ACCIDENT RECORD OF THE BEECH 99, THE SWEARINGEN 226/227 & THE EMBRAER-110

Office of Accident Investigation
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The FAA's recent study of the MU-2 found that "the fatal accident characteristics of the Beech 99, the Swearingen SA 226/227, and the Embraer-110 airplanes appear similar to the MU-2B in 14 CFR part 135 operations." [1] The report then recommended that FAA "analyze the safety record of the Beech 99, the Swearingen SA 226/227, and the Embraer-110 airplanes." The Office of Accident Investigation (AAI) has completed the recommended safety analysis by reviewing and analyzing 226 accidents involving 231 of the targeted aircraft in U.S. operations.

The AAI review found the targeted aircraft have substantially lower accident rates and especially lower fatal accident rates than does the MU-2 and the mix of accidents among the Beech 99, the Swearingen 226/227 (Metro) and the Embraer-110 (Bandeirante) differs from the mix of MU-2 accidents. The central conclusion is that the accident experiences of the 3 targeted aircraft are quite different from those of the MU-2 and that no case can be made to initiate special FAA actions against these aircraft, at least not based on the premise that their accidents are similar to those of the MU-2.

FLEET BACKGROUND ON THE BEECH 99, SWEARINGEN 226/227 AND EMBRAER-110

The Beech 99, the Swearingen SA 226/227, and the Embraer-110 airplanes are two-engine turboprops that are substantially larger than the MU-2. While the MU-2 typically is configured for 5 to 7 passengers, the Beech 99 typically is configured for 13 to 15 passengers. The Swearingen and Embraer typically are configured for 17 to 19 passengers. Their maximum weights initially were up to 12,500 pounds, but later versions of the Swearingen 226/227 and Embraer-110 exceeded 12,500. Of the 3 subject aircraft, only the Beech 99 entered service about the same time as did the MU-2.

The Beech 99 entered the U.S. fleet in May 1968 and was the first of a new class of turboprops to enter the airline industry. Prior to the introduction of the Beech 99, the air carrier turboprop fleet was limited to relatively large aircraft, such as the BAC Viscount, the Fairchild F-27, the Hawker-Siddley Argosy, and the Lockheed Electra. The Beech 99 made service between low-density city pairs economically feasible by providing twin-turboprop capabilities in aircraft that did not require 30 to 40 passengers to be economically viable, yet offered greater capacity and performance than other small aircraft that were available in that era.

A total of 239 Beech 99s were produced, including 164 through 1975, then 75 of the larger Beech 99s were produced from 1981 through 1986 before the aircraft was replaced by the BE-1900. Of the 239 produced, 226 have been on the U.S. Registry at one time or another. For most years, U.S. operators accounted for 70 to 80 percent of all in-service Beech 99s in the world. Exhibit 1 displays the in-service U.S. fleet for each of the 3 aircraft. The exhibit shows that the Beech 99 has maintained a comparatively stable presence in the U.S. fleet since about 1969, peaking at 147 in-service aircraft in 1984 and in 1986, with 114 still in service in the U.S.

The Swearingen 226/227 (Metro), later produced by Fairchild, entered service in the U.S. in early 1973. The Metro was the largest of the 3 subject fleets, with a production run of 777 airplanes through 1997, of which 511 have been on the U.S. Registry at one time or another. For most years, U.S. operators accounted for 60 to 70 percent of in-service Metros in the world. The Metro peaked in the U.S. fleet in 1988 and 1989 with 310 in-service aircraft; 187 Metros remain in service in the U.S.

The Embraer-110 (EMB-110, Bandeirante) entered U.S. service in mid-December 1978. Embraer produced 498 EMB-110s through early 1992, when it was replaced by the larger EMB-120 Brasilia. The EMB-110 relied less on the U.S. market than did the Beech 99 or the Metro. Of the 498 EMB-110s produced, a total of 148 were registered in the U.S. at one time or another and U.S. operators never accounted for more than about 25 percent of the world's in-service EMB-110s. The U.S. EMB-110 fleet peaked in 1983 at 114 in-service aircraft. That peak was short-lived, as the fleet decreased quickly into the early 1990's. The EMB-110 fleet in the U.S. has been rather stable since 1991, with just 28 EMB-110s in service in the U.S. as of mid-June 2006.

Exhibit 2 shows that the Beech 99 and the EMB-110 have been used almost exclusively by air carriers in the United States, including both passenger and cargo operators. This was true of the Metro for about it first two decades.

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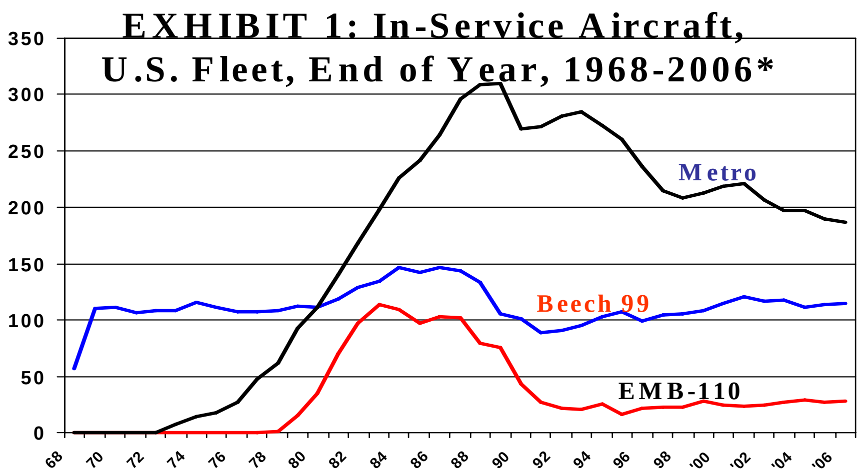
[1] See "MU-2B Series Airplane Safety Evaluation Report," FAA, December 2005; page 20.

Since then, general aviation operators have accounted for slightly higher shares of the active Metro fleet, though air carriers still account for a very large majority of the Metro fleet today.



Data for 2006 through June 14. Source: Airclaims.

EXHIBIT 2: U.S. In-Service Fleet, Air Carrier and Other Operators

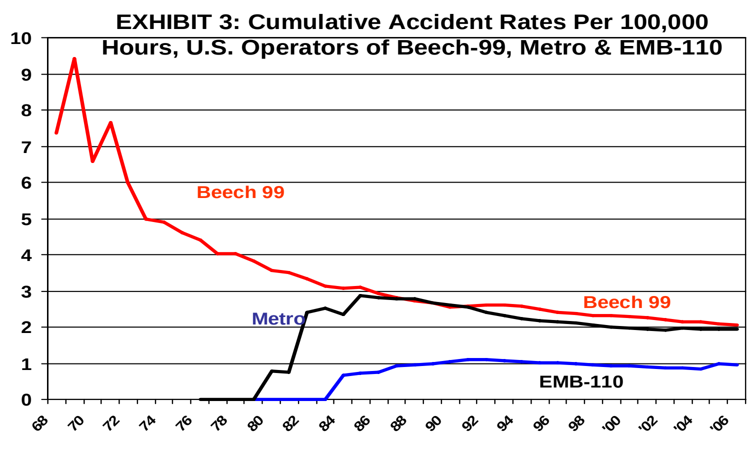
AS OF	EMB-110			Beech 99			Metro 226-227		
	Airline	Other	TOT	Airline	Other	TOT	Airline	Other	TOT
12/31/1968	0	0	0	51	6	57	0	0	0
12/31/1969	0	0	0	105	5	110	0	0	0
12/31/1970	0	0	0	110	2	112	0	0	0
12/31/1971	0	0	0	101	5	106	0	0	0
12/31/1972	0	0	0	101	7	108	0	0	0
12/31/1973	0	0	0	99	9	108	6	1	7
12/31/1974	0	0	0	110	6	116	13	1	14
12/31/1975	0	0	0	105	7	112	16	2	18
12/31/1976	0	0	0	103	4	107	25	2	27
12/31/1977	0	0	0	104	3	107	44	3	47
12/31/1978	1	0	1	106	2	108	60	2	62
12/31/1979	14	1	15	110	3	113	92	1	93
12/31/1980	35	0	35	107	4	111	110	2	112
12/31/1981	69	1	70	111	8	119	132	8	140
12/31/1982	95	2	97	123	6	129	155	13	168
12/31/1983	113	1	114	128	6	134	186	12	198
12/31/1984	103	6	109	142	5	147	210	16	226
12/31/1985	95	2	97	135	7	142	232	10	242
12/31/1986	101	2	103	141	6	147	254	10	264
12/31/1987	101	1	102	138	6	144	292	4	296
12/31/1988	77	2	79	129	4	133	305	4	309
12/31/1989	73	2	75	99	6	105	294	16	310
12/31/1990	42	1	43	98	3	101	252	17	269
12/31/1991	25	2	27	84	5	89	250	22	272
12/31/1992	19	3	22	87	4	91	232	49	281
12/31/1993	17	4	21	90	5	95	234	51	285
12/31/1994	23	3	26	95	8	103	220	53	273
12/31/1995	15	2	17	100	7	107	212	48	260
12/31/1996	19	3	22	90	9	99	187	49	236
12/31/1997	20	3	23	91	13	104	169	46	215
12/31/1998	20	3	23	95	10	105	164	45	209
12/31/1999	23	5	28	99	9	108	160	53	213
12/31/2000	20	5	25	104	11	115	169	50	219
12/31/2001	20	4	24	112	9	121	166	55	221
12/31/2002	21	4	25	111	6	117	161	46	207
12/31/2003	24	3	27	114	4	118	152	45	197
12/31/2004	26	3	29	107	5	112	146	51	197
12/31/2005	23	4	27	107	7	114	132	58	190
6/14/2006	24	4	28	107	8	115	130	57	187

THE ACCIDENT RECORD

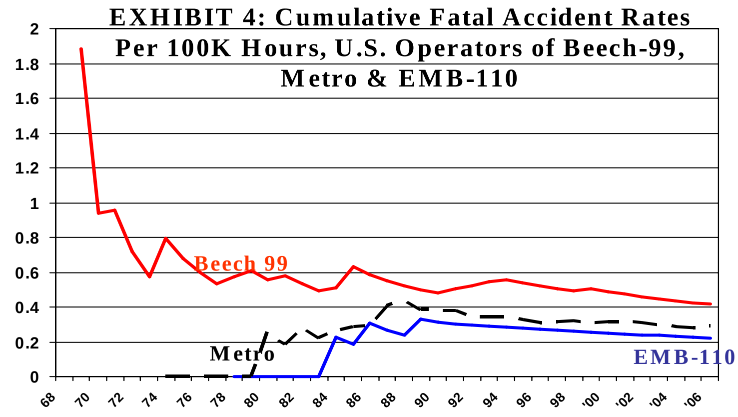
Whether we speak of air carrier aircraft, corporate aircraft, or more broadly based general aviation fleets, each new generation of aircraft has produced accident rates that resemble "elbow" curves, in which rates start out very high, then fall sharply and stabilize at much lower levels. Equally important, each subsequent generation of aircraft that follow the pioneering aircraft enters service with a lower initial accident rate than the preceding generation, and each has a shorter learning curve, with rates stabilizing more quickly and at lower levels than the preceding generation of aircraft. Large jet operations in airline service provide the best documented illustration of this point, but comparable patterns appear with other aircraft, including the three aircraft under review here. Note that the MU-2 also was clearly a pioneer aircraft but no aircraft of similar size and design followed. Consequently, the MU-2 remained a one-off pioneer aircraft.

Exhibit 3 shows cumulative accident rates for the Beech 99, Metro and EMB-110. The Beech 99, which introduced a new generation of aircraft at the time, had a very high accident rate early in its service history but then the rate decreased and stabilized at a much lower level. The Metro entered U.S. service six to seven years after the Beech 99. Like the Beech 99, the Metro started with a relatively high accident rate, but with a starting point below that of the pioneering Beech 99. The Metro's accident rate then decreased and stabilized at a rate somewhat below that of the Beech 99. The EMB-110 then entered service with a still lower accident rate. Though the EMB-110 has had the lowest accident rate of the three aircraft, its rather flat long-term accident rate is an exception to the established "elbow" curve seen in other aircraft. Nevertheless, the rate remains well below those of the Beech 99 or the Metro, consistent with the notion that subsequent generations of aircraft produce lower long-term accident rates.

As Exhibit 3 suggests, the cumulative accident rate for the Metro is only slightly lower than that of the Beech 99 (1.92 versus 2.11, respectively, per 100,000 flight hours). In contrast, the EMB-110 has a cumulative accident rate that is less than half of the other 2 aircraft (0.97 per 100,000 hours). A comparison of fatal accident rates among the 3 aircraft shows a similar pattern, though the difference between the rate for the Metro and the EMB-110 is less marked than in Exhibit 3 (at 0.29 versus 0.22 fatal accidents per 100,000 hours). Note that Exhibits 3 and 4 overstate annual accident rates in recent years, as accidents in the early service history of each aircraft continue to influence their respective cumulative rates.



*Data for 2006 as of June 14.



*Data for 2006 as of June 14 with annual exposure pro-rated.

The MU-2 report compared the accident record of the MU-2 to the records of three other twin-engine aircraft of similar size based on the number of aircraft that had ever been registered in the U.S. This was the only means available to normalize the frequency of accidents among those aircraft since no data exists on flight hours for that class of aircraft and no data exists on precise annual changes to those fleets. Consequently, the MU-2 report implicitly assumed that hours per aircraft were similar for each of the several make-models addressed in that study.

A direct comparison of the MU-2 accident record with the records of the Beech 99, the Metro and the EMB-110 is difficult, but a useful sense of scale can be developed. Difficulties include the following. First, the 3 larger turboprops have operated nearly exclusively in an air carrier environment, as Exhibit 2 shows. Consequently, the 3 larger turboprops have operated almost exclusively with two-pilot crews (as required of air carrier aircraft with more than 10 passenger seats), and very likely with higher shares of operations occurring under instrument flight rules, which is generally a safer regime than visual flight rules. In contrast, the MU-2 has operated much more often in business and personal flight. Even when the MU-2 has operated in the air carrier environment, it has operated exclusively in the on-demand market while the service histories of the 3 larger turboprops have been dominated by scheduled passenger service, though many of the remaining Metros now are in cargo service.

The different service profiles also imply more intense aircraft utilization rates for the 3 subject aircraft than MU-2s have experienced. For example, the U.S. Census of Aircraft, which the FAA had produced until 1994, consistently indicated that active twin-engine turboprops averaged about 375 hours per year. In contrast, data from Airclaims indicates much higher rates of annual usage for the 3 aircraft reviewed here: 955 hours per year for the Beech 99, with 1,040 per year for the Metro and 1,025 hours per year for the EMB-110. All this implies that a straightforward comparison to MU2 accident rates based exclusively on the number of aircraft in the fleet would significantly overstate exposure for the MU-2 relative to the 3 larger turboprops.

Yet we can develop a sense of scale by comparing the MU-2 and the Beech 99, which entered service at roughly the same time as the MU2. The approach compares MU-2 accident rates to the Beech 99 based on aircraft once in the U.S. fleet. It then uses accident rates per 100,000 flight hours among the Beech 99, the Metro and the EMB-110 as established in Exhibits 3 and 4 to compare the Metro and EMB-110 to the MU-2. If we know the relationship of the MU-2 to the Beech 99, and we know the relationships of the Beech 99 to the Metro and EMB-110, then we know the relationships of the Metro and EMB-110 to the MU-2.

The MU-2 review identified 675 MU-2s that had been on the U.S. Registry at one time. Those 675 MU-2s have had 188 accidents and 80 fatal accidents. In comparison, as noted above, 226 Beech 99s have been on the U.S. Registry at one time or another. Those aircraft have had 84 accidents and 17 fatal accidents. The larger Metro fleet has had 128 accidents and 19 fatal accidents, while the smaller EMB-110 fleet has had just 14 accidents and 3 fatal accidents in the U.S.

Based strictly on fleet size, the Beech 99 has had 0.372 accidents per aircraft versus 0.279 for the MU-2 and the Beech 99 has had 0.0752 fatal accidents per aircraft while the MU-2 has had 0.119 fatal accidents per aircraft. Therefore the Beech 99 has had 33 percent more accidents than the MU-2 but 37 percent fewer fatal accidents than the MU-2 per aircraft. If the Beech 99 has averaged 955 flight hours per aircraft per year compared to just 375 hours per aircraft per year for the MU-2, the above ratios change substantially. The Beech 99 would have an accident rate 47.5 percent lower than the MU-2 and a fatal accident rate about 75 percent lower ("X" times 375/955). If these ratios are inverted, the MU-2 has an accident rate that is about 1.9 times higher than the Beech 99 and a fatal accident rate that is about 4 times higher. Since we know the relationship of the Beech 99 accident rate to that of the MU-2 and to those of the Metro and EMB-110, we therefore know the relationship of the MU-2 accident rate to those of the Metro and EMB-110. The MU-2 accident rate is about 2.75 times the Metro's rate and 3.3 times the EMB-110's rate.

However the disparity is substantially greater with fatal accident rates. The MU-2's fatal accident rate, as noted above, is 4 times that of the Beech 99 but it is about 5.8 times that of the Metro and 7.7 times that of the EMB-110 . This greater disparity suggests that the 3 subject aircraft not only had significantly fewer accidents per unit of exposure, but a substantially higher share of their accidents were minor or low-risk events.

Exhibit 5 confirms this by comparing accident types. As with any make-model, controlled flight into terrain, loss of control in flight and landing short or losing control on approach account for most fatal accidents. However, these events occur much less frequently among the 3 subject aircraft relative to exposure than is the case with the MU-2. The only noteworthy observation on Metro accidents involves a relatively high number of gear-up landings and runway excursions on landing roll out. This may reflect some frequent observations by pilots about the Metro being a high-workload aircraft and/or a "heavy" aircraft on approach, but the more central point is that these types of events typically have low-risk outcomes.

For the Beech 99, the most significant type of event is loss of control in flight, which accounts for 9 of the 17 fatal accidents that have occurred over the aircraft's nearly 40 years of service. However, 2 of the 9 involved unusual maneuvers during proficiency checks and a third involved a pilot maneuvering low for photos on his last flight before retirement. The remaining 6 loss-of-control accidents over 40 years do not seem out of scale, particularly when assessed against exposure. Finally, the EMB-110 has too few fatal accidents for any meaningful discussion of most common accident types.

CONCLUSION

The accident rates and especially the fatal accident rates for the Beech 99, the Metro and the EMB-110 are significantly lower than are the corresponding rates for the MU-2. When accidents do occur, the mix of events among the 4 aircraft indicate that, on balance, MU-2 accidents are much more likely to have severe outcomes. The central conclusion must be that the accident experiences of the 3 targeted aircraft differ so substantially from those of the MU-2 and that no case can be made to initiate special FAA actions against these aircraft, at least not based on the premise that their accidents are similar to those of the MU-2.

EXHIBIT 5: ACCIDENT TYPES FOR 4 AIRCRAFT MAKE-MODELS

Accident Type	MU-2 Accidents		MU-2 Fatal Accidents			BE-99 Accidents		BE-99 Fatal Accidents	
	#	%	#	%		#	%	#	%
CFIT High	12	6.4	11	13.8		5	6.0	4	23.5
Emergency Maneuver	23	12.2	7	8.8		1	1.2	0	0.0
Gear-Up/Gear Collapse	28	14.9	0	0.0		20	23.8	0	0.0
Landing: Overrun-Excursion	22	11.7	0	0.0		6	7.1	0	0.0
Loss of Control (LoC) - T/O-Climbout	15	8.0	13	16.3		1	1.2	0	0.0
LoC In Flight	21	11.2	20	25.0		13	15.5	9	52.9
LoC - T/O Roll & RTO	8	4.3	0	0.0		1	1.2	0	0.0
Midair Collision	2	1.1	2	2.5		1	1.2	1	5.9
Ramp or Low-Speed Ground	7	3.7	4	5.0		7	8.3	0	0.0
Land Short - LoC on Approach	38	20.2	19	23.8		20	23.8	3	17.6
Missing-Unknown	3	1.6	2	2.5			0.0	0	0.0
Other	9	4.8	2	2.5		9	10.7	0	0.0
TOTAL	188	100.0	80	100.0		84	100	17	100.0

Accident Type	Metro Accidents		Metro Fatal Accidents			EMB-110 Accidents		EMB-110 Fatal Accidents	
	#	%	#	%		#	%	#	%
CFIT High	4	3.1	2	10.5		0	0.0	0	0.0
Emergency Maneuver	2	1.6		0.0		0	0.0	0	0.0
Gear-Up/Gear Collapse	32	25.0	1	5.3		3	21.4	0	0.0
Landing: Overrun-Excursion	26	20.3		0.0		2	14.3	0	0.0
Loss of Control (LoC) - T/O-Climbout	2	1.6	2	10.5		0	0.0	0	0.0
LoC In Flight	7	5.5	6	31.6		1	7.1	1	33.3
LoC - T/O Roll & RTO	9	7.0	1	5.3		1	7.1	0	0.0
Midair Collision	2	1.6	2	10.5		0	0.0	0	0.0
Ramp or Low-Speed Ground	18	14.1	1	5.3		3	21.4	0	0.0
Land Short - LoC on Approach	14	10.9	4	21.1		4	28.6	2	66.7
Missing-Unknown	0	0.0		0.0		0	0.0	0	0.0
Other	12	9.4	0	0.0		0	0.0	0	0.0
TOTAL	128		19	100.0		14	100.0	3	100.0