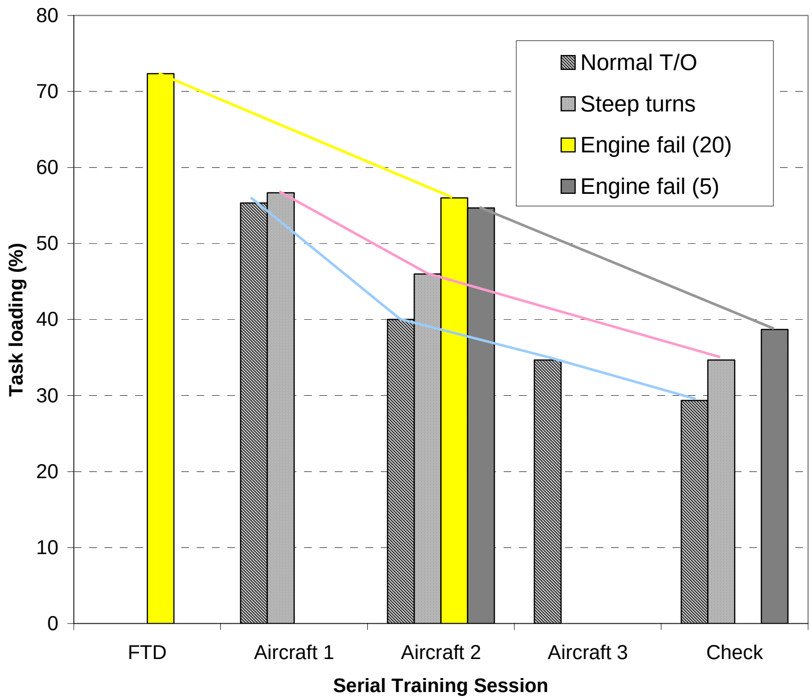


Figure 7 - Rated task loading for three flight profiles by serial training session.

Task performance and errors. The other two aspects that are relevant regarding the training process are, of course, proficiency (performance) and errors. Examination of the data available regarding errors indicated that there were a few errors of both commission and of omission in the early training sessions, but that these were virtually nonexistent by the conclusion of the training and performance of the check flight. Regarding task performance, the criterion measure was ultimately passage of the check flight, and this was passed within acceptable criteria.

Autopilot usage. It had been suggested that use of an autopilot would be helpful in reducing task loading during certain phases of operation. While this is generally true of most aircraft operations (autopilot reduces pilot task loading), comparison of two ILS approaches performed in the aircraft by Pilot 2 tends to support this contention. This pilot rated an ILS approach performed during the second session in the aircraft as requiring 42.6% of available working capacity. His rating for a similar ILS approach performed during the check ride using the autopilot was rated as requiring only 25% of available working capacity. Figure 8 shows the ratings on the 6 dimensions for these two profiles along with the overall task loading rating. The difference appears to lie in the mental, effort, performance, and frustration scales, each showing a reduction from the manual mode to the autopilot mode. The physical and time ratings were unchanged.

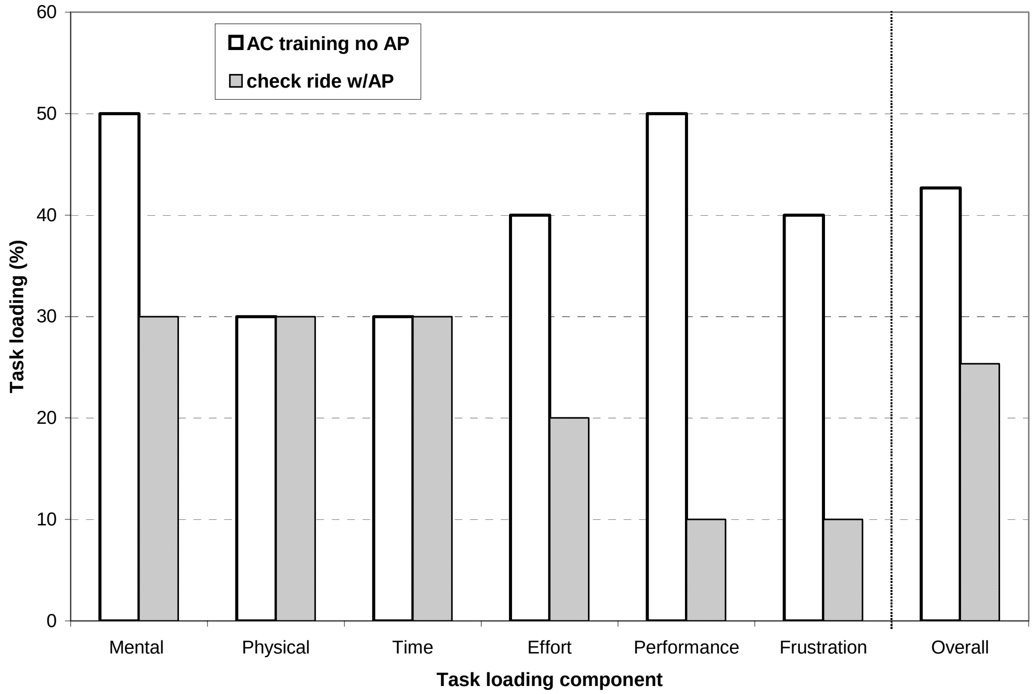


Figure 8 - Task loading ratings on an ILS approach without and with autopilot.

Summary

In summary, it appears that there were no significant cockpit-layout issues regarding the four specific items listed when they are considered within the context of standard and recommended operating procedures subject to commentary from AFS-820 and ACE-111 on the one item noted. It is also apparent that the training program proposed, for which task-loading ratings were obtained, was successful in producing a significant reduction in task loading by its conclusion (overall ratings in the area of 32% of available effort) and in reducing/eliminating observable errors while facilitating flight performance to published criteria (PTS).

Appendix 12

Record of Aircraft Maintenance Manual (AMM) Review

Date: 12/07/2005

Manual PN: MU-2B-25, Document Number YET 71370, Rev. 15
MU-2B-35, Document Number YET 70191, Rev. 17
MU-2B-40, Document Number MR-0333-MR-0334, Rev. 14
MU-2B-60, Document Number MR-0336-MR-0337, Rev. 14

Title: Maintenance Manual and Wiring Diagram Manual

Subject: Specific area of interest for review:

- Aircraft Flap Adjustment/Rigging;
- Fuel Control Adjustment/Rigging;
- Propeller Blade Angle Adjustment/Rigging.

Digest:

Aircraft Flap Adjustment/Rigging

Chapter V, Section 9. 9.3 Flap System Rigging and Check, from all Aircraft Maintenance Manual's were reviewed for adjustment and rigging of the aircraft flap system. Procedures given in all manuals were detailed, listed the use of rigging pins, gave torques for hardware where required, listed some special tools required, and referenced photographs by "Figure Number" for additional visual enhancement.

The manual could be improved in the identification of rigging pins used in the flap rigging process. Numerous times the phrase, "insert rigging pin" is used without identifying the pin by part number, or size, i.e., (Insert rigging pin 3/16 inch dia., 2.375 inch long in screw jack bellcrank.). There are several different size pins used in the process. Rigging pins may be listed in the Illustrated Parts Catalog (IPC) in sets, or by part number and identified for each rigging task, but the IPC was not provided for review.

Due to the lack of an MU-2B aircraft during the review of rigging procedures I was not able to verify that the data provided and rigging sequence used was adequate to accomplish the flap rigging.

Aircraft Fuel Control Adjustment/Rigging

Chapter VI, Section 7 thru 9: The data provided in all AMM.s for the MU-2B aircraft have very good procedures for accomplishment of individual tasks in the rigging of the engine control system. The Garrett TPE 331 maintenance manual is referenced for additional fuel control data.

I had a very hard time trying to identify a sequence of events to follow for a complete rigging procedure. The process appears to be a very complex procedure and the data provided is a bit convoluted. It is evident that the process requires a technician trained on the TPE 331 engine and MU-2B aircraft system.

With out having an aircraft to visually compare with the data contained in the AMM, I am unable to verify that the procedures and sequence referenced are adequate to accomplish the rigging task.

Propeller Blade Angle Adjustment/Rigging

Chapter VI, Section 13.4, .5, .6: The data provided for the, installation of the propeller, pitch adjustment, and measurements of propeller pitch angle, is well explained in the maintenance manual. An A&P mechanic should have no problem checking propeller pitch angle. The use of a prop protractor is known by all A&P mechanics. Method on how to zero the protractor to the propeller is given in detail in the AMM, and the AMM refers to the propeller maintenance manual for additional data. Although the procedure is not that complicated. A qualified MU-2B technician should supervise the mechanic who is not familiar with the MU-2B aircraft.

The manual could expound on the operation of the use of the feathering pump. Nothing is referenced on how the aircraft should be configured for the use of the pump. Is the power to operate the feathering pump provided through the battery switch when placed in the on position? Or are there additional steps that need to be taken?

Conclusion:

The AMM appears to be very well written and has information needed to properly maintain the aircraft.

It is also evident from the review that an un-trained MU-2B maintenance technician cannot maintain the aircraft. Technicians should be MU-2B trained or be supervised by a MU-2B trained supervisor.

Proving the viability of the data contained in the AMM would require observation of a maintenance technician performing the procedures identified in the AMM on a MU-2B aircraft.

Dick Coddington
MKC-AEG (AW)