Safety Information

Piper Malibu/Mirage

AOPA Air Safety Foundation

Safety Review

Piper Malibu/Mirage

Model PA-46

AOPA Air Safety Foundation

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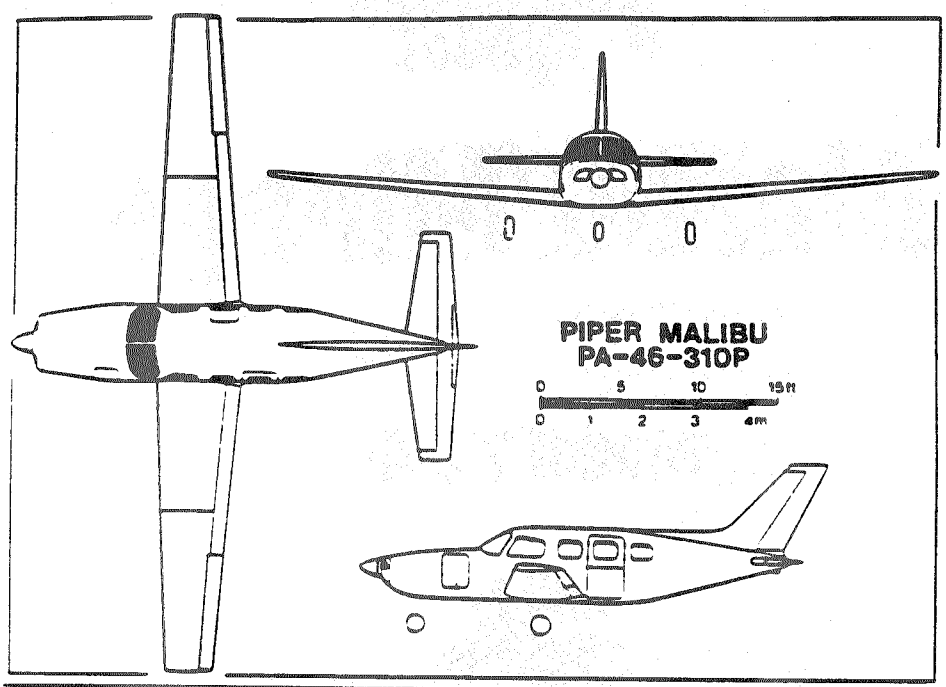

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Dear Fellow Pilot,

The AOPA Air Safety Foundation is pleased to present this Safety Review on the Piper PA-46 Malibu/Mirage. The Foundation, which houses the Emil Buehler Center for Aviation Safety, maintains records on more than 25,000 general aviation accidents and operates the largest nongovernment accident database in the United States.

The Foundation provides information and data to educational institutions, publications, and researchers on a variety of safety topics. Additionally, it conducts over 250 safety seminars and Flight Instructor Refresher Clinics every year throughout the nation.

The Foundation is an independent, nonprofit, nonpartisan organization that serves all pilots. Its sole purpose is to improve the aviation safety record through education, research, and dissemination of results by safety reviews, videotapes, pamphlets, newsletters, articles, and seminars. Its lifesaving work is made possible by grants from other charitable foundations, companies, and pilots like you who believe that an investment in aviation safety is a small price to pay for the joy and sense of accomplishment that flight brings to each of us.

After you have read the review, we would greatly appreciate it if you would give us your comments.

Respectfully,

Bruce Landsberg

Bruce Landsberg
Executive Director

Safety Review
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The NTSB is solely responsible for accident investigation. The AOPA Air Safety Foundation did not participate in any investigations contained in this review.

The accident data was collected and probable cause determinations were made by the NTSB. In Part 2 of this safety review, factual data is provided by the NTSB for the aircraft accident summary reports. ASF provided the interpretation in the field at the bottom of each report identified as ***ASF Comments****.*

This safety review is intended for educational purposes only and does not contain data or information suitable for litigation.

Nothing in this review supersedes official government determinations or aircraft manufacturer recommendations. All cautions, warnings, and recommended procedures in the Pilot's Operating Handbook or approved Flight Manual should be followed at all times.

Piper PA-46 Malibu/Mirage Safety Review

Introduction

The Piper Malibu/Mirage was designed from the beginning to be a pressurized single-engine aircraft. It operates in environments that have previously been reserved for mostly turbine powered equipment. Like its other single-engine pressurized predecessor, the Cessna P210, the PA-46 was able to be purchased by a number of individuals, most of whom were not professional pilots.

The Piper PA-46 Malibu/Mirage series airplanes are state-of-the-art, cabin class, pressurized, turbocharged, piston-powered, single-engine aircraft capable of airspeeds greater than 200 knots, operational altitudes up to 25,000 feet, and 1,000 nautical-mile legs. Four hundred and three Continental 310-horsepower Malibus were manufactured from 1984 through 1989. Piper began manufacturing the Mirage powered by 350-horsepower Lycoming engines in midyear 1989. As of the date of this review, 128 Mirage aircraft have been built.

In July 1990, after a series of seven well-publicized fatal accidents, Piper PA-46 Malibu/Mirage aircraft became the target of intensive investigation by the National Transportation Safety Board and the Federal Aviation Administration. Pilot error was identified as the primary accident cause. The investigative report stressed the importance of comprehensive training in the use of integrated flight guidance and control systems for pilots of small, pressurized, single-engine airplanes. Additional information regarding the investigation is contained in this review.

This review contains information about all reported Piper PA-46 accidents. Included are NTSB final reports of 35 PA-46 accidents, eight NTSB preliminary reports of PA-46 accidents and unofficial information about five PA-46 accidents that occurred in foreign countries. NTSB preliminary reports and the five foreign accidents are not included in the statistical graphs in Part 1. Analysis of the foreign accidents was not done because complete reports were unobtainable.

It compares 35 PA-46 accidents to 60 high performance, pressurized, single-engine (Cessna P210) accidents and 30 pressurized light twin-engine (Beechcraft BE58P) aircraft accidents. Included in the 35 accident summaries is one which does not involve injury to crew or passengers or damage to the aircraft (#86-5004), but was considered significant by the NTSB; and one that occurred during a post-production test flight (#84-2285). These summaries were included because we feel they contain information beneficial to our readers.

This review also focuses on serious accidents which resulted in serious or fatal injury (14 for the PA-46 and 42 for the comparative aircraft) and minor accidents which resulted in minor or noninjury (21 for the PA-46 and 48 for the comparative aircraft).

While this review is based on information derived from NTSB accident reports, the Air Safety Foundation had to deal with two major areas before it could begin the analysis. These were: 1) the relatively small number of accidents, and 2) ensuring that, insofar as possible, each accident was placed in the correct category. The latter area was complicated by the fact that nearly all accidents involve more than one factor. Because the number of accidents is small, improperly categorizing a single accident could result in a wide variation in statistical analysis on charts and graphs.

Because we were dealing with such a small number of accidents, the Air Safety Foundation attempted to not only provide factual information about these accidents, but also to identify and list trends. It is our hope that by including all of the PA-46 accident summaries, we have provided the reader with in-depth information concerning specific reasons for the accidents.

Use caution when interpreting the graphs, since small numbers can cause a disproportional increase in percentages. Some of our conclusions must be considered speculative due to the small population of accidents. All available information and verifiable comments are included to assist the reader in drawing his or her own conclusions.

Early Malibu aircraft had both hydraulically-activated gear and flaps powered by the same system, and a single pump. By mid-1986, flaps were converted to an all electric system, though gear activation remained via a hydraulic valve. Aircraft manufactured at the end of 1986 and since (including all Mirages) have electro-mechanical flaps and an electrically-activated hydraulic landing gear.

Alternators and vacuum pumps had a similar lineage. Backup alternator and vacuum pumps were initially offered as accessories. The second alternator and vauum pump were activated only when needed. By evolution, the Mirage is now equipped with full-time dual alternators and full-time dual vacuum pumps. Variations in models has bearing upon normal and especially emergency operating procedures. Any training must account for particular aircraft configuration.

Except for the powerplant and propeller, most PA-46s have system redundancy comparable to twin-engine aircraft, e.g., two vacuum pumps and two alternators, a split avionics bus, and are equipped with sophisticated avionics, thunderstorm avoidance equipment, and a Bendix/King Series 150 autopilot. The majority are equipped with an optional flight director (KFC 150) and an altitude/vertical speed preselect (KAS 297B). Many are equipped with an optional yaw damper and a complete set of copilot's instruments and are certificated for flight into known icing conditions.

Pilots should receive comprehensive transition training, with emphasis on the aircraft's systems and the autopilot prior to solo. They should also be instrument rated and experienced in flight in Class A airspace above 18,000 feet msl. Operation of the aircraft closely parallels that of a light twin and must be disciplined. In fact, the Malibu and Mirage outperform many light twin-engine aircraft.

Comparative Aircraft

For 100,000 flying hour comparison purposes, data was derived from the years 1984 through 1991 and average fleet sizes using FAA-registered aircraft (1991 is the last year that accurate PA-46 flight hour data was available from the FAA). The following aircraft were used in the comparison group:

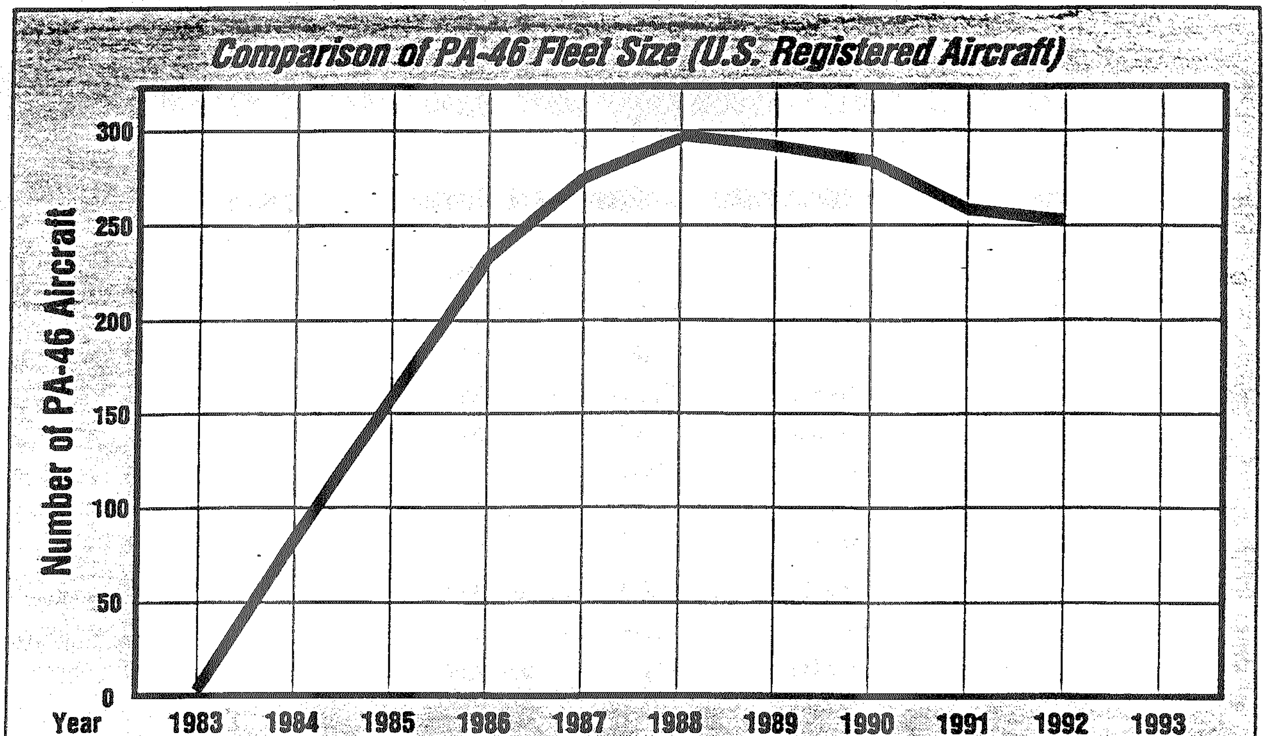
Cessna Centurion P210
Beechcraft Baron BE58P

The Cessna P210 is the only other single-engine pressurized aircraft manufactured in statistically significant numbers. The pressurized Beechcraft BE58P was selected for comparison because its performance is similar to that of the Piper PA-46 aircraft.

NTSB Chronological List of PA-46 Accidents

Date	Registration	Page	Reference	Injuries		Location
				Fatal	Other*	
08/13/84	N4323G	2-6	84-3244	1	0	Richmond, NH
08/20/84	N4371Y	2-31	84-2285	0	1	Vero Beach, FL
05/14/85	N4362F	2-20	85-0633	0	5	Osage Beach, MO
12/12/85	N4380A	2-32	85-2939	0	2	Evanston, IL
03/17/86	N4360V	2-35	86-5004	0	2	Reno, NV
03/23/86	N43769	2-8	86-1375	2	0	Boyne Falls, MI
07/26/86	N4346L	2-29	86-1973B	1	2	Boulder, CO
08/15/86	N27EE	2-34	86-2754	2	2	West Mifflin, PA
11/08/86	N4323N	2-33	86-2449	0	2	Bremerton, WA
11/29/87	N4369V	2-36	87-2653	1	1	Long Beach, CA
02/19/89	N9092W	2-2	89-0269	0	5	Angel Fire, NM
05/31/89	N9114B	2-42	89-1308	3	0	Bristol, IN
11/27/89	N919S	2-30	89-1655	0	3	Des Moines, IA
01/08/90	N9150X	2-5	90-0242	0	2	Van Nuys, CA
02/06/90	N8888M	2-44	90-2173	2	0	Bakersfield, CA
04/17/90	N4387S	2-19	90-1891	0	3	Paso Robles, CA
05/27/90	N22EK	2-48	90-2290	2	0	Naylor, MO
06/26/90	N315RC	2-46	90-2174	1	0	Lakeville, MI
12/01/90	N4370Z	2-10	90-1165	0	1	Seattle, WA
02/24/91	N9132X	2-17	91-0972	0	4	Los Angeles, CA
03/17/91	N9112K	2-50	91-0472	4	0	Bronson, FL
04/07/91	N9113X	2-18	91-0976	0	2	N. Hollywood, CA
08/07/91	N9094Z	2-37	91-1773	0	2	Cartersville, GA
09/08/91	N350MM	2-38	91-2255	0	6	Dayton, OH
10/14/91	N1FY	2-3	91-1000	0	5	Sioux Center, IA
12/27/91	N9GF	2-22	91-2028	0	1	Carson City, NV
01/13/92	N9161K	2-28	92-2264	0	4	Bowling Green, KY
01/30/92	N9103Q	2-39	92-0061	0	2	Baltimore, MD
03/10/92	N4321L	2-24	92-0068	0	2	Lima, OH
03/11/92	N4387V	2-26	92-0387	0	1	Aiken, SC
03/16/92	N872RJ	2-27	92-0073	0	1	Doylestown, PA
08/28/92	N350PM	2-14	92-2286	0	1	Sanford, ME
09/02/92	N1005B	2-16	92-1930	0	1	The Dalles, OR
12/11/92	N856M	2-12	92-0462	0	1	Twin Falls, ID
03/19/93	N24WW	2-4	93-0162	0	4	Hailey, ID

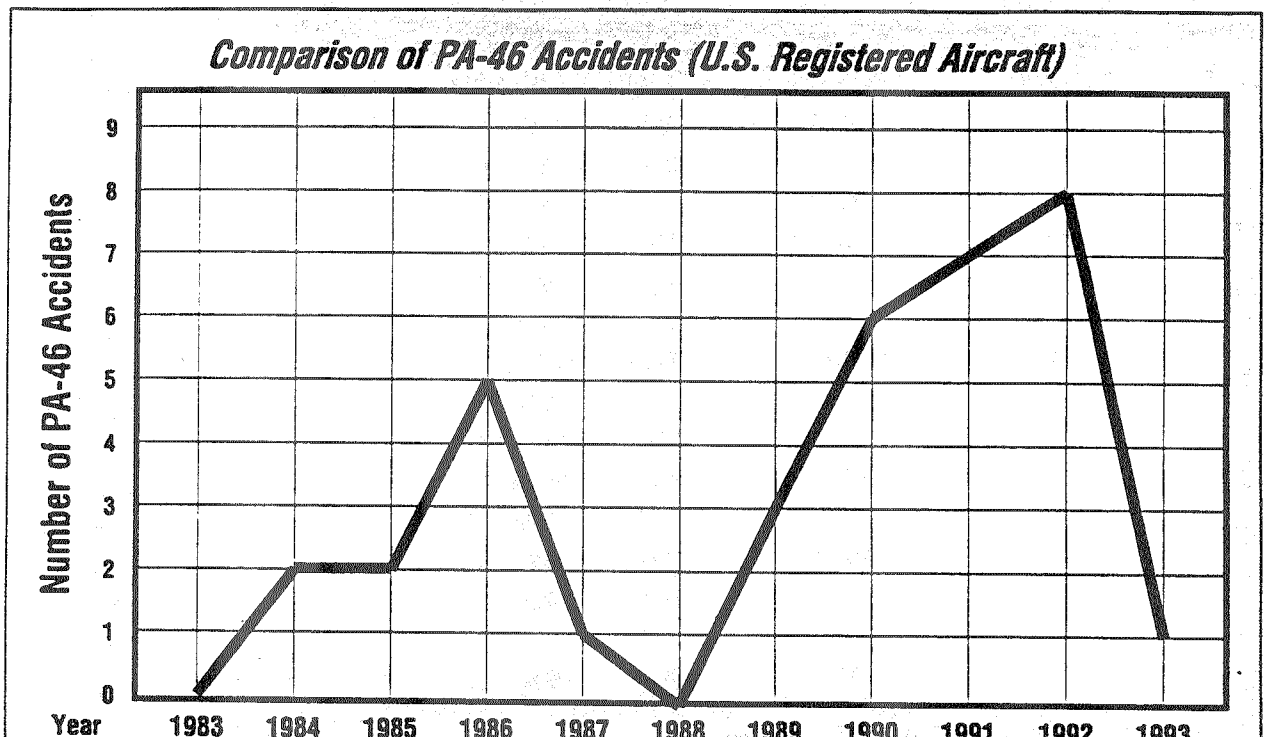
There are eight NTSB Preliminary Accident Reports beginning on page 2–52.
There are five Foreign Accident Reports beginning on page 2–61.



Year	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
No. of Aircraft		83	157	231	274	296	283	281	263	256	N/A

Figure a

Figure b



Year	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
No. of Accidents		2	2	5	1	0	3	6	7	8	1

Part 1

A comparison of PA-46 accidents to accidents of other aircraft with similar performance

Pilot Versus Aircraft
PA-46

Pilots are the primary causal factor in most accident scenarios, no matter what the aircraft. The Piper PA-46 is a state-of-the-art aircraft, yet the individuals flying them generate most of the mishaps. As shown in Figure 1, PA-46 pilots are identified as a causal factor in more accidents than pilots of comparative aircraft. This may be due to the relatively high number of approach and landing accidents in which pilot error is a leading cause. Significantly, the aircraft was a causal factor in one quarter of the PA-46 accidents. This is addressed later in the review.

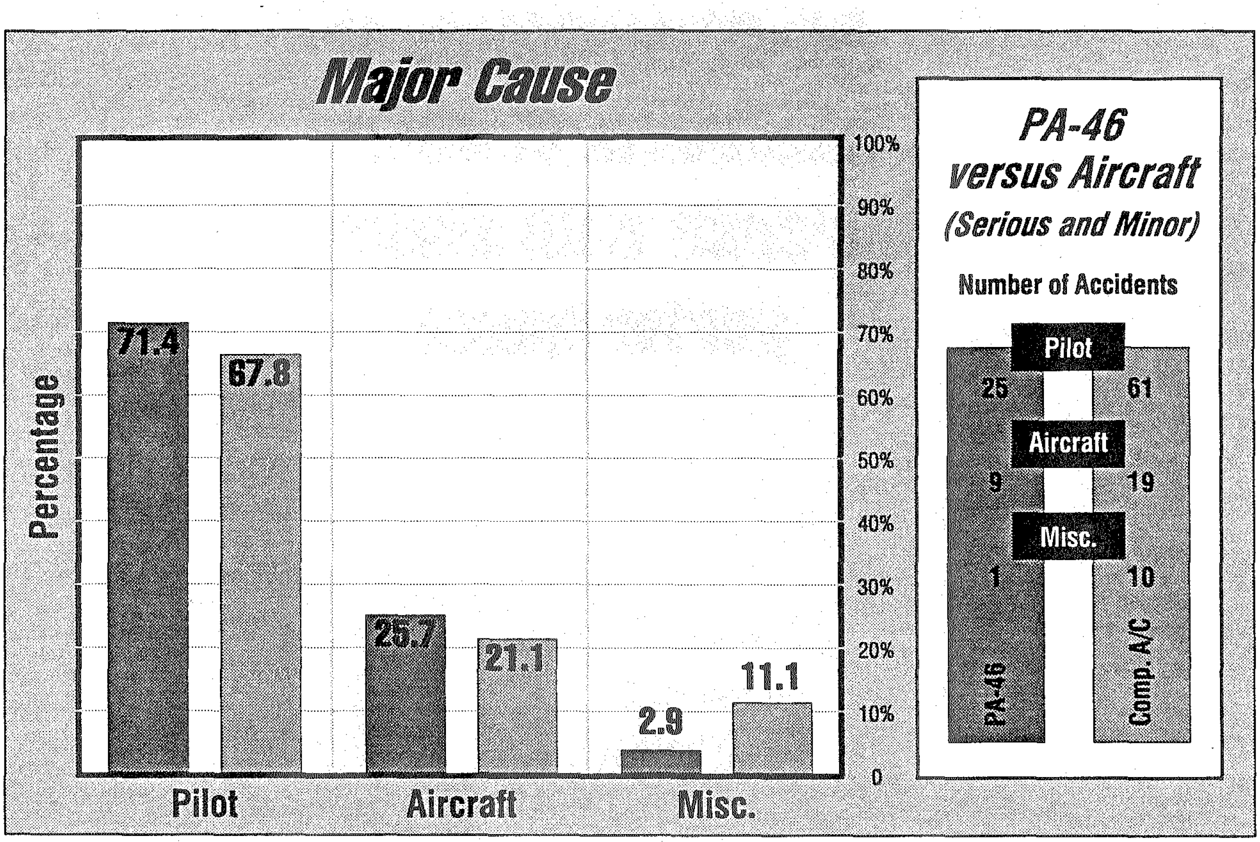


Figure 1

Figure1 shows the overall serious and minor accident percentage rates. Serious accidents are defined as those which result in serious or fatal injuries in accordance with NTSB Part 830 definitions. Although many minor accidents, including gear-up landings, result in costly damages, they are not classified as serious unless serious or fatal injuries have occurred.

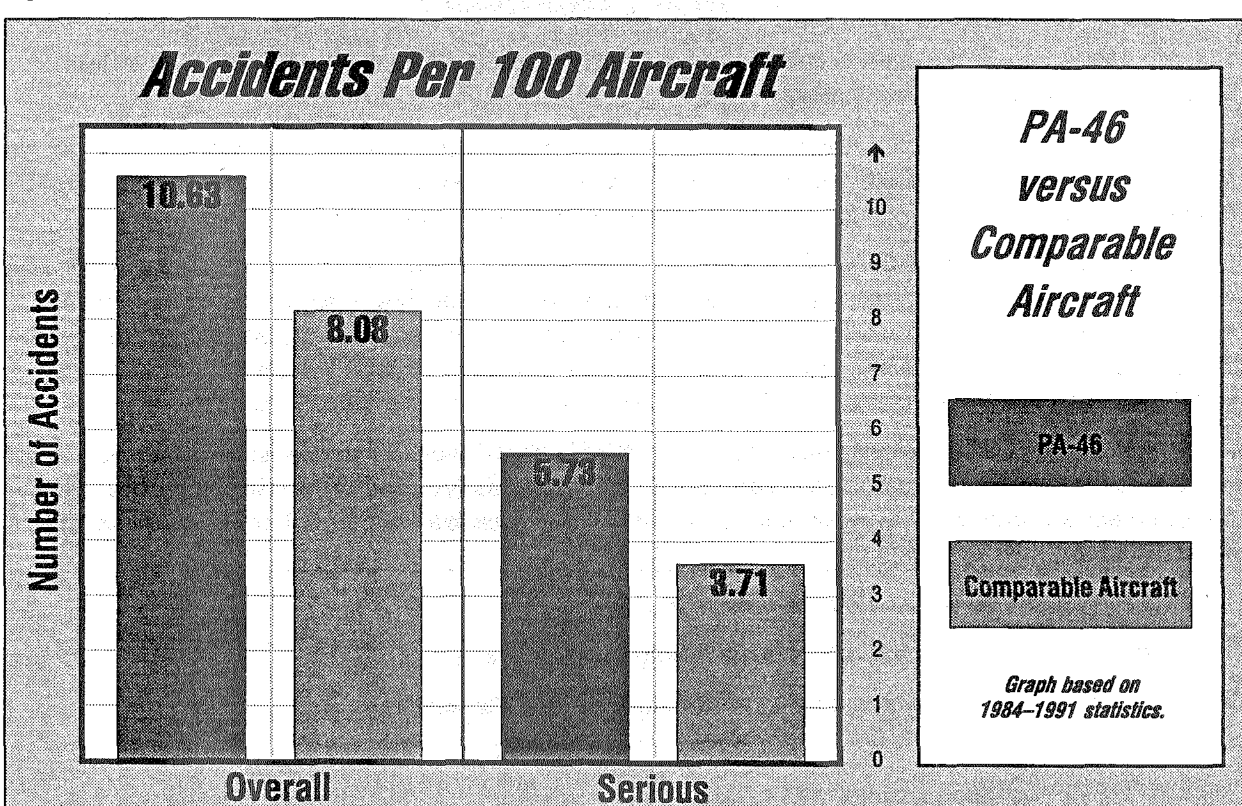
Accident Rate

Accident rates are computed using FAA estimates of active aircraft by make and model and their annual flying hours. These estimates are taken from the General Aviation Activity and Avionics Survey, an annual report of the results of their yearly survey of some 30,000 owners of U.S. registered general aviation aircraft. This report contains estimates of flying time, landings, fuel consumption, lifetime airframe hours, avionics, and engine hours of the active general aviation aircraft by manufacturer/model group, aircraft type, state and region of based aircraft and primary use.

Depending upon the measurement method selected, the PA-46 overall accident rate is either higher or lower than other aircraft in its category. One way of computing the accident rate is to compare the accidents with the number of aircraft built. When the overall accident rate is based on the number of aircraft built, the PA-46 rate is higher than the comparative aircraft. The second way of measuring accident rate is to use the 100,000-hour standard of measure. This is the method used by the NTSB. When the accident rate per 100,000 hours is used, the PA-46 has a slightly lower overall rate than the comparison group. In serious accidents, the PA-46 has a higher rate than the comparison group.

The two measures are shown in Figures 2 and 3. Figure 2 compares the rate of PA-46 accidents per 100 PA-46s built to the rate of accidents per 100 airplanes manufactured in the comparison group (see list page vi). The first two bars depict the overall accident rate for both serious and minor accidents. Bars three and four show serious accidents only. In Figure 3, each 100,000 hours flown in the PA-46 and in the comparison group respectively are categorized by 1) overall accidents, and 2) serious accidents.

Figure 2



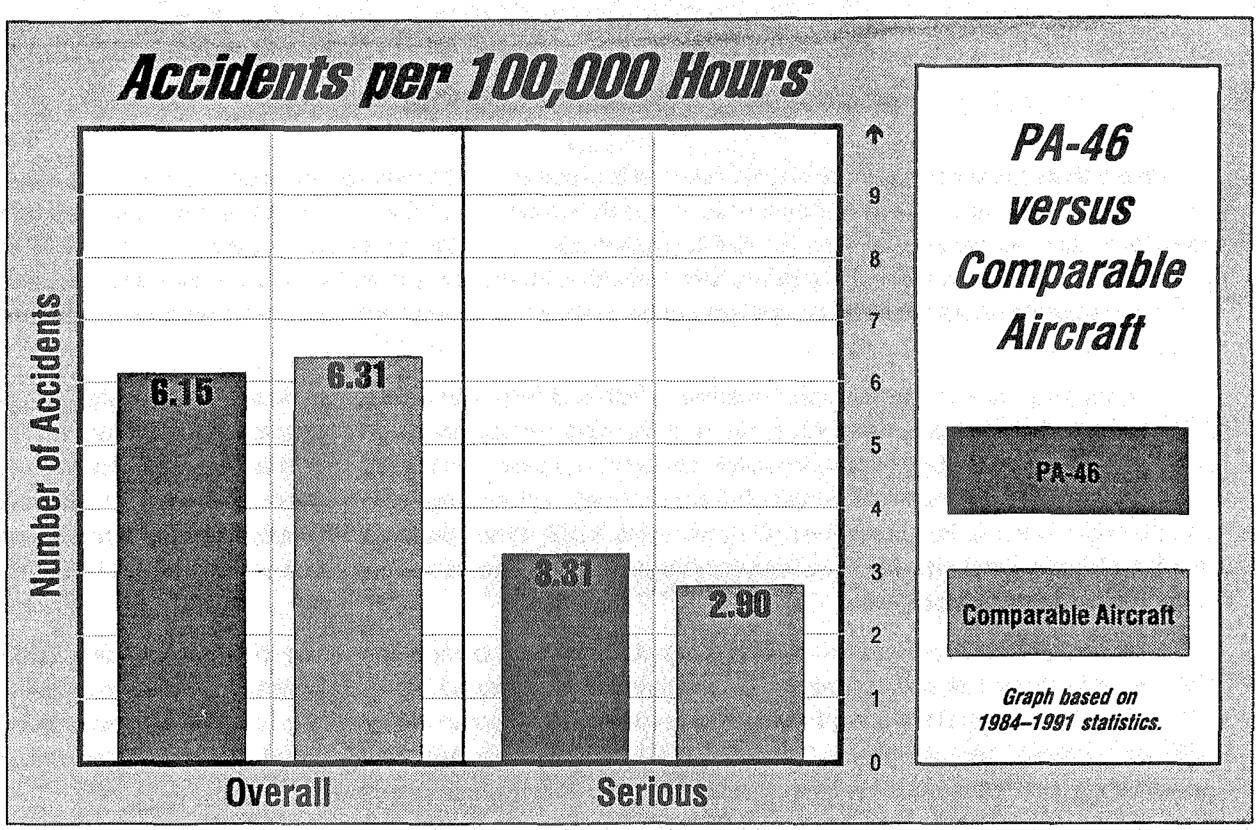


Figure 3

IMC Accidents

The next phase of the study focused on two specific kinds of accidents: those occurring in instrument meteorological conditions (IMC) and at night.

Using NTSB data for IMC accidents, the PA-46's IMC accident rate per 100,000 hours flown (3.26) is less than half of the comparison fleet (6.88) as shown in Figure 4. (An accident is coded as an IMC accident in the **Weather** field of the NTSB's final report if the surface weather at the nearest weather reporting facility is IMC.)

Under the NTSB criterion for IMC accidents, only six of the 35 PA-46 accidents were recorded as IMC for statistical purposes. ASF staff analysis attempted to determine whether IMC conditions were a key factor in the accident regardless of the **Weather** coding on the NTSB report. Using this criterion, at least 11 and possibly 13 of the 25 pilot-related accidents could be considered IMC accidents. Of the 11 accidents, all 11 pilots were instrument rated and flying on an IFR flight plan. Some key points for PA-46 pilots to remember:

Four accidents (Bakersfield, CA; Lakeville, MI; Naylor, MO; Bronson, FL) **stemmed from improper or non-use of the aircraft's anti/de-ice systems during climb in icing conditions resulting in loss of control. In three of these accidents, the aircraft was near convective activity which must be considered a major contributing factor, if not the cause.**

One each of the seven remaining accidents involved:

- Thunderstorm penetration during descent from altitude (Bristol, IN).
- An attempted circle-to-land maneuver at decision height (Sanford, ME).

- Loss of control (stall/spin) when the pilot attempted to override the autopilot during localizer intercept (Seattle, WA).
- Failure to adhere to published IFR approach procedure (Richmond, NH).
- Failure to maintain proper ILS glidepath (Twin Falls, ID).
- Weather reported below minimums or that subsequently dropped below minimums before time of impact (Boyne Falls, MI).
- An inadvertent stall on landing in VMC with an iced-up airplane (Lima, OH).

Figure **4** shows (1) accidents occurring in instrument meteorological conditions, and (2) accidents occurring while on an IFR flight plan. As the graph shows, all PA-46 IMC accidents occurred on an IFR flight plan. This was also true for most of the comparative aircraft accidents. The PA-46 shows a substantially lower involvement per 100,000 hours in IMC.

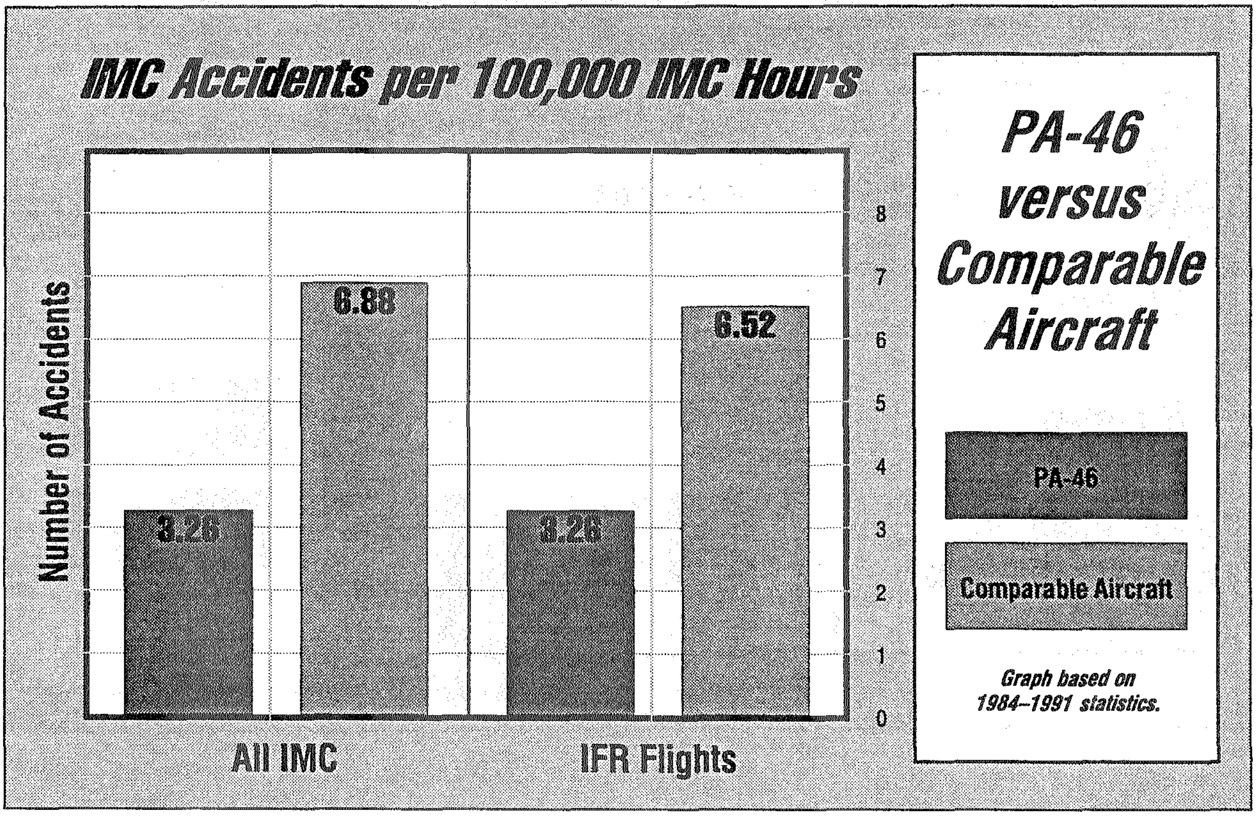


Figure 4

Night Accidents

The night accident rate is slightly better for the PA-46 than for the comparative aircraft. The PA-46 posted five night accidents, including one night IMC accident. The pilot involved in the night IMC accident was instrument rated and on an instrument flight plan. This accident is not factored into the night 100,000-flying-hour graph because it happened in 1992, a year in which accurate PA-46 flying hour statistics were not available.

Significantly, the primary cause of two PA-46 night accidents was mechanical/maintenance related rather than pilot error (an accident is coded as a night accident if the **Lighting** field on the NTSB final report is recorded as Night). For additional information regarding mechanical/system related accidents, see figure 11, page 1–11.

Figure **5** shows night accidents per 100,000 hours, night accidents in IMC, and night accidents on an IFR flight plan.

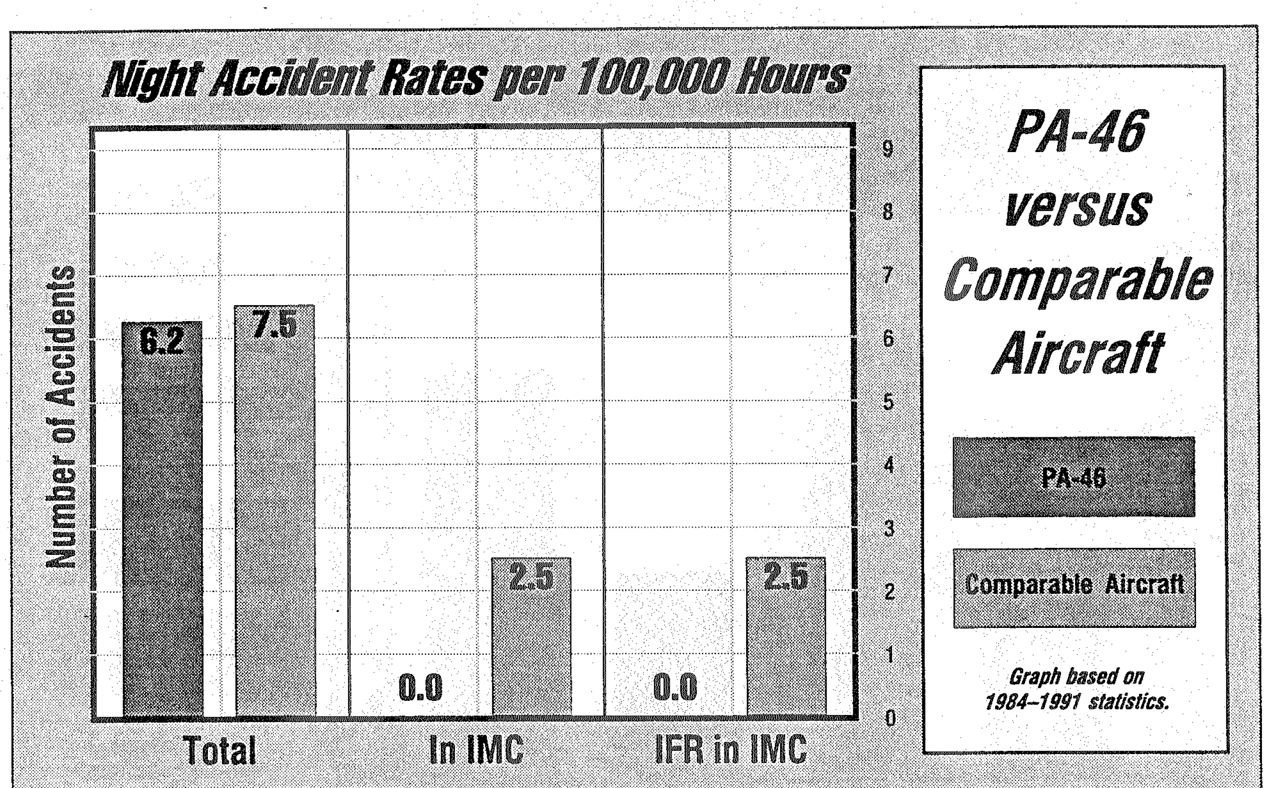


Figure 5

Accident Summary

Figure 6 demonstrates that the PA-46 has a lower percentage of serious accidents than the comparison group. However, the PA-46 has a higher incidence of minor accidents. As will be seen later, this is due to the unusually high number of accidents in two areas: landings and mechanical/maintenance.

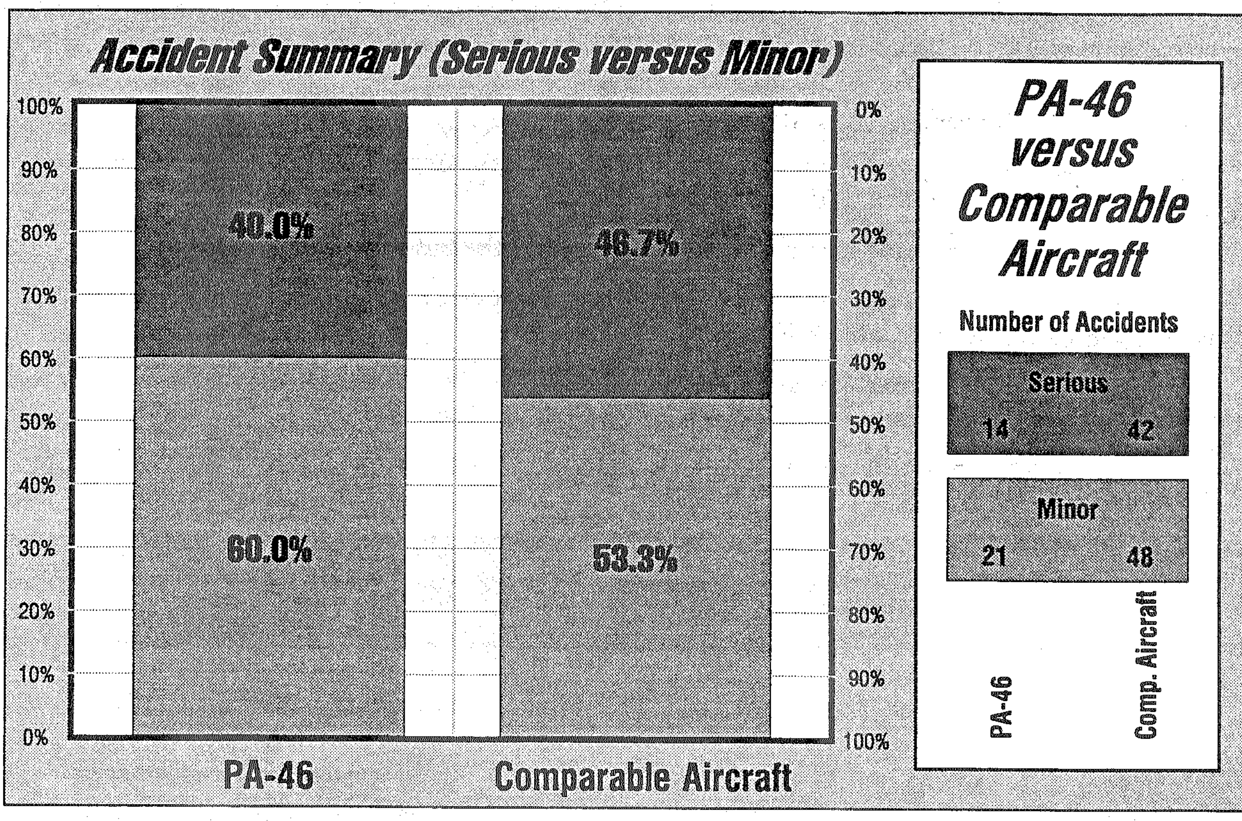


Figure 6

Pilot History

Figure 7 shows that the average total flight hours logged by PA-46 pilots involved in serious accidents is quite high—2,419 hours—but is significantly less than pilots in the comparison group who have accumulated an average 3,624 total flight hours. The greatest risk for serious accidents is in the 900- to 3,500-hour total time groups. The fact that only one low-time pilot (0–500 hours) was involved in a serious accident probably indicates that most PA-46 airplanes are being flown by experienced pilots (1,000 total hours plus).

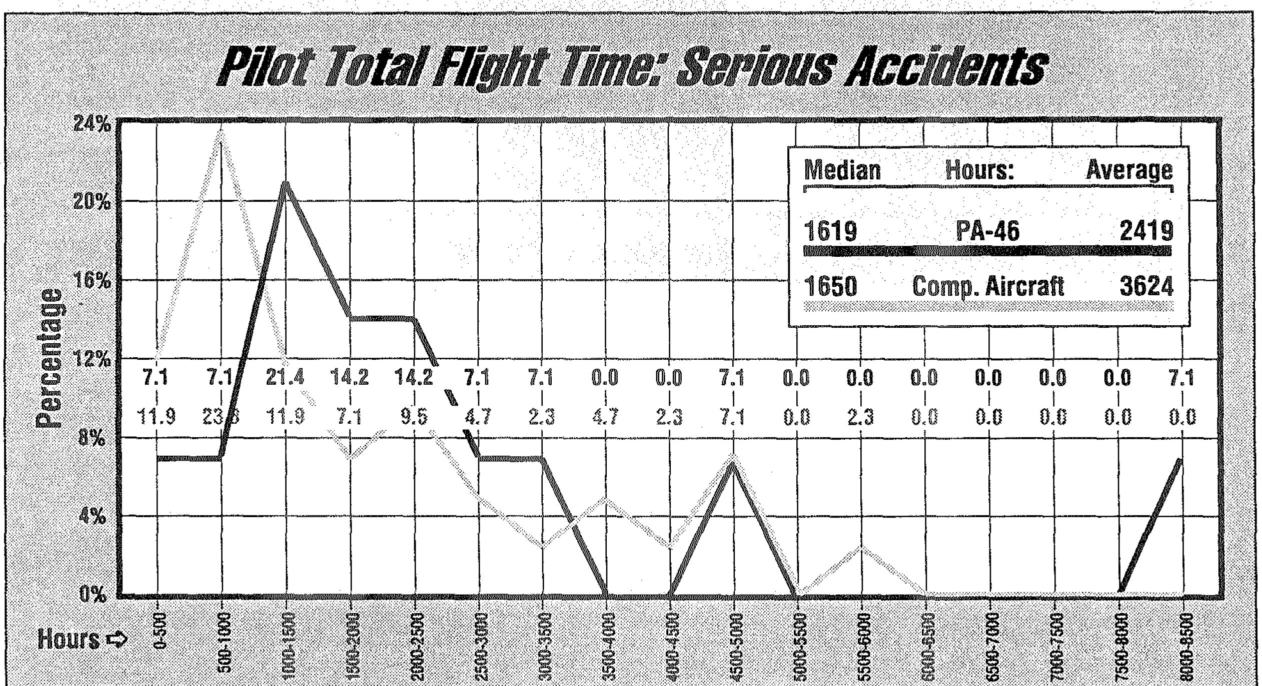
Pilots of all ages were involved in the pilot-related accidents; most fell in the 40–49- and 50–59-year age groups, however. This probably means that more PA-46s are being flown by pilots in these age groups than by younger pilots.

"The accident totals shown in Figure **6** differ from the sum of the *Number of Accidents* bars at the base of Figures **7**, **8**, **9**, and **10**; this stems from the fact that "pilot total time in type" and "time in type" is reported as unknown in some of the NTSB final reports."

The average instrument time for pilots involved in pilot-related accidents is 433 hours.

A study of the training history of the pilots involved was considered beyond the scope of this review due to the difficulty of obtaining accurate information.

Median hours have also been included with the average hours. The median is defined as the midpoint. Half the pilots involved in accidents will have more hours and half will have less.



PA-46	1	1	3	2	2	1	1	0	0	1	0	0	0	0	0	0	1
Comp. A/C	5	10	5	3	4	2	1	2	1	3	0	1	0	0	0	0	0

Number of Accidents

Figure 7

Figure **8** focuses on the serious accidents occurring between 0–1,000 hours time in type. **For both the PA-46 and comparative aircraft, most accidents occur in the first 200 hours, then the accident rate drops.** Not surprisingly, time in type for serious accidents is skewed more heavily toward the low time, less experienced pilots. The average time in type for PA-46 pilots is less than half that of pilots in the comparison group (198 hours versus 426 hours). There is a higher accident involvement of PA-46 pilots with less than 300 hours in type compared to pilots of comparative aircraft. The relatively high involvement of these pilots in serious accidents indicates a need for better initial transition training and qualification.

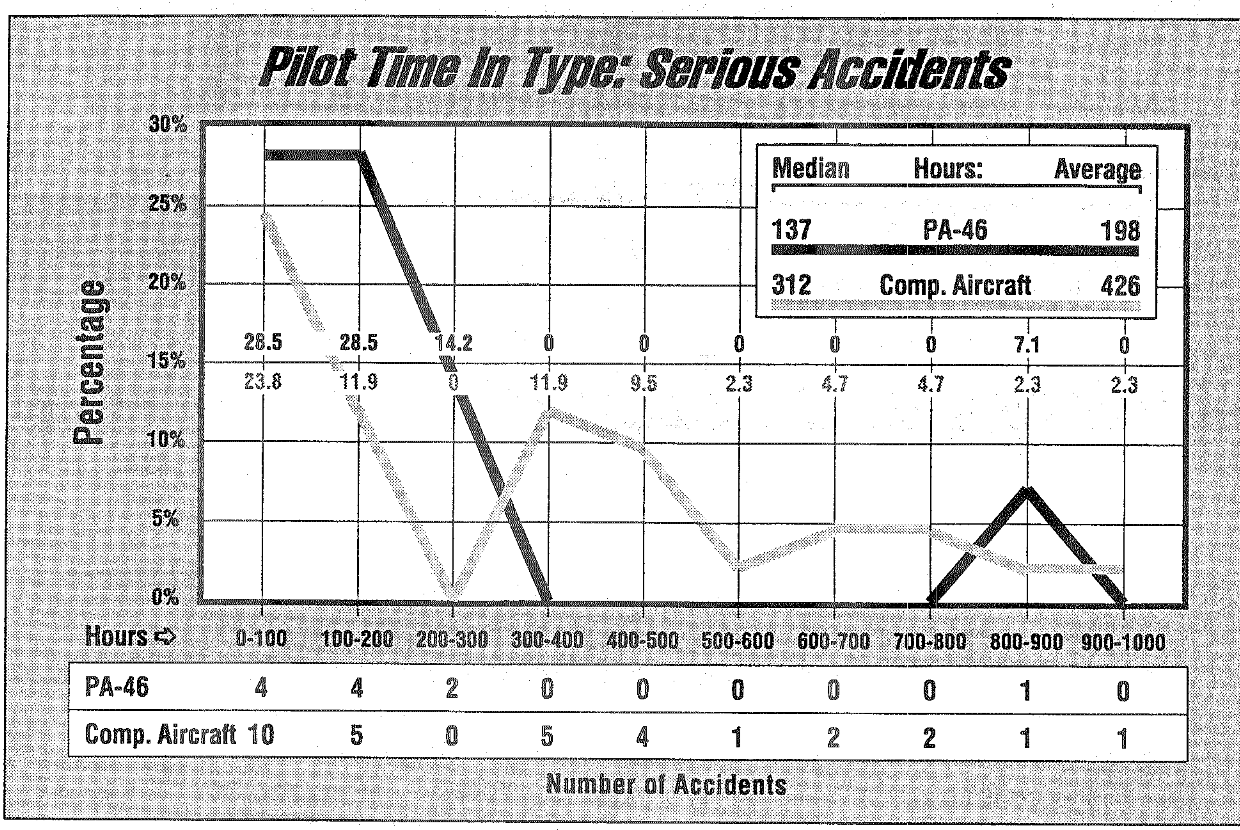
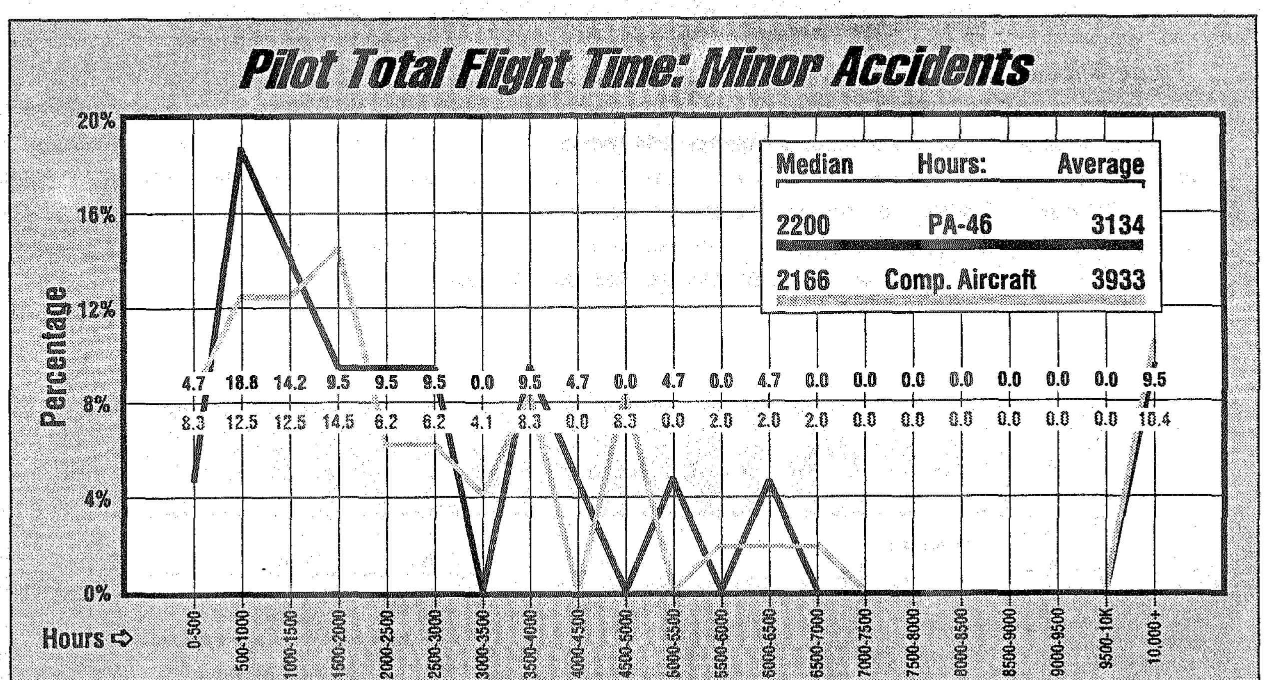


Figure 8

Minor Accidents

Figure **9** seems to reflect the average flight experience of the population of pilots flying both the PA-46 and the comparative aircraft. Figure **10** follows the typical curve of all aircraft ASF has studied thus far (Cessna P210, Cessna 182, Beech Bonanza/Debonair, and the Piper Cherokee/Arrow). Very simply, after the first 200 hours in type, the probability for minor accidents decreases significantly.

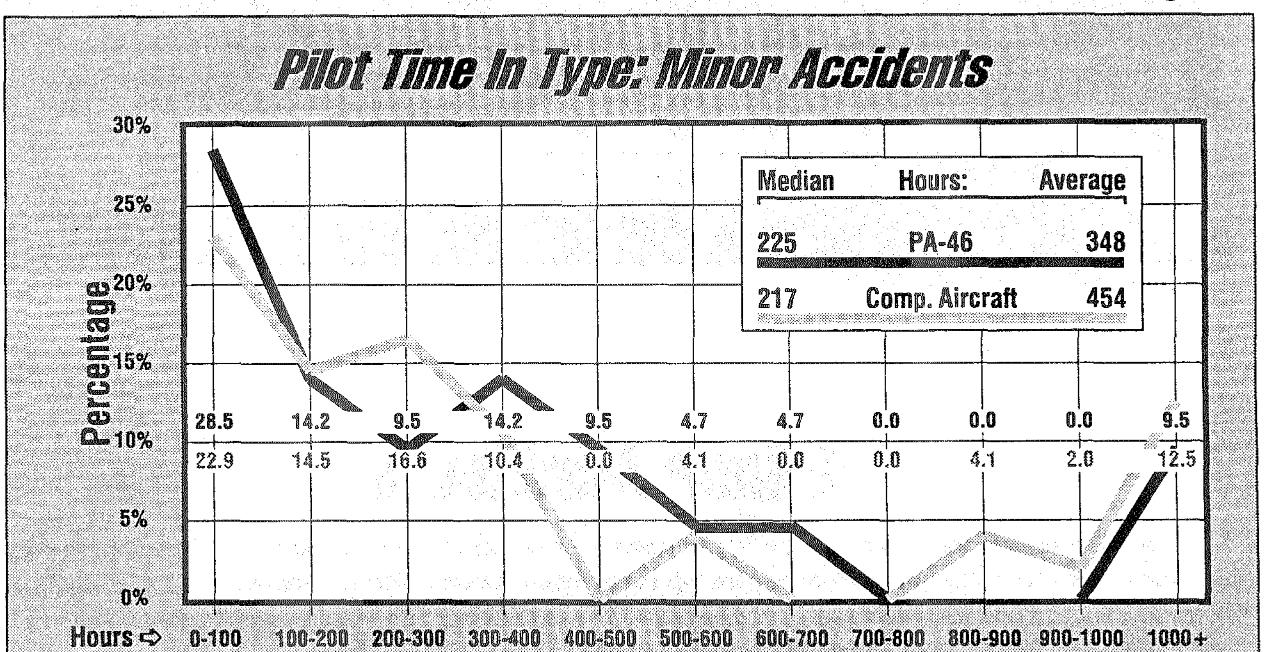


Hours ⇨	0-500	500-1000	1000-1500	1500-2000	2000-2500	2500-3000	3000-3500	3500-4000	4000-4500	4500-5000	5000-5500	5500-6000	6000-6500	6500-7000	7000-7500	7500-8000	8000-8500	8500-9000	9000-9500	9500-10K	10,000+
PA-46	1	4	3	2	2	2	0	2	1	0	1	0	1	0	0	0	0	0	0	0	2
Comp. A/C	4	6	6	7	3	3	2	4	0	4	0	1	1	1	0	0	0	0	0	0	5

Number of Accidents

Figure 9

Figure 10



Hours ⇨	0-100	100-200	200-300	300-400	400-500	500-600	600-700	700-800	800-900	900-1000	1000+
PA-46	6	3	2	3	2	1	1	0	0	0	2
Comp. A/C	11	7	8	5	0	2	0	0	2	1	6

Number of Accidents

Mechanical/System Malfunction: All Accidents

Of the 35 total accidents studied, nine accidents or 25% were attributed to mechanical/maintenance causes. The most predominant accident occurrence involved the fuel system, with four of nine total accidents. **The most common problem with the fuel system was leaks in the fuel lines.** One powerplant failure accident involved a crankshaft failure and another a cylinder separation in flight. See PA-46 Maintenance Summary (page 2–63) and individual mechanical/maintenance accident reports (pages 2–30 through 2–38) for additional information. Note that with the small number of accidents this will have a disproportionate effect on the percentage.

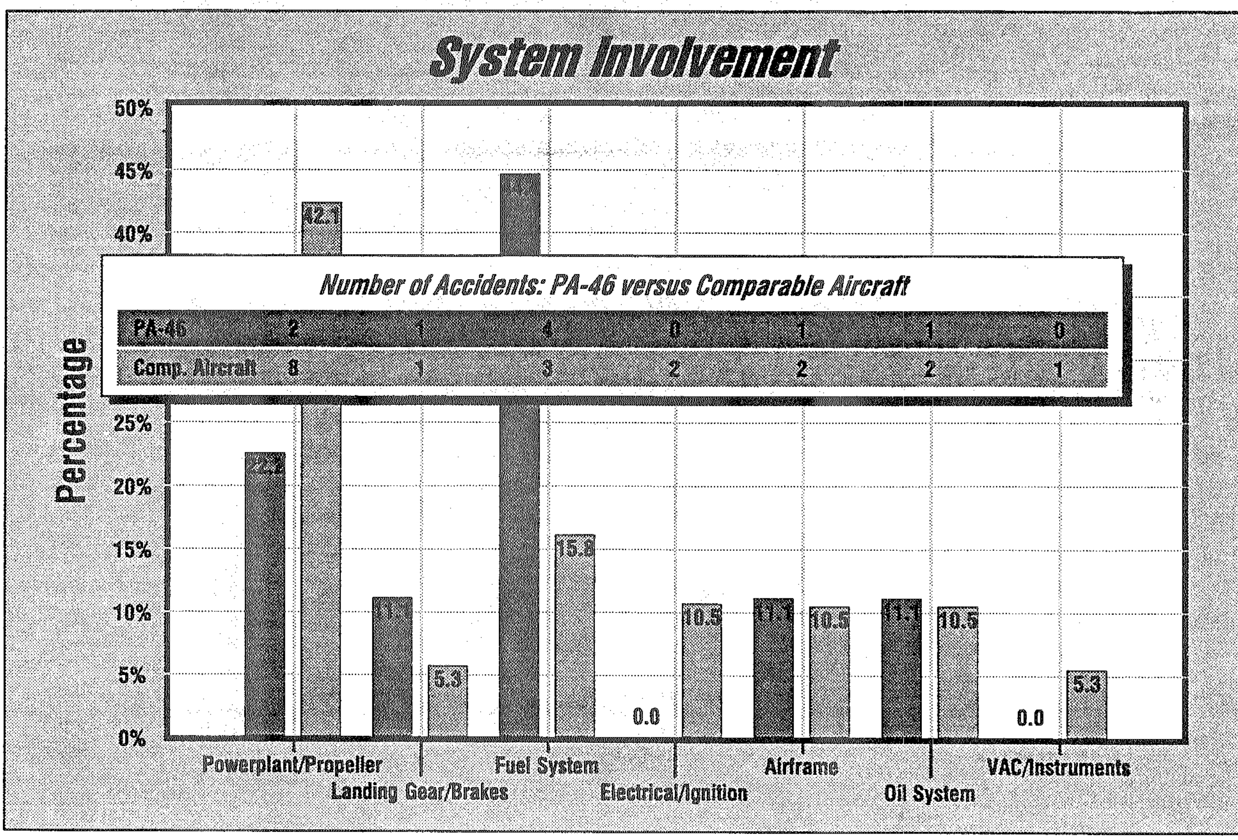


Figure 11

Pilot-Related Accidents

Phase of Flight/Causal Factors

A review of both serious and minor accidents illustrates that approaches and landings cause most problems for PA-46 pilots.

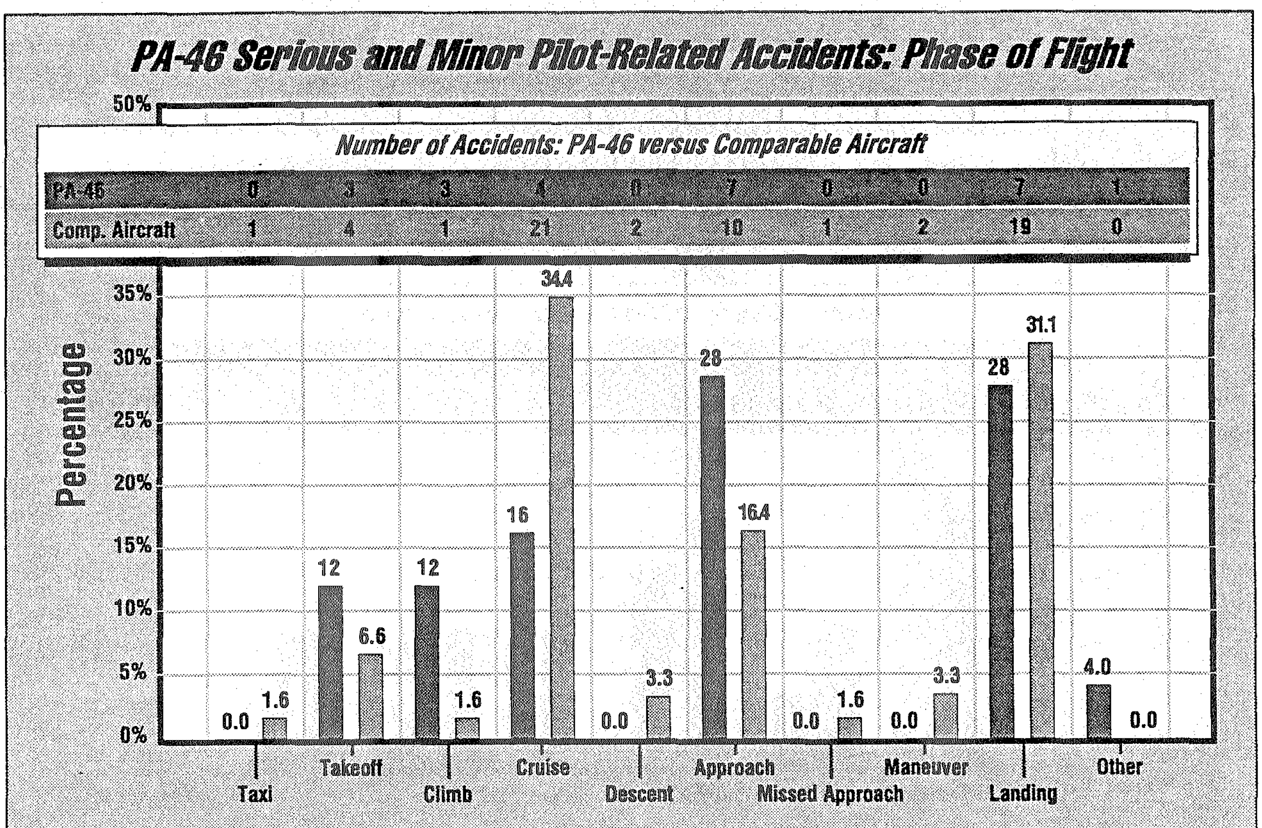


Figure 12

As shown in Figure 12, the PA-46 has a higher involvement than comparable aircraft in approach phase accidents, a slightly lower involvement in landing accidents, and about half the cruise-related accidents.

Seventeen of 25 accidents occurred during takeoff, approach, and landing. Two of three takeoff accidents and two of seven landing accidents involved pilot loss of directional control. This indicates a need to **stress crosswind takeoffs and landings during pilot training.** The five IFR approach accidents (including one circling approach) indicate a **need for rigorous instrument training that includes both coupled and manual approaches to minimums followed by missed approaches and full-stop landings from ILS and nonprecision approaches.**

Despite the publicity surrounding the PA-46 accidents enroute, the PA-46 has about one half as many as the comparative aircraft.

Six accidents—four Special Investigation and the Des Moines, IA, and Lima, OH, accidents were icing/ systems related.

There were two possible stall/spin accidents: one during a VFR approach (Van Nuys, CA) and one during an IFR approach (Seattle, WA); seven landing accidents, including one gear-up landing (Osage Beach, MO, Paso Robles, CA, Carson City, NV, Lima, OH, Aiken, SC, Doylestown, PA, and Bowling Green, KY); one thunderstorm penetration accident (Bristol, IN); two fuel exhaustion accidents (Los Angeles, CA, and North Hollywood, CA) and one formation midair collision accident (Boulder, CO).

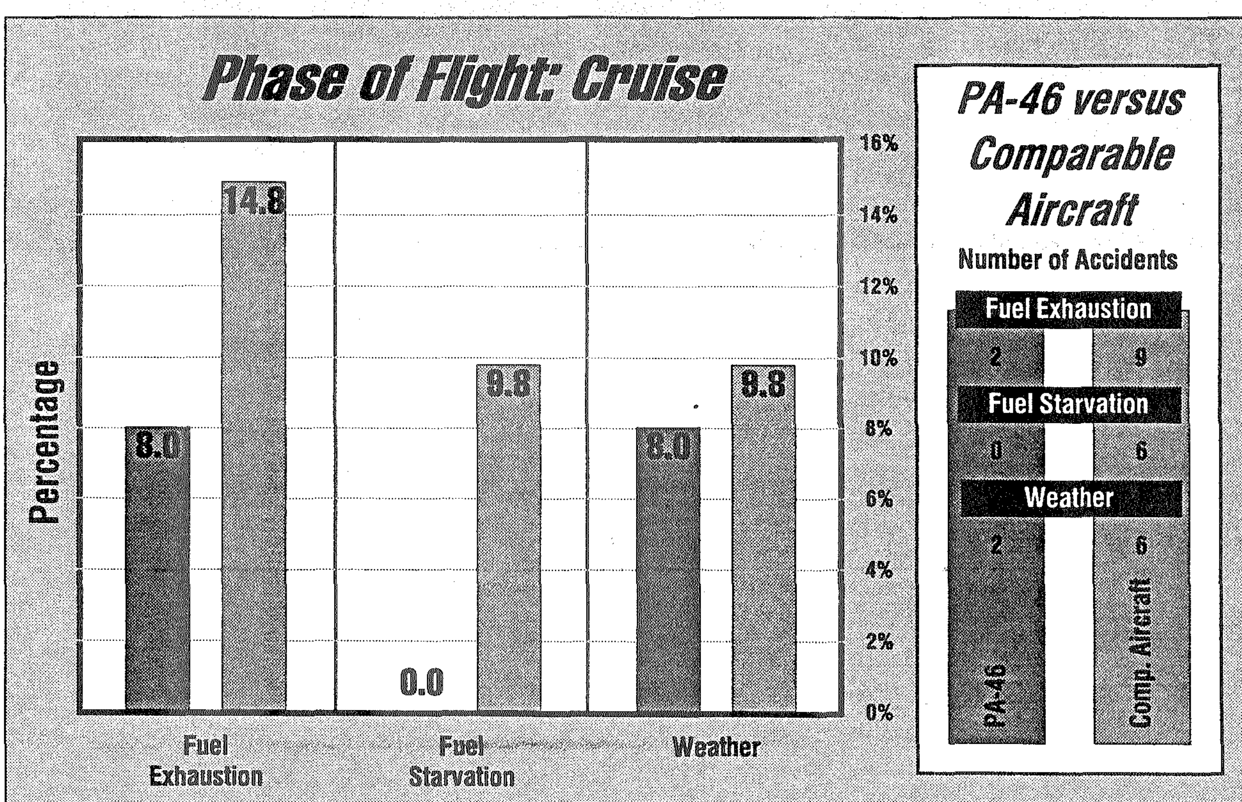
The reader is again reminded that the small number of accidents can skew percentages greatly.

Causal Factors: Cruise Accidents

As shown in Figure 13, during the cruise phase of flight, the PA-46 performs better than the comparative group. The same causal factors leading to cruise accidents in all types of aircraft affect the PA-46 pilot: fuel exhaustion (no fuel remaining in any tank), and weather.

PA-46 aircraft have been involved in two fuel exhaustion accidents, but unlike the comparative aircraft, had no fuel starvation accidents. Fuel starvation means there is fuel in a tank not connected to the engine.

Figure 13



Causal Factors: Approach Accidents

Figure **14** demonstrates that the PA-46 had a higher percentage of accidents during VFR approaches than the comparative group, and a higher percentage during IFR approaches. Lower pilot experience levels (for both total time and time in type) for the PA-46 versus comparative aircraft could be the underlying factor in this category.

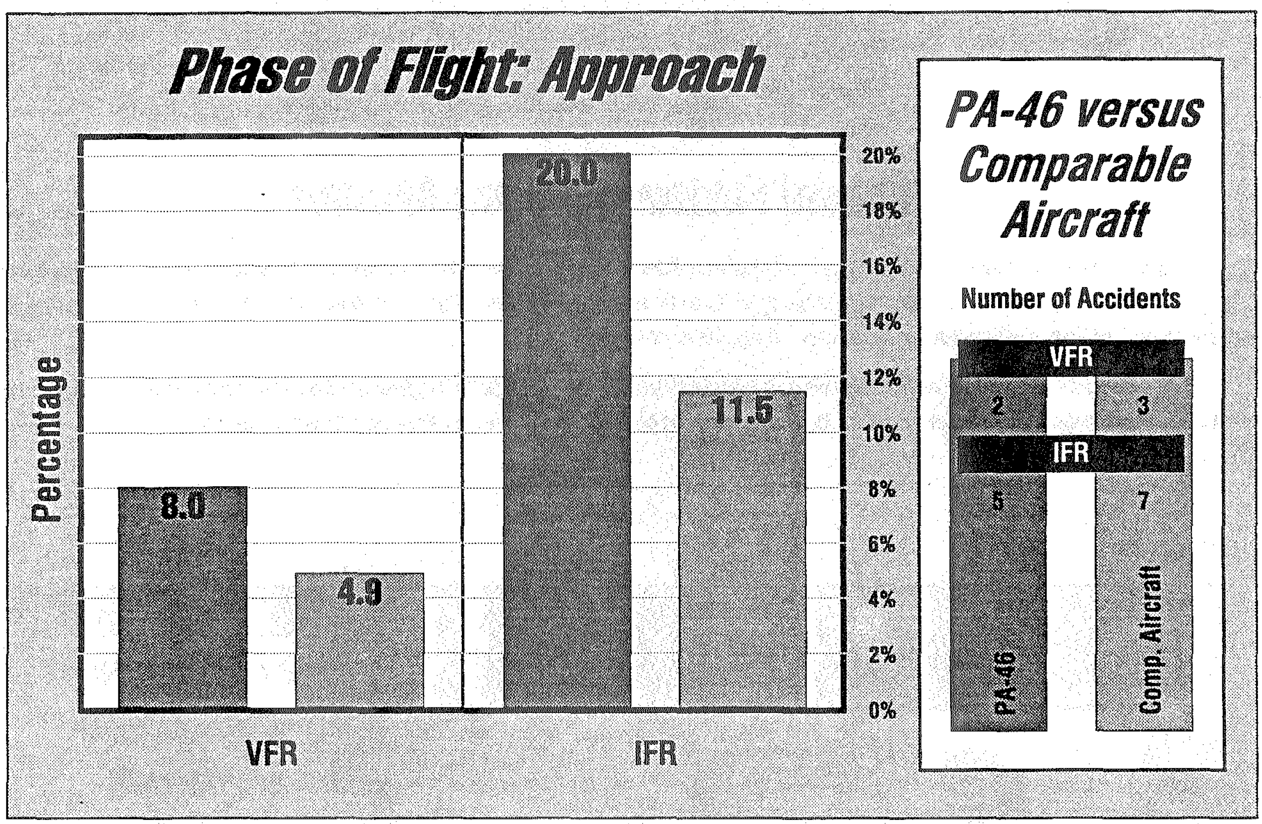


Figure 14

Causal Factors: Landing Accidents

Of the 35 total accidents studied in the seven-year period, seven were due to landing difficulties. Of these, three landed hard, one landed long, and two landing accidents involved loss of control, landing in crosswind/ gusts/tailwind—a major cause of landing-related accidents. Figure 15 shows the percentage of landing accidents that are related to pilot causal factors.

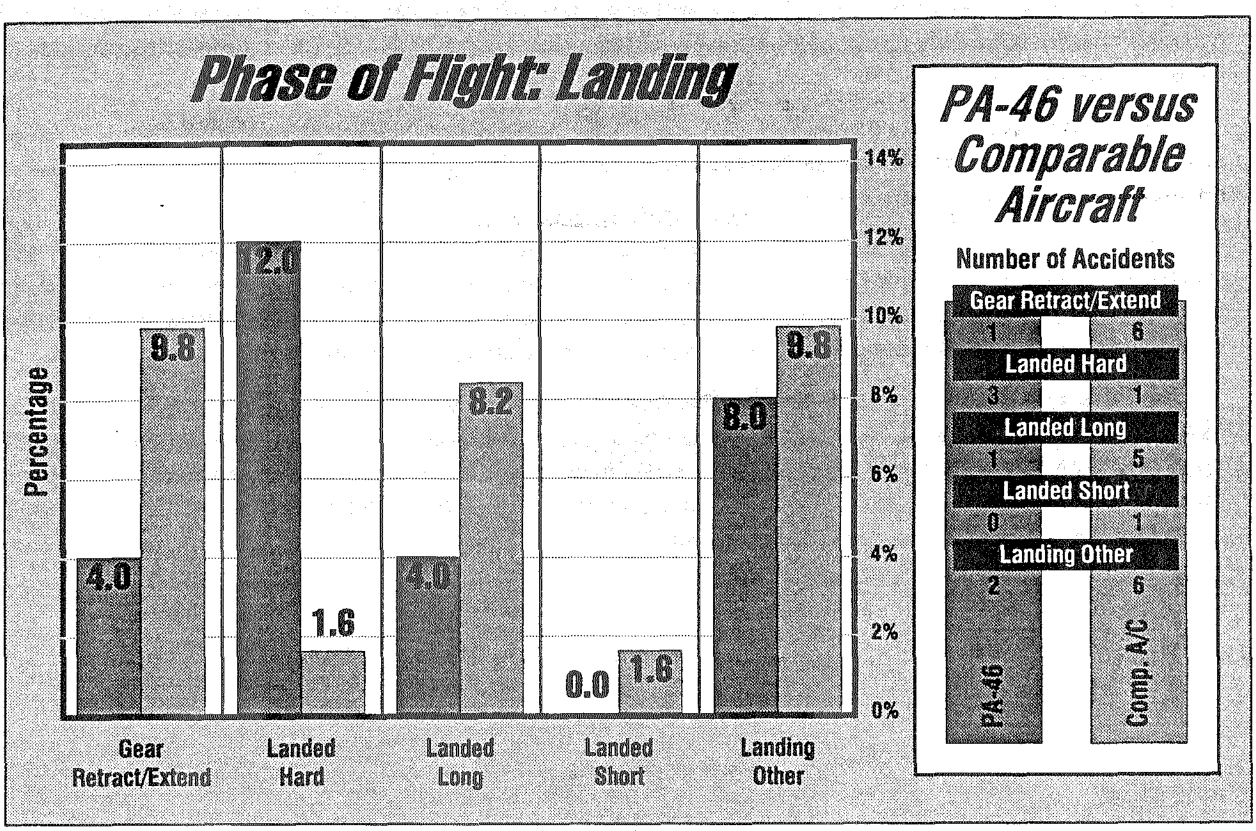


Figure 15

Summary

The PA-46 is a complex airplane capable of routinely operating in instrument meteorological conditions and the "flight level" environment. To operate the airplane safely, it is essential that pilots receive comprehensive and rigorous transition and recurrent training commensurate with the airplane's complexity and performance capability.

Thorough knowledge of the airplane's systems and their application is a necessary prerequisite to operate the PA-46 safely to its maximum capability. This is especially true of the ice protection equipment and the flight control system of which the autopilot is an integral part. Failure to understand these systems and use them properly was the probable cause of four fatal accidents that led to the NTSB Special Investigation and FAA Certification Review.

In addition to a thorough knowledge of the aircraft's systems and their application, PA-46 pilots need to acquire and maintain a high level of piloting skill and instrument proficiency. These skills are essential to the safe and efficient operation of the PA-46.

Additionally, a healthy respect for thunderstorms is essential. The NTSB Special Report is silent on this point, yet it must be considered. Flight in the low flight levels gives the pilot some of the highest exposure to adverse weather possible. The aircraft is frequently incapable of topping it. The other option is to descend a long way to reach an alternate airport, or avoid thunderstorms visually at low altitude.

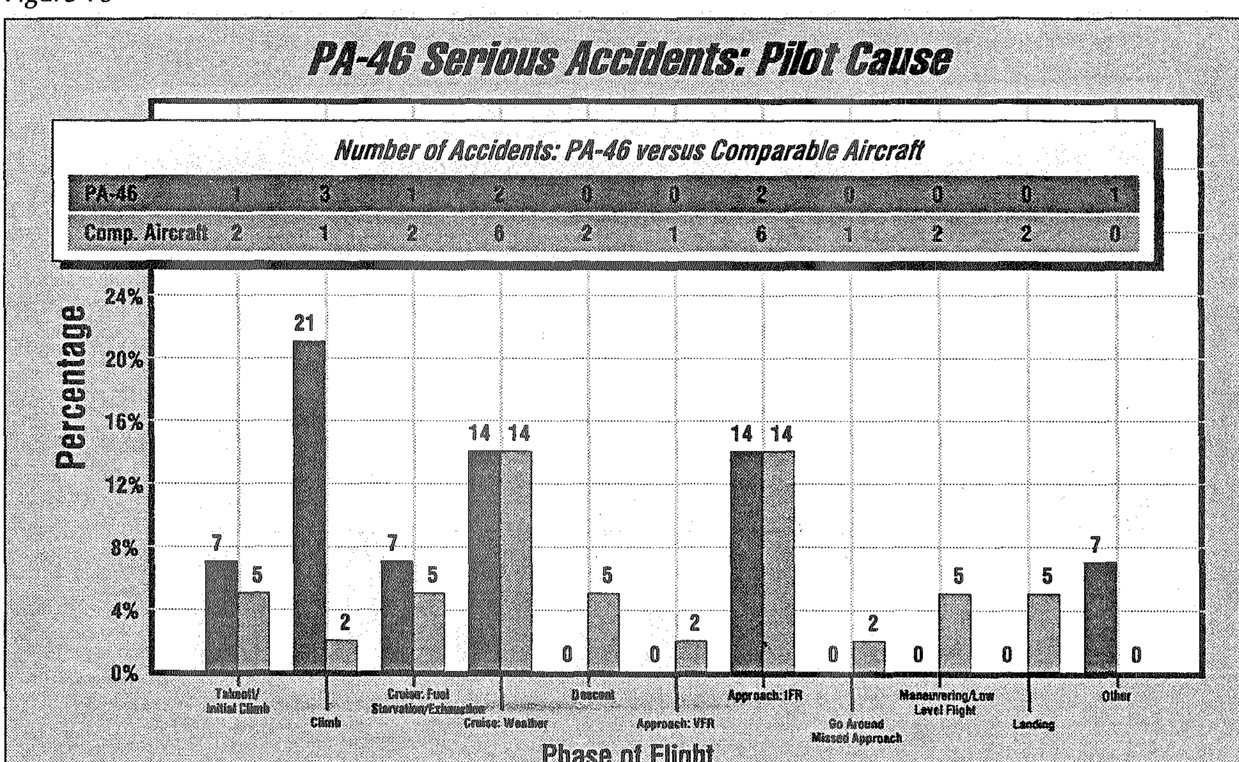
The PA-46 is a crashworthy airplane. In the 35 accidents covered by the NTSB final reports, 13 aircraft were destroyed and 22 received substantial damage. In these 22 accidents, only one involved serious injury, one minor injury, and 20 where there were no injuries to crew or passengers. In any airplane, accidents tend to be survivable if the pilot maintains control and keeps flying the airplane to a landing. It's far better to strike the surface under control than to stall, spin, and crash out of control.

Percentage and Number of Piper PA-46 Serious Accidents

Total Accidents		Fatal/Serious Injuries		Aircraft Damage: Destroyed		Aircraft Damage: Substantial		Category
%	#	%	#	%	#	%	#	**Pilot**
7.1	1	3.4	1	0.0	0	100.0	1	Takeoff/Initial Climb
21.4	3	17.2	5	23.1	3	0.0	0	Climb
7.1	1	6.9	2	7.7	1	0.0	0	Cruise: Fuel Starvation/Exhaustion
14.3	2	24.1	7	15.4	2	0.0	0	Cruise: Weather
14.3	2	10.3	3	15.4	2	0.0	0	Approach: IFR
7.1	1	3.4	1	7.7	1	0.0	0	Other Causes
71.4%	**10**	**65.5%**	**19**	**69.2%**	**9**	**100.0%**	**1**	**Subtotal: Pilot**
								Mechanical Maintenance
7.1	1	6.9	2	7.7	1	0.0	0	Powerplant/Propeller
7.1	1	3.4	1	7.7	1	0.0	0	Fuel System
7.1	1	13.8	4	7.7	1	0.0	0	Oil System
21.4	**3**	**24.1**	**7**	**23.1**	**3**	**0.0**	**0**	**Subtotal: Mechanical Maintenance**
7.1	**1**	**10.3**	**3**	**7.7**	**1**	**0.0**	**0**	**Subtotal: Other/Undetermined**
100%	**14**	**100%**	**29**	**100%**	**13**	**100%**	**1**	**Grand Total: All Causes**

Percentages are rounded off.

Figure 16

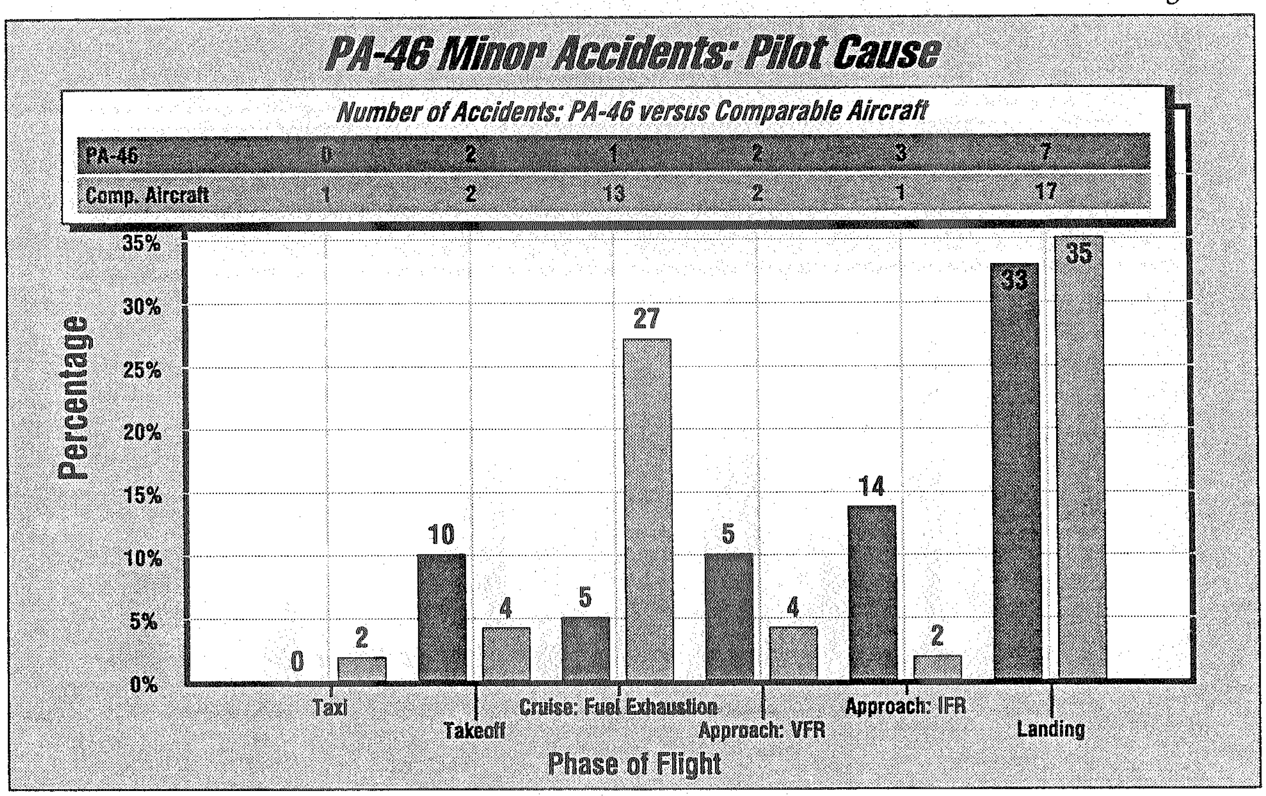


Percentage and Number of Piper PA-46 Minor Accidents

Total Accidents		Aircraft Destroyed		Aircraft Damage Substantial		Aircraft Damage None		Category
%	#	%	#	%	#	%	#	**Pilot**
9.5	2	0.0	0	10.5	2	0.0	0	Takeoff/Initial Climb
9.5	1	0.0	0	10.5	2	0.0	0	Cruise: Fuel Starvation/Exhaustion
4.8	2	0.0	0	5.3	1	0.0	0	Approach: VFR
14.3	3	0.0	0	15.8	3	0.0	0	Approach: IFR
4.8	1	0.0	0	5.3	1	0.0	0	Landing Gear: Extension/Retraction
14.3	3	0.0	0	15.8	3	0.0	0	Landing: Hard
4.8	1	0.0	0	5.3	1	0.0	0	Landing: Long
9.5	2	0.0	0	10.5	2	0.0	0	Landing: Other
71.4%	**15**	**0.0%**	**0**	**78.9%**	**15**	**0.0%**	**0**	**Subtotal: Pilot**
								Mechanical Maintenance
4.8	1	100.0	1	0.0	0	0.0	0	Powerplant/Propeller
4.8	1	0.0	0	5.3	1	0.0	0	Landing Gear/Brakes/Wheels
14.3	3	0.0	0	10.5	2	100.0	1	Fuel System
4.8	1	0.0	0	5.3	1	0.0	0	Control/Airframe
28.6	**6**	**100.0**	**1**	**21.1**	**4**	**100.0**	**1**	**Subtotal: Mechanical Maintenance**
100%	**21**	**100%**	**1**	**100%**	**19**	**100%**	**1**	**Grand Total: All Causes**

Percentages are rounded off.

Figure 17



Part 2

Piper PA-46
Accident Briefs and Maintenance Summary

Summaries of Final NTSB Accident Reports 2–2

NTSB Special Investigation Report 2–39

NTSB Preliminary Accident Reports 2–52

Foreign Accidents 2–61

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The AOPA Air Safety Foundation — Aircraft Accident Summary Report

Reference Number: 89-0269 **Data Provided By NTSB**

Date & Time	Aircraft Data	Registration No.	Type Operation	Phase Occurred	Aircraft Damage
89.02.19 1620 MST	PA-46 (SERP) 310 HP	N9092W	PERSONAL	TAKEOFF	SUBSTNTL

Injuries:	Fatal	Serious	Minor	None
Crew:	0	0	0	1
Pass:	0	0	0	4
Other:	0	0	0	0

Location: Angel Fire, NM **Flight Plan:** IFR
Itinerary: Angel Fire, NM, to Eagle, CO
Airport: Angel Fire **Runway:** 35, 8900/75, Asphalt, Wet

Weather:	VMC			**Clouds:**	N/A Broken
Visibility:	3.000 SM, B.Snw	**Precip:**	Snw Shower	**Ceiling:**	1500 ft.
Wind:	230/20	**Gusts:**	40	**Lighting:**	Day
Briefing:	FSS	**Type:**	Telephone	**Complete:**	Y

Pilot:	PVT/SEL/GLI			**Hours:** Last 24 Hrs - 2	**Total:**	6160
Age:	60 Yrs.	**Instrument:**	Y	Last 30 Dys - 40	**Type:**	1100
Medical:	Y	**Waivers:**	Y	Last 90 Dys - 130	**Instmt:**	2020
BFR:	Y	**Months Since:**	24	**Aircraft:** PA-46	**M. Eng:**	0

Emergency Occurred During: TAKEOFF

A private pilot and four passengers were making a personal IFR flight. A takeoff was attempted on Runway 35, with snow drifts on both sides. Wind was estimated as 230 degrees at 25 knots, with gusts to 35 knots. The pilot said that at rotation, the plane hit wind shear from 260 degrees, that lifted the left wing. Directional control was lost, and the airplane settled back on the runway. The left main wheel struck a snow bank, and the aircraft spun left 180 degrees. The tail section went through the snow bank, and the airplane departed the runway to the left. The pilot said that when he exited the aircraft, the wind was from 190 degrees at an estimated 40 knots. A witness verified a 180-degree wind shift and estimated the wind speed at 40 knots.

Probable Cause: PIC - Inadequate compensation for wind conditions, Aircraft control not maintained.

Factors: Weather condition - Unfavorable wind, Gusts. Terrain condition - Snow bank.

ASF Comments:

This pilot exercised poor judgment by attempting to take off in a strong, gusty quartering tailwind (estimated 230 degrees at 25 to 30 knots) that may have exceeded the maximum demonstrated crosswind component for PA-46 aircraft. Pilot technique is a factor in successful takeoffs made in a strong, gusty crosswind. By holding full aileron into the wind and maintaining directional control with opposite rudder until sufficient airspeed is gained for the controls to become effective and keeping the airplane on the ground until 5 to 10 knots past normal liftoff speed, the aircraft can be flown into the air under full control. As soon as a positive rate of climb is established, a shallow coordinated turn into the wind will compensate for drift.

The AOPA Air Safety Foundation — Aircraft Accident Summary Report

Reference Number: 91-1000 **Data Provided By NTSB**

Date & Time	Aircraft Data	Registration No.	Type Operation	Phase Occurred	Aircraft Damage
91.10.14 0615 CDT	PA-46 (SERP) 310 HP	N1FY	BUSINESS	TAKEOFF	SUBSTNTL

Injuries:	Fatal	Serious	Minor	None
Crew:	0	1	0	0
Pass:	0	0	4	0
Other:	0	0	0	0

Location: Sioux Center, IA **Flight Plan:** NONE
Itinerary: Sioux Center, IA, to St. Louis, MO
Airport: Sioux Center Muni. **Runway:** 35, 3002/50, Concrete, Dry

Weather:	VMC			**Clouds:**	8000 ft. Broken
Visibility:	15.0 SM, None	**Precip:**	None	**Ceiling:**	8000 ft.
Wind:	315/15	**Gusts:**	21	**Lighting:**	Dawn
Briefing:	FSS	**Type:**	Telephone	**Complete:**	Y

Pilot:	COMM/SMEL		**Hours:** Last 24 Hrs - UN	**Total:**	UNK
Age:	55 Yrs.	**Instrument:** Y	Last 30 Dys - UNK	**Type:**	UNK
Medical:	Y	**Waivers:** Y	Last 90 Dys - UNK	**Instmt:**	UNK
BFR:	Y	**Months Since:** 5	**Aircraft:** PA-46	**M. Eng:**	UNK

Emergency Occurred During: TAKEOFF

The high performance single-engine corporate airplane commenced its pre-dawn takeoff roll with a left front, quartering crosswind of approximately 25 miles per hour. Passengers stated that the airplane lifted off earlier than they've been accustomed to. After liftoff, the airplane contacted the ground, departed the left side of the runway, and struck a wind sock pole and a wind tee. The airplane was reestablished on the runway and ran off the departure end. After traveling approximately 1,000 feet from the departure end, the airplane struck a tree with its left wing, separating it from the fuselage at the wing root. The airplane then collided with a road embankment, went over it, and came to rest in a plowed field.

Probable Cause:
PIC - Directional control not maintained, aborted takeoff not performed.

Factors: Weather condition - Wind shear.

ASF Comments:
Assuming a quartering crosswind of 20 statute miles per hour, the aircraft may have been operating near its maximum demonstrated crosswind capability. Also, with five people on board, the CG may have been aft of limit. The combination of the two factors may have caused a premature liftoff with inadequate airspeed to maintain control. Use of full aileron into the wind until the controls are effective and becoming airborne at 5 to 10 knots above normal liftoff speed is an accepted crosswind takeoff technique for most general aviation aircraft. Once a positive rate of climb is established, a shallow coordinated turn into the wind will correct for drift.

The AOPA Air Safety Foundation — Aircraft Accident Summary Report

Reference Number: 93-0162 **Data Provided By NTSB**

Date & Time	Aircraft Data	Registration No.	Type Operation	Phase Occurred	Aircraft Damage
93.03.19 0630 MST	PA-46 (SERP) 310 HP	N24WW	PERSONAL	TAKEOFF	SUBSTNTL

Injuries:	Fatal	Serious	Minor	None
Crew:	0	0	0	1
Pass:	0	0	0	3
Other:	0	0	0	0

Location: Hailey, ID
Flight Plan: VFR
Itinerary: Hailey, ID, to Mexicali, Mexico
Airport: Friedman Memorial
Runway: 13, 6602/100, Asphalt, Dry

Weather:	VMC			**Clouds:**	Clear Clear
Visibility:	30.0 SM, None	**Precip:**	None	**Ceiling:**	None
Wind:	330/05	**Gusts:**	0	**Lighting:**	Day
Briefing:	FSS	**Type:**	Telephone	**Complete:**	U

Pilot:	PVT/SMEL			**Hours:**	Last 24 Hrs - 1	**Total:**	1509
Age:	46 Yrs.	**Instrument:**	Y		Last 30 Dys - 9	**Type:**	21
Medical:	Y	**Waivers:**	N		Last 90 Dys - 16	**Instmt:**	246
BFR:	Y	**Months Since:**	3	**Aircraft:**	PA-46	**M. Eng:**	829

Emergency Occurred During: TAKEOFF

During the takeoff roll on Runway 13 the aircraft began to drift left. The pilot was unsuccessful in correcting for the drift and the aircraft impacted a snow bank along the east outboard edge of the runway before nosing over. Subsequent examination of the aircraft revealed no mechanical malfunction with either the brakes, rudder system, or nosewheel steering and the passenger seated in the front right cockpit seat reported that he did not have his feet on the rudder pedals. Winds were northwesterly at 5 knots.

Probable Cause:
PIC - Directional control not maintained.

Factors:

ASF Comments:
It's difficult to understand how the pilot could lose control of the aircraft under the reported weather conditions unless the runway was icy. Positive aircraft control should be established early in the takeoff run, otherwise the takeoff should be aborted.

The AOPA Air Safety Foundation — Aircraft Accident Summary Report

Reference Number: 90-0242 **Data Provided By NTSB**

Date & Time	Aircraft Data	Registration No.	Type Operation	Phase Occurred	Aircraft Damage
90.01.08 1114 PST	PA-46 (SERP) 350 HP	N9150X	PERSONAL	DESCENT	SUBSTNTL

Injuries:	Fatal	Serious	Minor	None
Crew:	0	0	0	1
Pass:	0	0	0	1
Other:	0	0	0	0

Location: Van Nuys, CA
Itinerary: Oxnard, CA, to Van Nuys, CA
Airport: Van Nuys
Flight Plan: IFR
Runway: 16R, 8000/150, Macadam, Dry

Weather: VMC
Visibility: 25.0 SM, None **Precip:** None
Wind: 00/00 **Gusts:** 0
Briefing: UNK **Type:** UNK
Clouds: 15000 ft. Scattered
Ceiling: None
Lighting: Day
Complete: U

Pilot: PVT/SEL
Age: 42 Yrs. **Instrument:** Y
Medical: Y **Waivers:** Y
BFR: U **Months Since:** UN
Hours: Last 24 Hrs - UN **Total:** 225
Last 30 Dys - UNK **Type:** 169
Last 90 Dys - UNK **Instmt:** UNK
Aircraft: UNKNOWN **M. Eng:** UNK

Emergency Occurred During: APPROACH

The pilot of a Piper PA-46 allowed the aircraft to stall and collide with the runway, while landing. He stated he had slowed down during the approach due to previous traffic still on the runway. The aircraft went into a full stall and the pilot's application of power was too late to prevent a collision with the runway.

Probable Cause:
PIC - Airspeed not maintained.

Factors:
PIC - Inadvertent stall/mush.

ASF Comments:
The stall/mush/hard landing accident has been with us since the days of the Wright Brothers and pilot distraction is often the underlying cause. This pilot allowed himself to be distracted by the aircraft ahead on the runway to the point where he lost control. The pilot's low total time and relatively low time in type are certainly factors to be considered.

The AOPA Air Safety Foundation — Aircraft Accident Summary Report

Reference Number: 84-3244 **Data Provided By NTSB**

Date & Time	Aircraft Data	Registration No.	Type Operation	Phase Occurred	Aircraft Damage
84.08.13 0745 EDT	PA-46 (SERP) 310 HP	N4323G	PERSONAL	APPROACH	DESTROYED

Injuries:	Fatal	Serious	Minor	None
Crew:	1	0	0	0
Pass:	0	0	0	0
Other:	0	0	0	0

Location: Richmond, NH **Flight Plan:** IFR
Itinerary: Westerly, RI, to Keene, NH
Airport: Dillant-Hopkins **Runway:** 02, 6502/150, Asphalt, Unk

Weather:	UNK			**Clouds:**	Unknown Partly Obsc
Visibility:	5.0 SM, Fog	**Precip:**	None	**Ceiling:**	1000 ft.
Wind:	Unk/Un	**Gusts:**	Un	**Lighting:**	DAY
Briefing:	FSS	**Type:**	Telephone	**Complete:**	Y

Pilot:	COMM/CFI/SMEL			**Hours:** Last 24 Hrs - UN	**Total:**	3097
Age:	59 Yrs.	**Instrument:**	Y	Last 30 Dys - UNK	**Type:**	UNK
Medical:	Y	**Waivers:**	Y	Last 90 Dys - UNK	**Instmt:**	1322
BFR:	Y	**Months Since:**	16	**Aircraft:** C-182	**M. Eng:**	27

Emergency Occurred During: APPROACH

The pilot was flying inbound for the ILS Runway 02 approach via the Gardner VOR transition. While on the transition, the aircraft descended below the 4,000-foot-msl minimum altitude to 2,600 feet msl. The pilot was alerted by ATC. He responded that his chart read 3,000 feet. The aircraft then climbed above 2,700 feet, but descended again (to 1,500 feet msl) until about 2 miles outside the outer marker. The minimum published altitude to intercept the glideslope was 2,600 feet, and the recommended (glideslope) altitude for crossing the outer marker was 2,588 feet. Before reaching the outer marker, the aircraft made an abrupt turn to the southwest, entered a steep descent, and crashed in a wooded area. An examination of the aircraft did not disclose any evidence of a malfunction. A flight inspection of the navigation aids disclosed satisfactory operation. A post-mortem examination was inconclusive as to possible physical impairment. The procedure turn altitude for the approach was 3,000 feet, but the Gardner transition did not require a procedure turn.

Probable Cause:
PIC - IFR procedure not followed, directional control not maintained, proper altitude not maintained.

Factors:

ASF Comments:
Considering the lack of information about existing weather conditions, the pilot's recent IFR experience, and the erratic flight path flown, this accident could have stemmed from a lack of pilot IFR proficiency.

84-3244
Richmond, New Hampshire

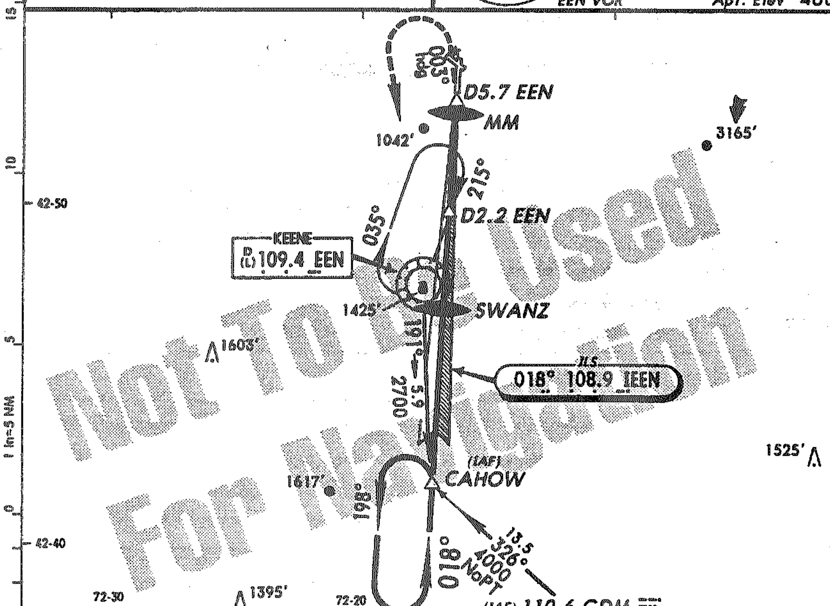
Note: The approach chart shown was the current edition at press time. It may differ from the one in use at the time of the accident.

JEPPESEN 28 JAN 94 (11-1) Eff 3 Feb

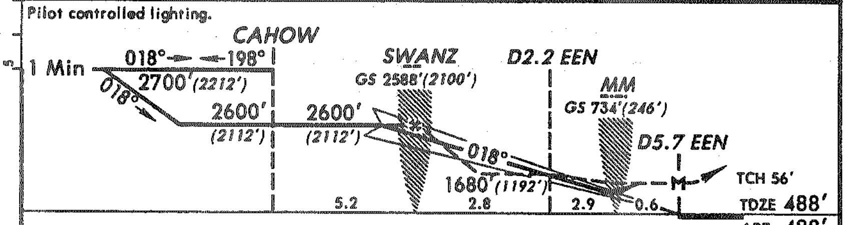
KEENE, NH
DILLANT-HOPKINS
ILS Rwy 2
LOC 108.9 IEEN
Apt. Elev 488'

AWOS-3 119.02
BOSTON Center (R) 123.75
BANGOR Radio 122.1G 109.4T
DILLANT-HOPKINS UNICOM CTAF 123.0

MSA EEN VOR: 3500' / 4200' / 3100' (025° / 315° / 045°)



Pilot controlled lighting.



MISSED APPROACH: Immediate climbing LEFT turn to 1400' heading 003° then climbing LEFT turn to 3000' direct EEN VOR and hold.

STRAIGHT-IN LANDING RWY 2

	ILS DA(H) 769' (281')		LOC (GS out) MDA(H) 1040' (552') With D2.2 EEN			LOC (GS out) MDA(H) 1680' (1192') Without D2.2 EEN			CIRCLE-TO-LAND Max Kts	With D2.2 EEN MDA(H)	Without D2.2 EEN MDA(H)
	FULL	RAIL or ALS out		RAIL out	ALS out		RAIL out	ALS out			
A	1		1			1¼			90	1360' (872')-1	1680' (1192')-1¼
B						1½			120	1480' (992')-1½	1680' (1192')-1½
C			1	1½		2½		3	140	1480' (992')-3	1680' (1192')-3
D			1¼	1¾					165	1580' (1092')-3	

Gnd speed-Kts		70	90	100	120	140	160
GS	3.00°	379	487	541	649	758	866
MAP at D5.7 EEN or SWANZ to MAP	6.3	5:24	4:12	3:47	3:09	2:42	2:22

CHANGES: Procedure.

The AOPA Air Safety Foundation — Aircraft Accident Summary Report

Reference Number: 86-1375 **Data Provided By NTSB**

Date & Time	Aircraft Data	Registration No.	Type Operation	Phase Occurred	Aircraft Damage
86.03.23 1643 EST	PA-46 (SERP) 310 HP	N43769	PERSONAL	APPROACH	DESTROYED

Injuries:	Fatal	Serious	Minor	None
Crew:	1	0	0	0
Pass:	1	0	0	0
Other:	0	0	0	0

Location: Boyne Falls, MI
Flight Plan: IFR
Itinerary: Detroit, MI, to Boyne City, MI
Airport: Boyne Mountain
Runway: 35, 4300/80, Asphalt, Dry

Weather: IMC
Visibility: 0.75 SM, BSnow **Precip:** Snow
Wind: 300/40 **Gusts:** Un
Briefing: FSS **Type:** Telephone
Clouds: Unknown Unknown
Ceiling: Unknown
Lighting: DAY
Complete: Y

Pilot: PVT/SMEL/SES
Age: 52 Yrs. **Instrument:** Y
Medical: Y **Waivers:** Y
BFR: Y **Months Since:** 3
Hours: Last 24 Hrs - 1
Last 30 Dys - 10
Last 90 Dys - 30
Aircraft: PA-46
Total: 1168
Type: UNK
Instmt: UNK
M. Eng: Unk

Emergency Occurred During: APPROACH

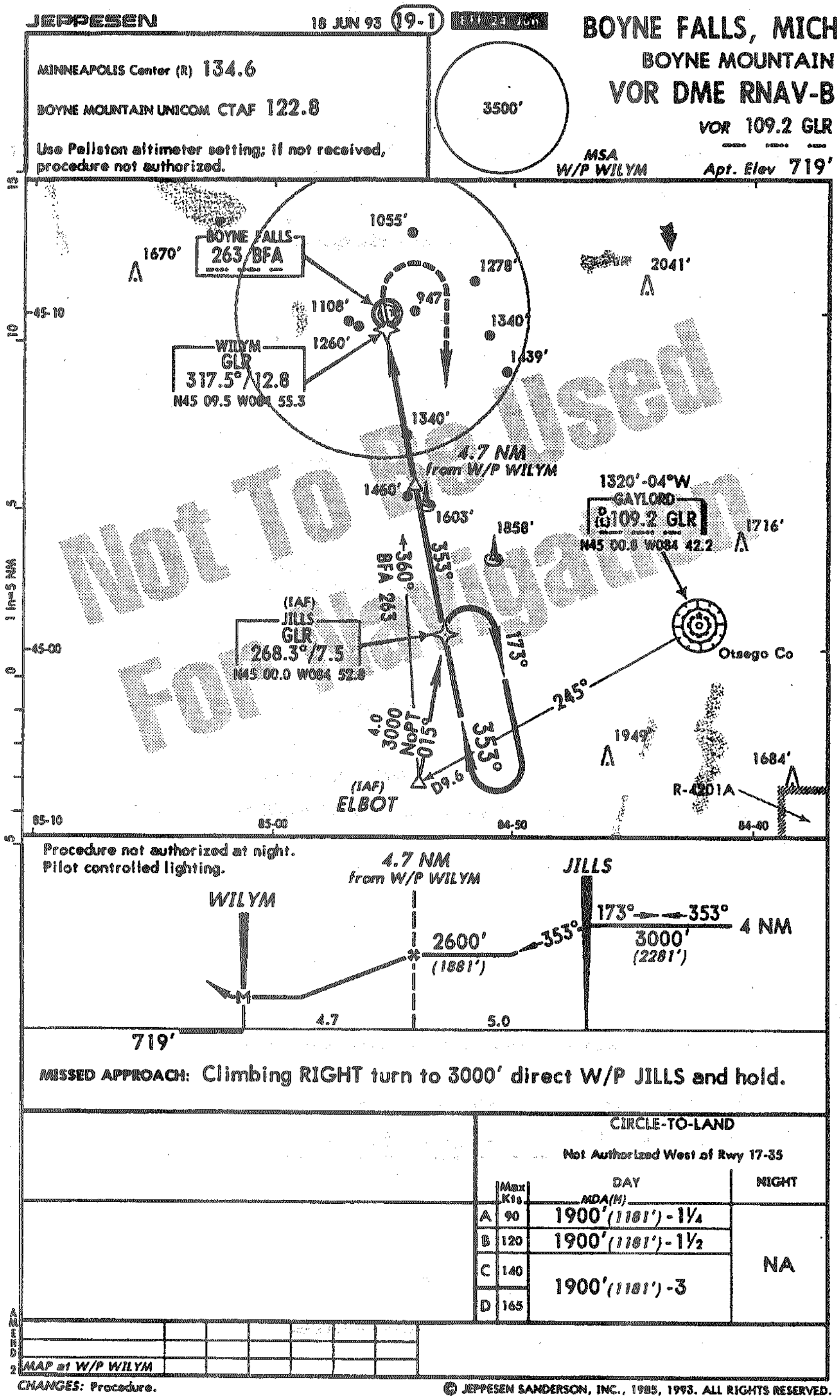
After the pilot was cleared for an RNAV-B approach, the aircraft crashed on hilly terrain approximately 3 mile SE of the airport at an elevation of 750 feet msl. Impact occurred after the aircraft had turned to the south-southeast and was descending. Minimum descent altitude for the approach was 1,680 feet. No preimpact mechanical problems were found. Approximately 4 hours before takeoff, FSS personnel provided a weather briefing. There was no weather reporting station at the destination, but the area forecast was for marginal VMC with isolated visibilities of 3 to 5 miles in light snowshowers. Pellston (approximately 25 miles away) was forecast for a chance of 1,200 feet overcast and 3-mile visibility with light snowshowers, but this information was not given to the pilot. Later, when the pilot filed an IFR flight plan, he did not update his weather briefing. While enroute, he checked the Pellston and Traverse City weather and was advised they had indefinite or obscured ceilings of 1,500 feet or less with gusty winds and light snow squalls. According to witnesses, there were snowshowers or squalls in the accident area with ¼- to ¾-mile visibility. The missed approach procedure called for: Right climbing turn to 3,000 feet, proceed to the initial approach fix (8 miles south of airport), and hold.

Probable Cause:
PIC - IFR procedure not followed, minimum descent altitude not maintained, descent not corrected.

Factors: PIC - Preflight planning/preparation inadequate. ATC personnel (FSS) - Preflight briefing service inadequate. Weather condition - Low ceiling, snow, high wind, gusts, obscuration, below approach minimums.

ASF Comments:
This appears to be a classic IFR approach accident that resulted from a descent below minimums. The pilot apparently did not receive an updated weather briefing, which may have been a contributing factor. The surface wind was reported as 300/40 with gusts. The winds aloft could have been much higher, thus making the approach difficult to execute. A rule of thumb: If winds aloft equal or exceed one third of the aircraft's cruising speed, it is prudent to accept a delay for better weather.

Note: The approach chart shown was the current edition at press time. It may differ from the one in use at the time of the accident.



	Max Kts	DAY MDA(H)	NIGHT
A	90	1900' (1181') - 1¼	NA
B	120	1900' (1181') - 1½	NA
C	140	1900' (1181') - 3	NA
D	165	1900' (1181') - 3	NA

The AOPA Air Safety Foundation — Aircraft Accident Summary Report

Reference Number: 90-1165 **Data Provided By NTSB**

Date & Time	Aircraft Data	Registration No.	Type Operation	Phase Occurred	Aircraft Damage
90.12.01 0130 PST	PA-46 (SERP) 310 HP	N4370Z	PERSONAL	APPROACH	SUBSTNTL

Injuries:	Fatal	Serious	Minor	None
Crew:	0	0	0	1
Pass:	0	0	0	0
Other:	0	0	0	0

Location: Seattle, WA
Itinerary: Portland, OR, to Seattle, WA
Airport: Off Airport
Flight Plan: IFR
Runway: N/A

Weather: VMC
Visibility: 5.0 SM, None
Wind: 180/08
Briefing: UNK
Precip: Rain
Gusts: 0
Type: UNK
Clouds: UNK Broken
Ceiling: 1300 ft.
Lighting: Night
Complete: U

Pilot: PVT/SEL
Age: 38 Yrs.
Medical: N
BFR: N
Instrument: Y
Waivers: N
Months Since: NA
Hours: Last 24 Hrs - 5
Last 30 Dys - 35
Last 90 Dys - 35
Aircraft: C-172RG
Total: 846
Type: 311
Instmt: 98
M. Eng: 0

Emergency Occurred During: APPROACH

The pilot of the Piper PA-46-310P attempted to override his autopilot during a localizer intercept. He heard the stall warning horn, misidentfying it as the landing gear horn. He stated that he then lowered the landing gear. He said the aircraft then stalled and entered a spin. During his spin recovery attempt, he broke out into visual conditions. He reentered the clouds and was vectored for a second ILS approach, which was successful. The upper wing skins on both wings were found to have been wrinkled during the event.

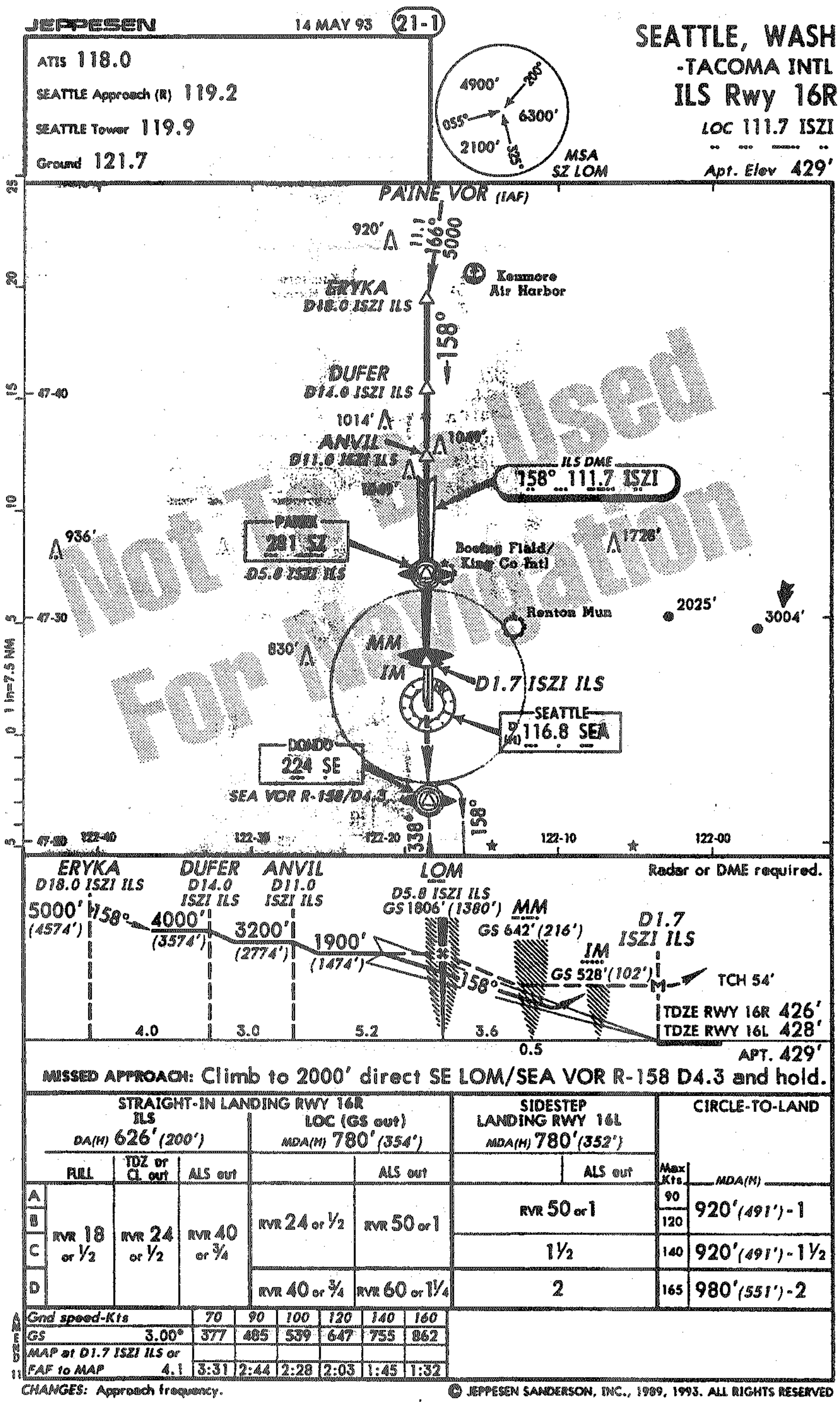
Probable Cause:
PIC - Airspeed(V_{SO}) not maintained.

Factors:
PIC - Inadvertent stall/spin, exceeded design stress limits of aircraft.

ASF Comments:
Considering the fact that this pilot lost control of the aircraft on the first approach, he was fortunate to be successful on the second. It appears that lack of familiarity with the autopilot may have been a contributing factor.

90-1165
Seattle, Washington

Note: The approach chart shown was the current edition at press time. It may differ from the one in use at the time of the accident.



The AOPA Air Safety Foundation — Aircraft Accident Summary Report

Reference Number: 92-0462 — **Data Provided By NTSB**

Date & Time	Aircraft Data	Registration No.	Type Operation	Phase Occurred	Aircraft Damage
92.12.11 1858 MST	PA-46 (SERP) 310 HP	N856M	PERSONAL	APPROACH	SUBSTNTL

Injuries:	Fatal	Serious	Minor	None
Crew:	0	0	1	0
Pass:	0	0	0	0
Other:	0	0	0	0

Location: Twin Falls, ID
Itinerary: Greeley, CO, to Hailey, ID
Airport: Twin Falls Regional
Flight Plan: IFR
Runway: 25, 8703/150, Asphalt, N/A

Weather: IMC
Visibility: .500 SM, Fog
Wind: 014/06
Briefing: FSS
Precip: None
Gusts: 0
Type: UNK
Clouds: UNK Obscured
Ceiling: 200 ft.
Lighting: Night
Complete: U

Pilot: PVT/SMEL
Age: 46 Yrs.
Medical: Y
BFR: Y
Instrument: Y
Waivers: N
Months Since: 1
Hours: Last 24 Hrs - 12
Last 30 Dys - 41
Last 90 Dys - 67
Aircraft: PA-46
Total: 1171
Type: 19
Instmt: 232
M. Eng: 829

Emergency Occurred During: APPROACH

After an all day flight from Vero Beach, Florida, the pilot diverted from his destination to his alternate and attempted a coupled ILS approach at Twin Falls, Idaho. During the approach, his autopilot disengaged and he missed the approach, and then elected to hand fly an approach, when he couldn't reengage the autopilot. During the second approach attempt, he descended below the glide path and impacted terrain. Weather at the time of the occurrence was one half mile visibility and 200 feet obscured cloud layer. The aircraft rolled over after impacting in a level plowed field. The pilot turned on the ELT after trying his radios and discovering that the ELT was not transmitting.

Probable Cause:
PIC - Proper glidepath not maintained.

Factors:

ASF Comments:
Fatigue and lack of familiarity with the aircraft may have been factors in the accident. The pilot had flown from Vero Beach, Florida, the day of the accident after partially completing the PAC factory training course. When he was unable to reengage the autopilot, he attempted to fly the approach manually and crashed when the aircraft descended below the glideslope. Autopilots with approach coupler capability are very useful tools, but pilots need to maintain manual IFR piloting skills as well. Attempting an approach to minimums with such low time in type is questionable judgment. Fatigue must also be considered a factor.

92-0462
Twin Falls, Idaho

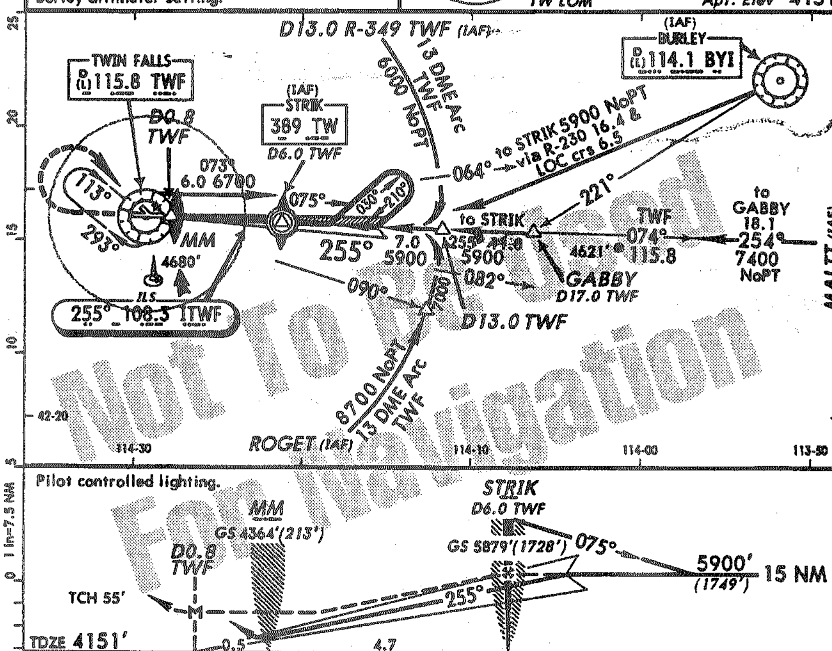
Note: The approach chart shown was the current edition at press time. It may differ from the one in use at the time of the accident.

JEPPESEN 23 JUL 93 (11-1)

TWIN FALLS, IDAHO
-SUN VALLEY REGL-JOSLIN
ILS Rwy 25
LOC 108.3 ITWF
Apt. Elev 4151'

*TWIN FALLS Approach 126.7
SALT LAKE Center (R) 118.05 when App inop.
*TWIN FALLS Tower CTAF 118.2
*Ground 121.7
When Control Zone not effective, except for operators with approved weather service, use Burley altimeter setting.

MSA TW LOM: 6200' 070°–220°; 9100' 220°–340°; 8600' 340°–070°



MISSED APPROACH: Climb STRAIGHT AHEAD to 5000' then climbing RIGHT turn to 6700' direct TWF VOR and hold.

STRAIGHT-IN LANDING RWY 25

<table>
<tr><th rowspan="3"></th><th colspan="2">ILS
DA(H) 4351'(200')</th><th colspan="3">LOC (GS out)
MDA(H) 4420'(269')</th><th colspan="2">CIRCLE-TO-LAND
Control Zone Effective or With Approved Weather Service</th></tr>
<tr><th rowspan="2">FULL</th><th rowspan="2">RAIL or ALS out</th><th rowspan="2"></th><th rowspan="2">RAIL out</th><th rowspan="2">ALS out</th><th>Max Kts</th><th>MDA(H)</th></tr>
<tr><th></th><th></th></tr>
<tr><td>A</td><td rowspan="4">½</td><td rowspan="4">¾</td><td rowspan="3">½</td><td rowspan="3">¾</td><td rowspan="3">1</td><td>90</td><td rowspan="2">4680'(529')-1</td></tr>
<tr><td>B</td><td>120</td></tr>
<tr><td>C</td><td>140</td><td>4680'(529')-1½</td></tr>
<tr><td>D</td><td>¾</td><td colspan="2">1</td><td>165</td><td>4760'(609')-2</td></tr>
</table>

With Burley Altimeter Setting

<table>
<tr><th rowspan="2"></th><th colspan="2">ILS
DA(H) 4491'(340')</th><th colspan="3">LOC (GS out)
MDA(H) 4560'(409')</th><th colspan="2">With Burley Altimeter Setting</th></tr>
<tr><th>FULL</th><th>RAIL or ALS out</th><th></th><th>RAIL out</th><th>ALS out</th><th>Max Kts</th><th>MDA(H)</th></tr>
<tr><td>A</td><td colspan="2" rowspan="4">¾</td><td rowspan="2">½</td><td rowspan="2">¾</td><td rowspan="2">1</td><td>90</td><td rowspan="2">4820'(669')-1</td></tr>
<tr><td>B</td><td>120</td></tr>
<tr><td>C</td><td rowspan="2">¾</td><td colspan="2" rowspan="2">1¼</td><td>140</td><td>4820'(669')-1¾</td></tr>
<tr><td>D</td><td>165</td><td>4900'(749')-2½</td></tr>
</table>

Gnd speed-Kts	70	90	100	120	140	160
GS 3.00°	378	485	539	647	755	863
MAP at D0.8 TWF or STRIK to MAP 5.2	4:27	3:28	3:07	2:36	2:14	1:57

CHANGES: See other side.

The AOPA Air Safety Foundation — Aircraft Accident Summary Report

Reference Number: 92-2286 **Data Provided By NTSB**

Date & Time	Aircraft Data	Registration No.	Type Operation	Phase Occurred	Aircraft Damage
92.08.28 1005 EDT	PA-46 (SERP) 350 HP	N350PM	PERSONAL	MANEUVER	SUBSTNTL

Injuries:	Fatal	Serious	Minor	None
Crew:	0	0	0	1
Pass:	0	0	0	0
Other:	0	0	0	0

Location: Sanford, ME
Itinerary: Sommerset, NJ, to Sanford, ME
Airport: Sanford Municipal
Flight Plan: IFR
Runway: 07, 6000/150, Asphalt, N/A

Weather: IMC
Visibility: .250 SM, Fog
Wind: 00/00
Briefing: PTWS
Precip: Drizzle
Gusts: 0
Type: Teletype
Clouds: UNK Obscured
Ceiling: 200 ft.
Lighting: Day
Complete: y

Pilot: PVT/SMEL
Age: 60 Yrs.
Medical: Y
BFR: Y
Instrument: Y
Waivers: Y
Months Since: 6
Hours: Last 24 Hrs - UN
Last 30 Dys - 43
Last 90 Dys - 92
Aircraft: BE 33
Total: 704
Type: 90
Instmt: 136
M. Eng: 33

Emergency Occurred During: MANEUVER

On the second attempted ILS approach the pilot said he did not have the runway in sight but, "...continued at D.H. [SIC] for a few moments ..." and then saw the runway. He said there was not enough runway remaining to land and "...[the pilot] would attempt to circle at decision height and re-intercept the glideslope. During this ill-conceived maneuver I encountered one or more pine trees..." After declaring an emergency, the pilot was vectored to an airport 24 minutes away. The pilot described the airplane's flight characteristics on the flight to the alternate airport as, "...a control condition similar to an engine out in a multi-engine airplane." After touchdown, the airplane departed the runway and came to rest in a median between a runway and taxiway.

Probable Cause: PIC - IFR procedure not followed.

Factors: PIC - Disregarded decision height, missed approach not performed.

ASF Comments:

This pilot displayed poor judgment by attempting a circle-to-land maneuver rather than execute the missed approach. All instrument approaches should include an alternate plan of action, i.e., execute missed approach if the landing cannot be made safely upon reaching DH or MDA. Multiple approaches (more than two) to the same airport present their own hazards, and the circle-to-land maneuver can be extremely hazardous unless properly executed. Note that the circling minimums are more than 220 feet higher than the straight-in decision height. Circling at DH is a high risk maneuver even under good VFR conditions.

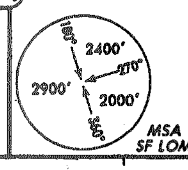
92-2286
Sanford, Maine

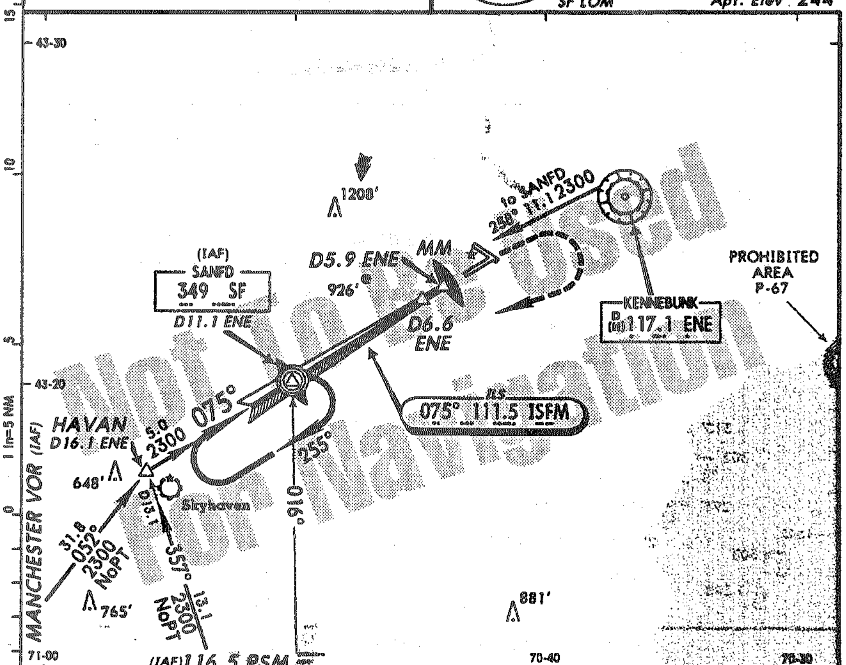
Note: The approach chart shown was the current edition at press time. It may differ from the one in use at the time of the accident.

JEPPESEN 1 APR 94 (11-1)

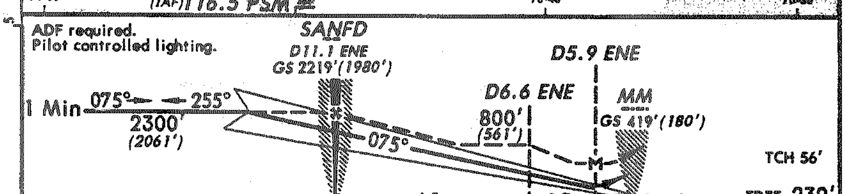
SANFORD, MAINE
SANFORD MUN
ILS Rwy 7
LOC 111.5 ISFM
Apt. Elev 244'

AWOS-3 120.02
*PORTLAND Approach 119.75
BOSTON Center (R) 128.2 when App inop.
SANFORD MUN UNICOM CTAF 122.8





ADF required.
Pilot controlled lighting.



MISSED APPROACH: Climb to 800', then climbing RIGHT turn to 2300' direct SANFD LOM and hold.

	STRAIGHT-IN LANDING RWY 7			CIRCLE-TO-LAND		
	ILS	LOC (GS out)				
	DA(H) 519'(280')	MDA(H) 620'(381') With D6.6	MDA(H) 800'(561') Without D6.6	Max Kts	With D6.6 MDA(H)	Without D6.6 MDA(H)
A	1	1	1	90	740'(496')-1	800'(556')-1
B	1	1	1	120	740'(496')-1	800'(556')-1
C	1	1	1½	140	740'(496')-1½	800'(556')-1½
D	1	1¼	1¾	165	860'(616')-2	860'(616')-2

Gnd speed-Kts	70	90	100	120	140	160
GS 3.00°	378	486	541	649	757	865
MAP at D5.9 ENE or SANFD to MAP 5.2	4:27	3:28	3:07	2:36	2:14	1:57

CHANGES: Straight-in ILS minimums.

The AOPA Air Safety Foundation — Aircraft Accident Summary Report

Reference Number: 92-1930 **Data Provided By NTSB**

Date & Time	Aircraft Data	Registration No.	Type Operation	Phase Occurred	Aircraft Damage
92.09.02 1515 PDT	PA-46 (SERP) 310 HP	N1005B	BUSINESS	APPROACH	SUBSTNTL

Injuries:	Fatal	Serious	Minor	None
Crew:	0	0	0	1
Pass:	0	0	0	0
Other:	0	0	0	0

Location: The Dalles, OR **Flight Plan:** IFR
Itinerary: Salt Lake City, UT, to The Dalles, OR
Airport: The Dalles **Runway:** 03, 5097/150, Asphalt, Dry

Weather:	VMC			**Clouds:**	Clear
Visibility:	30.0 SM, None	**Precip:**	None	**Ceiling:**	None
Wind:	270/14	**Gusts:**	0	**Lighting:**	Day
Briefing:	FSS	**Type:**	Telephone	**Complete:**	Y

Pilot:	PVT/SEL			**Hours:** Last 24 Hrs - UN	**Total:**	697
Age:	46 Yrs.	**Instrument:**	Y	Last 30 Dys - 19	**Type:**	201
Medical:	Y	**Waivers:**	Y	Last 90 Dys - 43	**Instmt:**	92
BFR:	Y	**Months Since:**	8	**Aircraft:** PA-46	**M. Eng:**	UNK

Emergency Occurred During: DESCENT

During a business cross-country flight, the pilot reported that he was aware of a low fuel status while enroute, but thought that he could make it to his final destination without stopping for fuel. The flight was cleared to descend at 96 miles from the airport. At approximately 16 to 18 miles from the airport, the engine lost power. During the descent, the pilot felt that the airplane was high on the approach and extended the landing gear and lowered one notch of flaps. At approximately one half mile from the runway, the airplane began to descend below the intended glide. Unable to reach the runway, the airplane touched down approximately 200 feet short of the runway, colliding with the terrain during the landing roll. After the accident, the pilot reported that he apparently did not have as much fuel on board as he thought he did before takeoff, and misjudged the approach by lowering the landing gear too soon.

Probable Cause: PIC - misjudged planned approach.

Factors: Fluid, fuel - exhaustion. PIC - fuel consumption calculations - inaccurate.

ASF Comments:

This pilot displayed poor judgment by attempting to reach his destination knowing that fuel remaining was marginal. The fact that he was low on fuel could have been caused by fueling the aircraft on sloping ground or failure of the line person to completely top off the tanks. The POH is very specific about fueling the aircraft in a wings-level attitude. Personal supervision of the fueling operation by the PIC could prevent many fuel starvation/fuel contamination type accidents. A one-hour reserve is prudent.

The AOPA Air Safety Foundation — Aircraft Accident Summary Report

Reference Number: 91-0972 **Data Provided By NTSB**

Date & Time	Aircraft Data	Registration No.	Type Operation	Phase Occurred	Aircraft Damage
91.02.24 1800 PST	PA-46 (SERP) 310 HP	N9132X	PERSONAL	APPROACH	SUBSTNTL

Injuries:	Fatal	Serious	Minor	None
Crew:	0	0	0	1
Pass:	0	0	0	3
Other:	0	0	0	0

Location: Los Angeles, CA **Flight Plan:** VFR
Itinerary: Taos, NM, to Santa Monica, CA
Airport: Santa Monica **Runway:** 21, 4987/150, Asphalt, Dry

Weather:	VMC			**Clouds:**	Part Obs.
Visibility:	6.0 SM, Haze	**Precip:**	None	**Ceiling:**	None
Wind:	260/08	**Gusts:**	0	**Lighting:**	Night
Briefing:	FSS	**Type:**	Telephone	**Complete:**	U

Pilot:	COMM/CFI/SMEL/HEL			**Hours:** Last 24 Hrs - 4	**Total:**	3779
Age:	39 Yrs.	**Instrument:**	Y	Last 30 Dys - 29	**Type:**	103
Medical:	Y	**Waivers:**	N	Last 90 Dys - 104	**Instmt:**	160
BFR:	Y	**Months Since:**	18	**Aircraft:** B 412	**M. Eng:**	93

Emergency Occurred During: APPROACH

A Piper PA-46-310P lost engine power and was forced to land in a residential area. Examination of the aircraft fuel system revealed about one pint of fuel in each wing tank. There was no evidence of fuel spillage or any evidence of aircraft fuel leaks at the accident scene. There was no evidence of an inflight fuel leak on the aircraft fuselage. The pilot indicated that his planned fuel consumption should have averaged 17 gallons per hour. The average fuel consumption for the trip was 19.9 gallons per hour. The Piper PA-46-310P pilot operating handbook predicts a fuel consumption of 17.5 gallons per hour for the trip flight conditions. The pilot calculated the maximum gross weight of the aircraft at the start of the accident flight to be 4,116 pounds, 2 pounds below the maximum ramp weight of 4,118 pounds. The weight of the aircraft was recalculated based on actual passenger weights and actual baggage weights. The aircraft was determined to be 260 pounds over maximum gross weight before takeoff. The pilot operating handbook does not list any performance data for an aircraft being operated over maximum gross weight.

Probable Cause: PIC - Poor preflight planning/preparation, inaccurate aircraft weight and balance, fuel consumption calculations.

Factors: Fluid, fuel - exhaustion.

ASF Comments:

Improper leaning could explain the high fuel consumption rate, but this is unlikely. The pilot could have prevented this accident by refueling enroute had he realized that fuel remaining was marginal. Good procedure is to have at least one hour of fuel in reserve. That will provide the margin even if fuel consumption is running slightly high.

The AOPA Air Safety Foundation — Aircraft Accident Summary Report

Reference Number: 91-0976 **Data Provided By NTSB**

Date & Time	Aircraft Data	Registration No.	Type Operation	Phase Occurred	Aircraft Damage
91.04.07 1919 PDT	PA-46 (SERP) 310 HP	N9113X	PERSONAL	DESCENT	DESTROYED

Injuries:	Fatal	Serious	Minor	None
Crew:	0	1	0	0
Pass:	0	1	0	0
Other:	0	0	0	0

Location: North Hollywood, CA **Flight Plan:** NONE
Itinerary: Las Vegas, NV, to Santa Monica, CA
Airport: Burbank **Runway:** 33, 6885/150, Asphalt, Dry

Weather:	VMC			**Clouds:**	300 ft. Scattered
Visibility:	20.0 SM, None	**Precip:**	None	**Ceiling:**	None
Wind:	340/10	**Gusts:**	0	**Lighting:**	Dusk
Briefing:	None	**Type:**	N/A	**Complete:**	N

Pilot:	PVT/SEL			**Hours:** Last 24 Hrs - 4	**Total:** 398
Age:	36 Yrs.	**Instrument:**	Y	Last 30 Dys - 15	**Type:** 45
Medical:	U	**Waivers:**	U	Last 90 Dys - 46	**Instmt:** 63
BFR:	Y	**Months Since:**	4	**Aircraft:** PA-46	**M. Eng:** UNK

Emergency Occurred During: DESCENT

A Piper PA-46-310P loss engine power and collided with a telephone pole during the forced landing. The pilot contacted the TRACON and informed the facility he had a partial power loss. The airplane was about 2 miles east of the airport at about 3,500 feet msl heading in a southwesterly direction. The TRACON instructed the pilot to turn to 150 degrees for radar vectors to Runway 33. The pilot did not turn to the 150-degree heading, but continued on a southwesterly course. The airplane flew past the approach ends of two runways. The airplane continued westbound and crashed 2.5 miles west of the airport. The pilot indicated the airplane had 300 pounds (about 50 gallons) of fuel on board at takeoff. The pilot operating handbook for the Piper PA-34-310P is about 16 gallons per hour. The duration of the flight was about one hour. There was no evidence of fuel in the airplane's fuel system or any evidence of fuel spillage from either of the wings after the accident.

Probable Cause:
PIC - Poor preflight planning/preparation, fuel consumption calculations not performed.

Factors: Fluid, fuel - exhaustion. PIC - Instructions, written/verbal not followed.

ASF Comments:
It appears that this pilot badly miscalculated the amount of fuel on board at takeoff. Fifty (50) gallons should have given an endurance of over two and one-half hours. The power loss apparently stemmed from fuel exhaustion after approximately one hour in flight. The pilot's failure to accept ATC help in reaching the field is puzzling. The lesson here is that unless fuel on board is known to be adequate to complete the flight safely with reserves, add fuel before takeoff.

The AOPA Air Safety Foundation — Aircraft Accident Summary Report

Reference Number: 90-1891 **Data Provided By NTSB**

Date & Time	Aircraft Data	Registration No.	Type Operation	Phase Occurred	Aircraft Damage
90.04.17 1145 PDT	PA-46 (SERP) 310 HP	N4387S	INSTRUCTL	LANDING	SUBSTNTL

Injuries:	Fatal	Serious	Minor	None
Crew:	0	0	0	2
Pass:	0	0	0	1
Other:	0	0	0	0

Location: Paso Robles, CA **Flight Plan:** NONE
Itinerary: Santa Maria, CA, to Paso Robles, CA
Airport: Paso Robles Municipal **Runway:** 31, 4700/100, Asphalt, Dry

Weather: VMC **Clouds:** Clear Clear
Visibility: 10.0 SM, None **Precip:** None **Ceiling:** None
Wind: 0/0 **Gusts:** 0 **Lighting:** Day
Briefing: None **Type:** N/A **Complete:** N

Pilot: PVT/COM/AT/SEL/GLI **Hours:** Last 24 Hrs - 1 **Total:** 11020
Age: 64 Yrs. **Instrument:** Y Last 30 Dys - 33 **Type:** 367
Medical: Y **Waivers:** Y Last 90 Dys - 103 **Instmt:** 250
BFR: Y **Months Since:** 6 **Aircraft:** PA 34 **M. Eng:** 1511

Emergency Occurred During: LANDING

According to statements from all three individuals on board, upon arriving in the vicinity of Paso Robles airport at about 5,800 feet above the airport, the instructor shut down the engine to simulate an engine failure. The pilot being trained was instructed to glide the aircraft to a safe landing at the airport. During the simulated emergency descent, the pilot being trained asked several times if the gear should not be extended until the turn from base to final was being made. The witnesses aboard the aircraft further stated that on short final, at a very low altitude, the gear was lowered using the emergency gear extension procedure. The left main gear did not fully extend and lock into position prior to the aircraft touching down on the runway. On touchdown, the left main gear collapsed, causing the left wing to collide with the runway.

Probable Cause:
PIC (CFI) - Gear down and locked - Not attained, complacency, inadequate altitude.

Factors:

ASF Comments:

Shutting down an engine to simulate an emergency is always risky business. Damage to the airplane certainly exceeded the value of the training received. Fortunately, the airplane landed on the field and there were no injuries; only a bruised ego for the flight instructor and substantial damage to the airplane.

The AOPA Air Safety Foundation — Aircraft Accident Summary Report

Reference Number: 85-0633 **Data Provided By NTSB**

Date & Time	Aircraft Data	Registration No.	Type Operation	Phase Occurred	Aircraft Damage
85.05.14 1030 CDT	PA-46 (SERP) 301 HP	N4362F PASSENGER	AIR TAXI	LANDING	SUBSTNTL

Injuries:	Fatal	Serious	Minor	None
Crew:	0	0	0	1
Pass:	0	0	0	4
Other:	0	0	0	0

Location: Osage Beach, MO **Flight Plan:** IFR
Itinerary: Addison, TX, to Osage Beach, MO
Airport: Lynn Crk-Grnd Glaize **Runway:** 32, 3205/60, Asphalt, Dry

Weather:	VMC			**Clouds:**	Unknown Broken
Visibility:	10.0 SM, None	**Precip:**	None	**Ceiling:**	Unknown
Wind:	200/10	**Gusts:**	Un	**Lighting:**	DAY
Briefing:	FSS	**Type:**	Telephone	**Complete:**	Y

Pilot:	ATP/SMEL			**Hours:** Last 24 Hrs - UN	**Total:**	2825
Age:	31 Yrs.	**Instrument:**	Y	Last 30 Dys - UNK	**Type:**	7
Medical:	Y	**Waivers:**	N	Last 90 Dys - 155	**Instmt:**	293
BFR:	Y	**Months Since:**	2	**Aircraft:** PA 32	**M. Eng:**	850

Emergency Occurred During: LANDING

The pilot landed the aircraft mid-field on the 3,205-foot runway. The aircraft landing speed was higher than normal, and a decision was made to continue the landing instead of going around for another attempt. The pilot applied brakes, and the aircraft skidded off the runway. The pilot stated he should have made a go-around instead of the decision to continue the landing. Winds were reported as light and variable at the airport.

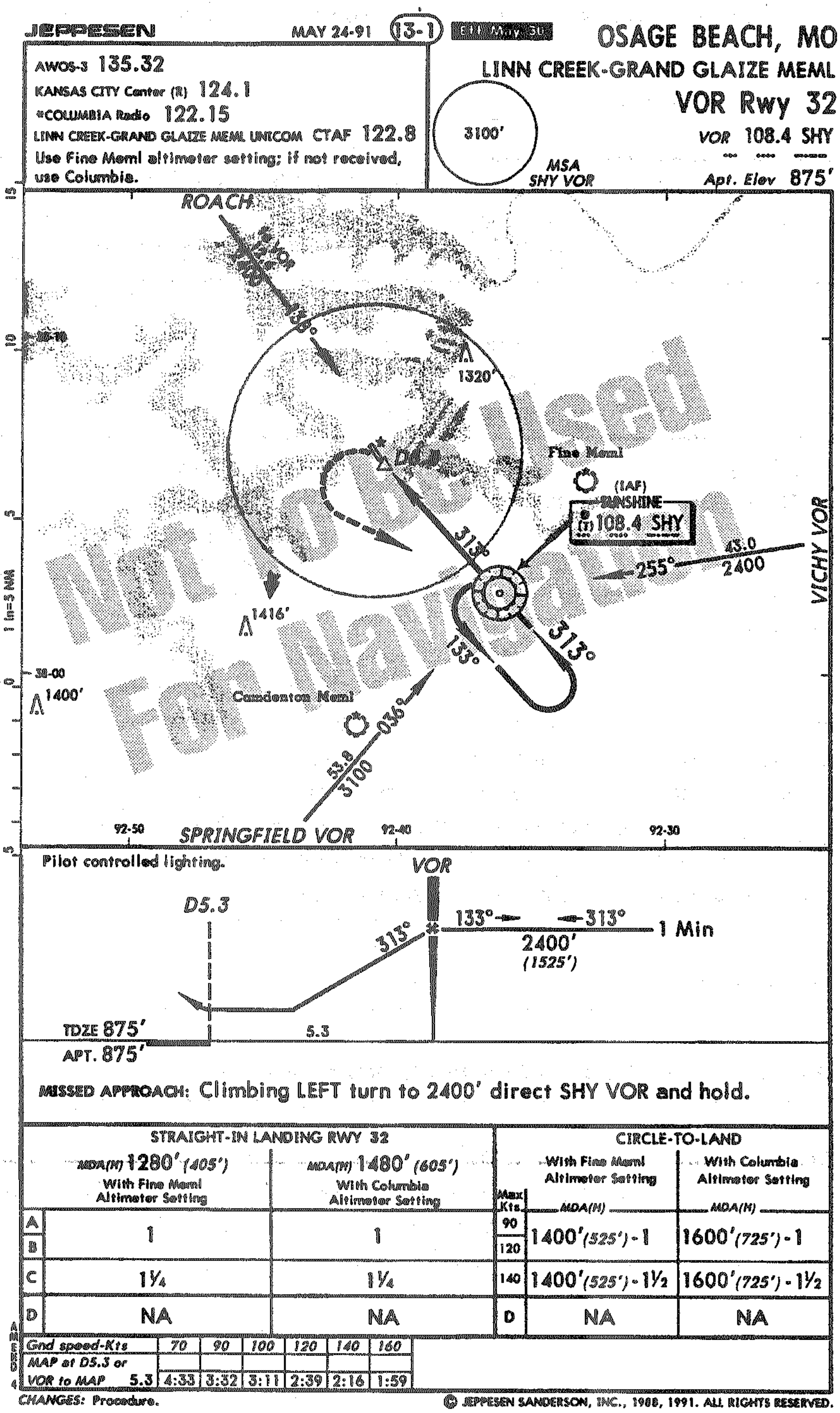
Probable Cause:
PIC - Airspeed excessive, proper touchdown point exceeded.

Factors:

ASF Comments:
Given proper pilot technique, a 3,200-foot runway is certainly long enough to land a PA-46 safely. This pilot displayed poor judgment by attempting to land even though his approach was high and fast. Where a runway of adequate length exists, a good rule of thumb is "If you are not down safely in the first third of the runway, go around."

85-0633
Osage Beach, Missouri

Note: The approach chart shown was the current edition at press time. It may differ from the one in use at the time of the accident.



The AOPA Air Safety Foundation — Aircraft Accident Summary Report

Reference Number: 91-2028 **Data Provided By NTSB**

Date & Time	Aircraft Data	Registration No.	Type Operation	Phase Occurred	Aircraft Damage
91.12.27 1350 PST	PA-46 (SERP) 310 HP	N9GF	PERSONAL	LANDING	SUBSTNTL

Injuries:	Fatal	Serious	Minor	None
Crew:	0	0	0	1
Pass:	0	0	0	0
Other:	0	0	0	0

Location: Carson City, NV
Itinerary: Dayton, NV, to Carson City, NV
Airport: Carson City
Flight Plan: NONE
Runway: 27, 5900/75, Asphalt, Dry

Weather: VMC
Visibility: 30.0 SM, None **Precip:** None
Wind: 210/05 **Gusts:** 0
Briefing: None **Type:** N/A
Clouds: 14000 ft. Scattered
Ceiling: 25000 ft.
Lighting: Day
Complete: N

Pilot: PVT/SEL
Age: 60 Yrs. **Instrument:** Y
Medical: Y **Waivers:** Y
BFR: Y **Months Since:** 5
Hours: Last 24 Hrs - 3 **Total:** 3000
Last 30 Dys - 5 **Type:** UNK
Last 90 Dys - 5 **Instmt:** 0
Aircraft: PA-46 **M. Eng:** UNK

Emergency Occurred During: LANDING
The certificated private pilot, the sole occupant, was landing after conducting touch and go takeoffs and landings. During the final landing approach, the pilot failed to arrest the excessive sink and the airplane touched down about 12 inches short of the paved end of the runway. The paved runway was about 6 inches above the surrounding unpaved area. When the right landing gear struck the lip of the runway, the strut was bent aft about 20 degrees, and the right wing received structural damage. The FAA advisory circular recommends that the runway lip distance to the surrounding runway safety area is 1½ inches for drainage, with a maximum recommended distance of 3 inches. The airport personnel failed to maintain these recommended distances.

Probable Cause:
PIC - Excessive descent, proper touchdown point not attained.

Factors:
Airport personnel - Other airport/runway maintenance - Inadequate.

ASF Comments:
Undershooting a 5,900 foot runway is difficult to explain. Certainly this accident was preventable even though the runway was 6 inches above the surrounding overrun. It's the pilot's responsibility to land the airplane on the runway. Unless the runway is exceptionally short, a touchdown point of several hundred feet from the threshold is a good practice.

The AOPA Air Safety Foundation — Aircraft Accident Summary Report

Reference Number: 92-0387 **Data Provided By NTSB**

Date & Time	Aircraft Data	Registration No.	Type Operation	Phase Occurred	Aircraft Damage
92.03.11 1400 EST	PA-46 (SERP) 310 HP	N4387V	PERSONAL	LANDING	SUBSTNTL

Injuries:	Fatal	Serious	Minor	None
Crew:	0	0	0	1
Pass:	0	0	0	0
Other:	0	0	0	0

Location: Aiken, SC **Flight Plan:** NONE
Itinerary: Darlington, SC, to Aiken, SC
Airport: Aiken Municipal **Runway:** 24, 5000/100, Asphalt, Dry

Weather:	VMC			**Clouds:**	25000 ft. Scattered
Visibility:	15.0 SM, None	**Precip:**	None	**Ceiling:**	None
Wind:	270/14	**Gusts:**	14	**Lighting:**	Day
Briefing:	FSS	**Type:**	Telephone	**Complete:**	Y

Pilot:	PVT/SMEL			**Hours:** Last 24 Hrs - 2	**Total:**	1080
Age:	55 Yrs.	**Instrument:**	Y	Last 30 Dys - 15	**Type:**	70
Medical:	Y	**Waivers:**	Y	Last 90 Dys - 80	**Instmt:**	252
BFR:	Y	**Months Since:**	01	**Aircraft:** PA-46	**M. Eng:**	655

Emergency Occurred During: LANDING

The pilot reported that he obtained a standard weather briefing before departing for the flight. The briefing noted that a SIGMET was in effect for severe turbulence and wind shear. During the final approach at his destination, he observed the wind sock periodically and noted that it indicated the wind was aligned with the runway. At touchdown the left wing was lifted by a wind gust, the pilot said, which could not be controlled with the aileron. The airplane veered off the runway to the right, which resulted in the collapse on the right main landing gear.

Probable Cause:
Weather condition - Crosswind, Gusts.

Factors:

ASF Comments:
Many pilots have been surprised by wind gusts, even when they have been advised to expect them. Don't be lulled into a false sense of security by relaxing when wind and weather is not as forecast.

The AOPA Air Safety Foundation — Aircraft Accident Summary Report

Reference Number: 92-0068 **Data Provided By NTSB**

Date & Time	Aircraft Data	Registration No.	Type Operation	Phase Occurred	Aircraft Damage
92.03.10 1152 EST	PA-46 (SERP) 310 HP	N4321L	BUSINESS	APPROACH	SUBSTNTL

Injuries:	Fatal	Serious	Minor	None
Crew:	0	0	0	1
Pass:	0	0	0	1
Other:	0	0	0	0

Location: Lima, OH
Flight Plan: IFR
Itinerary: Dickson, TN, to Lima, OH
Airport: Lima Allen County
Runway: 27, 5149/150, Asphalt, Dry

Weather: VMC
Clouds: Clear Overcast
Visibility: 10.0 SM, None
Precip: None
Ceiling: 1100 ft.
Wind: 310/19
Gusts: 0
Lighting: Day
Briefing: FSS
Type: Telephone
Complete: Y

Pilot: PVT/SEL
Hours: Last 24 Hrs - 2
Total: 2312
Age: 53 Yrs.
Instrument: Y
Last 30 Dys - 27
Type: 1640
Medical: Y
Waivers: Y
Last 90 Dys - 68
Instmt: 267
BFR: Y
Months Since: 8
Aircraft: C-310
M. Eng: UNK

Emergency Occurred During: APPROACH

The pilot was on final approach to Runway 27 when the aircraft stalled and landed hard 300 feet short of the runway and slid to a stop. According to the pilot, he attempted three instrument approaches, but two of the three, a VOR and an ILS, were unsuccessful. The pilot attributed this to ice accumulation on the antenna, which affected the reception of the navigational signal and caused his radios to operate erroneously. Also, he stated that during the unsuccessful approaches, the wing accumulated ½ inch of ice on the leading edge. On final approach with the gear extended, flaps 10 degrees, and the aircraft at 110 knots slowing to 100 knots, the aircraft stalled 150 feet above the ground. The pilot stated that he tried to recover by applying full power, but the aircraft landed hard and slid to a stop. The pilot stated that there was no mechanical malfunction.

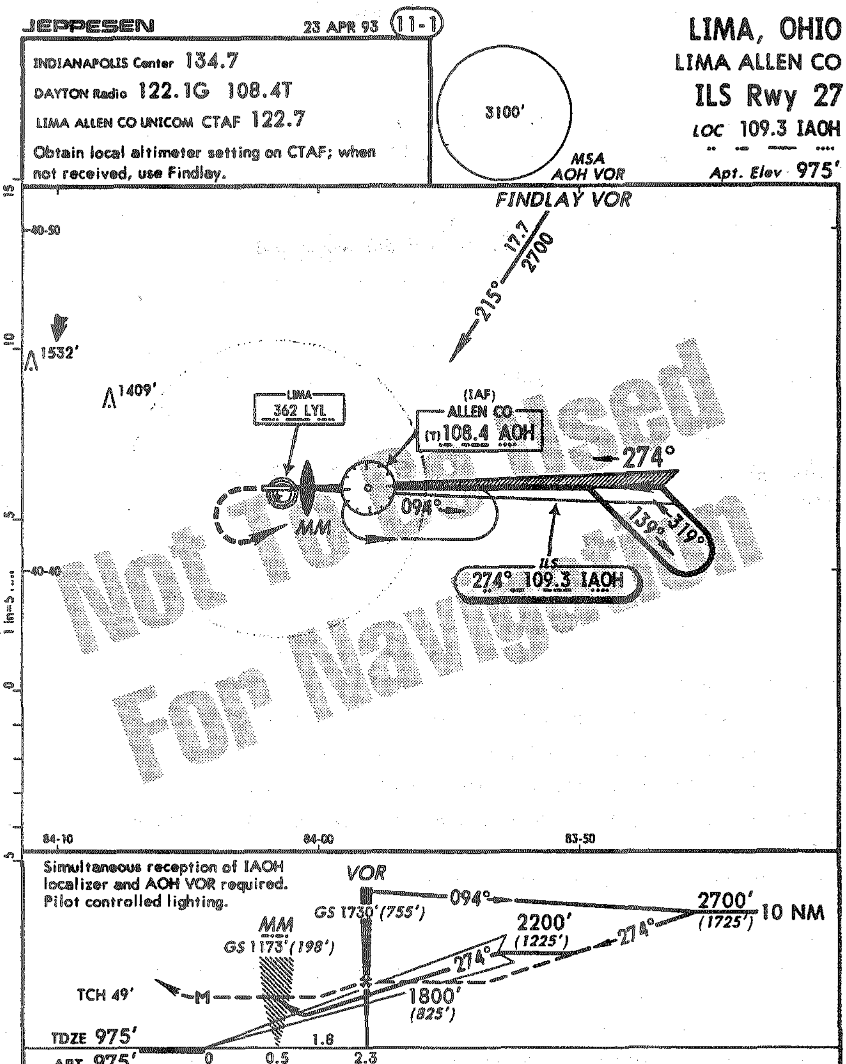
Probable Cause: PIC - Inadvertent stall.

Factors: Weather condition - Icing conditions. Wing - Ice.

ASF Comments:

Multiple IFR approaches (more than two) are not a good idea at any airport. This pilot would have been better served by proceeding to an alternate airport with a precision approach. The ice-laden Malibu simply would not fly with 10 degrees flap and gear down at 100 knots. It is essential to maintain a higher than normal speed in icing conditions. This particular aircraft was not certified for flight in known icing, as it did not have deicing boots. Iced-up aircraft stall at higher than normal speeds. No flaps should be used as they may disturb the precarious aerodynamics, and speeds up to 40 percent higher than normal may be needed on final approach. Far too many aircraft accidents involving structural ice occur when the aircraft stalls on short final after making a successful approach. Despite the high time in type, the pilot may not have had much experience in handling an iced-up aircraft

Note: The approach chart shown was the current edition at press time. It may differ from the one in use at the time of the accident.



MISSED APPROACH: Climb to 3000' then LEFT turn direct AOH VOR and hold.

	STRAIGHT-IN LANDING RWY 27 – With Local Altimeter Setting: ILS DA(H) 1225' (250') FULL	LOC (GS out) MDA(H) 1380' (405')	With Findlay Altimeter Setting: ILS DA(H) 1323' (348') FULL	LOC (GS out) MDA(H) 1480' (505')	Max Kts	CIRCLE-TO-LAND With Local Altimeter Setting MDA(H)	With Findlay Altimeter Setting MDA(H)
A	3/4	1	1	1	90	1420' (445')-1	1520' (545')-1
B					120	1440' (465')-1	
C		1¼		1½	140	1440' (465')-1½	1520' (545')-1½
D					165	1540' (565')-2	1540' (565')-2

Gnd speed-Kts		70	90	100	120	140	160
GS	3.00°	374	481	534	641	748	855
VOR to MAP	2.3	1:58	1:32	1:23	1:09	0:59	0:52

AMEND 2A

CHANGES: Straight-in visibilities.

The AOPA Air Safety Foundation — Aircraft Accident Summary Report

Reference Number: 92-0073 **Data Provided By NTSB**

Date & Time	Aircraft Data	Registration No.	Type Operation	Phase Occurred	Aircraft Damage
92.03.16 1330 EST	PA-46 (SERP) 350 HP	N872RJ	PERSONAL	LANDING	SUBSTNTL

Injuries:	Fatal	Serious	Minor	None
Crew:	0	0	0	1
Pass:	0	0	0	0
Other:	0	0	0	0

Location: Doylestown, PA **Flight Plan:** VFR
Itinerary: Charleston, SC, to Doylestown, PA
Airport: Doylestown Airport **Runway:** 23, 3004/60, Asphalt, Dry

Weather:	VMC			**Clouds:**	Clear Clear
Visibility:	30.0 SM, None	**Precip:**	None	**Ceiling:**	None
Wind:	Unk/16	**Gusts:**	16	**Lighting:**	Day
Briefing:	FSS	**Type:**	Telephone	**Complete:**	Y

Pilot:	PVT/SMEL			**Hours:** Last 24 Hrs - 6	**Total:**	1149
Age:	45 Yrs.	**Instrument:**	Y	Last 30 Dys - 21	**Type:**	408
Medical:	Y	**Waivers:**	N	Last 90 Dys - 27	**Instmt:**	164
BFR:	Y	**Months Since:**	3	**Aircraft:** PA-46	**M. Eng:**	46

Emergency Occurred During: LANDING

During touchdown on Runway 23 at Doylestown airport, Doylestown, Pennsylvania, the airplane encountered a turbulent gust of wind and the right wing rose abruptly. The pilot stated that even though he input full aileron and almost full rudder, the airplane veered off the left of the runway and impacted a wind sock pole and wind tee. There was no reported airframe or engine malfunction prior to hitting the wind sock pole. The pilot was not injured, but the airplane was substantially damaged.

Probable Cause:
PIC - Directional control not maintained.

Factors:
Weather condition - Crosswind, Gusts. PIC - Ground loop/swerved - Inadvertent.

ASF Comments:
Another loss-of-control on the ground accident with no injuries or fatalities. The preliminary report gave the wind direction and velocity as 340/16 gusting to 20. This places the wind near a 90-degree angle very close to the maximum demonstrated crosswind capability. Bad idea!

The AOPA Air Safety Foundation — Aircraft Accident Summary Report

Reference Number: 92-2264 **Data Provided By NTSB**

Date & Time	Aircraft Data	Registration No.	Type Operation	Phase Occurred	Aircraft Damage
92.01.13 0800 CST	PA-46 (SERP) 350 HP	N9161K	BUSINESS	LANDING	SUBSTNTL

Injuries:	Fatal	Serious	Minor	None
Crew:	0	0	0	1
Pass:	0	0	0	3
Other:	0	0	0	0

Location: Bowling Green, KY **Flight Plan:** IFR
Itinerary: Bowling Green, KY, to Lexington, KY
Airport: Warren County Reg. **Runway:** 03, 6500/150, Asphalt, Wet

Weather:	IMC			**Clouds:**	UNK Obscured
Visibility:	1.000 SM, Fog	**Precip:**	Drizzle	**Ceiling:**	500 ft.
Wind:		**Gusts:**		**Lighting:**	Day
Briefing:	FSS	**Type:**	Telephone	**Complete:**	Y

Pilot:	COMM/SMEL			**Hours:** Last 24 Hrs - 0	**Total:**	3611
Age:	28 Yrs.	**Instrument:**	Y	Last 30 Dys - 19	**Type:**	617
Medical:	Y	**Waivers:**	N	Last 90 Dys - 35	**Instmt:**	730
BFR:	Y	**Months Since:**	7	**Aircraft:** PA-46	**M. Eng:**	330

Emergency Occurred During: TAKEOFF

During initial climb out from the Warren County airport on an IFR clearance, the airplane had dual fuel flow gauge failure. The pilot elected to return to the airport and make a precautionary landing. The pilot stated he received a special VFR clearance direct to the VOR, Runway 03, and proceeded to the airport. He stated that he prematurely flared the airplane and it stalled, falling 30 feet to the runway. The dual fuel flow failure could not be duplicated during the post accident investigation.

Probable Cause:
PIC - Initiated precautionary landing, premature flare.

Factors:
Engine instruments, fuel flow gauge - false indication. Weather condition - low ceiling, fog, drizzle.

ASF Comments:
Both digital and analog fuel flow indicators receive input from the same sensor. Therefore, failure of the sensor leads to abnormal readings on two instruments. Had fuel flow dropped to zero or near zero, a power loss would have occurred. That didn't happen, but the precautionary landing was appropriate. Continuing flight with discrepancies is not a good idea. As long as the engine was developing power normally, however, the pilot should not have hesitated to use it to land safely. Marginal weather and the pilot's concern for engine integrity may have contributed to the accident.

The AOPA Air Safety Foundation — Aircraft Accident Summary Report

Reference Number: 86-1973B **Data Provided By NTSB**

Date & Time	Aircraft Data	Registration No.	Type Operation	Phase Occurred	Aircraft Damage
86.07.26 0740 MDT	PA-46 (SERP) 310 HP	N4346L PHOTOGPHY	OTHER WORK	MANEUVER	DESTROYED

Injuries:	Fatal	Serious	Minor	None
Crew:	1	0	0	0
Pass:	0	0	0	0
Other:	0	0	0	2

Location: Boulder, CO
Itinerary: Boulder, CO, to Local
Airport: Off Airport
Flight Plan: NONE
Runway: N/A

Weather: VMC
Visibility: 75.0 SM, None
Wind: 310/10
Briefing: None
Precip: None
Gusts: Un
Type: N/A
Clouds: 16,000 ft. Scattered
Ceiling: None
Lighting: DAY
Complete: N

Pilot: COMM/SMEL
Age: 41 Yrs.
Medical: Y
BFR: Y
Instrument: Y
Waivers: Y
Months Since: 12
Hours: Last 24 Hrs - UN
Last 30 Dys - UNK
Last 90 Dys - 25
Aircraft: PA-46
Total: 1255
Type: 83
Instmt: 213
M. Eng: 171

Emergency Occurred During: MANEUVER

The purpose of the flight for both aircraft was an aerial photo mission. N5113S was used as the camera platform. The pilots of N5113S and N4346L discussed prior to takeoff the procedures of the flight. Both aircraft departed and flew a course to position the airplanes on a southerly heading. N5113S was to the east and slightly above and ahead of N4346L. The photographer shot one roll of film and reloaded. He was ready to begin shooting when N4346L began to close in on N5113S. The pilot of N5113S felt two bumps as N4346L closed, and did not see the aircraft pass under. The pilot of N5113S maneuvered his aircraft to determine control ability and saw N4346L spiralling to the ground. Exam of N4346L revealed the vertical stabilizer and rudder had separated in flight. There were numerous paint smears found on the right side on N5113S.

Probable Cause: PIC - Altitude misjudged, distance misjudged, clearance not maintained.

Factors: PIC - In-flight planning/decision inadequate, improper use of equipment/ aircraft, over-confidence in personal ability.

ASF Comments:

Formation flying can be hazardous, especially when the aircraft are of dissimilar performance. Formation missions must be meticulously planned and precisely executed. The procedure each aircraft will fly if sight of the other aircraft is lost must be determined and briefed prior to takeoff. Proper training in formation flying is essential, and it should not be conducted unless both pilots have been trained.

The AOPA Air Safety Foundation — Aircraft Accident Summary Report

Reference Number: 89-1655 **Data Provided By NTSB**

Date & Time	Aircraft Data	Registration No.	Type Operation	Phase Occurred	Aircraft Damage
89.11.27 1726 CST	PA-46 (SERP) 350 HP	N919S	BUSINESS	APPROACH	DESTROYED

Injuries:	Fatal	Serious	Minor	None
Crew:	0	1	0	0
Pass:	0	2	0	0
Other:	0	0	0	0

Location: Des Moines, IA **Flight Plan:** IFR
Itinerary: Omaha, NE, to Des Moines, IA
Airport: Des Moines Intl. **Runway:** 30R, 9001/150, Asphalt, N/A

Weather: IMC **Clouds:** N/A Overcast
Visibility: 4.000 SM, Fog **Precip:** Drizzle **Ceiling:** 800 ft.
Wind: 310/12 **Gusts:** 0 **Lighting:** Dusk
Briefing: FSS **Type:** Telephone **Complete:** U

Pilot: PVT/SEL **Hours:** Last 24 Hrs - 2 **Total:** 2278
Age: 61 Yrs. **Instrument:** Y Last 30 Dys - 27 **Type:** 832
Medical: Y **Waivers:** Y Last 90 Dys - 70 **Instmt:** 276
BFR: Y **Months Since:** 17 **Aircraft:** PA-46 **M. Eng:** 9

Emergency Occurred During: DESCENT

The aircraft was on an ILS approach at dusk in IMC and icing conditions with the alternate air on. According to the pilot, he had just descended below an overcast, on final approach, when the engine lost power and would not respond to throttle application. A forced landing was made in a wooded area short of the runway and the aircraft was extensively damaged. During an exam of the engine, the turbocharger and wastegate transition pipes were found separated at the flange. Carbonaceous residue was found in the area of separation, but no heat damage was noted. The gasket, bolts, washers, and self-locking nuts (for holding the pipes together) were not found. Later, the engine ran successfully during an operational check. During the investigation, three similar cases of pipe separation were identified, which involved other aircraft; these resulted in only partial losses of power. The right front seat passenger reported seeing a trace of ice on the wings as the aircraft was descending through clouds. The pitot heat, stall warning heat, and ice light switch were found in the off position. At 1650 CST, the temperature and dew point at the surface were 36 and 35 degrees, respectively.

Probable Cause: Undetermined.

Factors: Light condition - dusk. Object - tree(s).

ASF Comments:

It is not clear whether the loss of power was due to mechanical malfunction or induction system icing. The investigative report does not document the status of the alternate air intake or propeller heat. Ambient air conditions were favorable for icing yet the pilot did not use all the ice protection equipment. Except for pneumatic boots, all should be activated prior to entering icing conditions.

The AOPA Air Safety Foundation — Aircraft Accident Summary Report

Reference Number: 84-2285 **Data Provided By NTSB**

Date & Time	Aircraft Data	Registration No.	Type Operation	Phase Occurred	Aircraft Damage
84.08.20 1400 EDT	PA-46 (SERP) 310 HP	N4371Y USE	OTHERWORK	DESCENT	DESTROYED

Injuries:	Fatal	Serious	Minor	None
Crew:	0	1	0	0
Pass:	0	0	0	0
Other:	0	0	0	0

Location: Vero Beach, FL **Flight Plan:** VFR
Itinerary: Vero Beach, FL, to Local
Airport: Off Airport **Runway:** N/A

Weather:	VMC			**Clouds:**	2000 ft. Broken
Visibility:	7.0 SM, None	**Precip:**	None	**Ceiling:**	2000 ft.
Wind:	220/10	**Gusts:**	Unk	**Lighting:**	DAY
Briefing:	None	**Type:**	N/A	**Complete:**	N

Pilot:	COMM/CFI/SMEL			**Hours:** Last 24 Hrs - 1	**Total:**	2694
Age:	27 Yrs.	**Instrument:**	Y	Last 30 Dys - UNK	**Type:**	137
Medical:	Y	**Waivers:**	N	Last 90 Dys - 252	**Instmt:**	47
BFR:	Y	**Months Since:**	21	**Aircraft:** UNKNOWN	**M. Eng:**	520

Emergency Occurred During: CRUISE

On post-production test flight, pilot noted symptoms of uncommanded lean mixture and turned to return for landing. Enroute to the airport, the engine lost power completely. On base leg for forced landing (off airport), fire broke out in the engine area and burned through a hydraulic line causing the gear to extend. Due to increased glide angle, the planned flight path would not clear obstruction (drawbridge). When the pilot maneuvered to avoid the obstacle, the aircraft stalled, mushed, and collided with a boat dock. Investigation revealed a loose fuel line fitting.

Probable Cause:
Fuel system, line fitting - loose, leak. Production/design personnel - maintenance, installation improper.

Factors:
Landing gear, normal retraction/extension assembly - Burned, deployed inadvertently. Terrain condition - high obstruction(s). PIC - Stall/mush inadvertent, maneuver attempted.

ASF Comments:
This was a case of mechanical failure compounded by uncommanded gear extension which decreased gliding distance. The POH does not include glide performance with the gear (or flaps) extended. When faced with a dead-stick landing, it's probably better to remain high and close, risking an overrun, rather than land short of the selected runway either on or off the airport.

The AOPA Air Safety Foundation — Aircraft Accident Summary Report

Reference Number: 85-2939 **Data Provided By NTSB**

Date & Time	Aircraft Data	Registration No.	Type Operation	Phase Occurred	Aircraft Damage
85.12.12 0930 CST	PA-46 (SERP) 310 HP	N4380A	BUSINESS	LANDING	DESTROYED

Injuries:	Fatal	Serious	Minor	None
Crew:	0	0	0	1
Pass:	0	0	0	1
Other:	0	0	0	0

Location: Evanston, IL **Flight Plan:** IFR
Itinerary: West Chicago, IL, to Troy, MI
Airport: Off Airport **Runway:** N/A, N/A/N/A, Water, N/A

Weather:	VMC			**Clouds:**	None Clear
Visibility:	7.0 SM, None	**Precip:**	None	**Ceiling:**	None
Wind:	270/08	**Gusts:**	Unk	**Lighting:**	DAY
Briefing:	FSS	**Type:**	Unknown	**Complete:**	Y

Pilot:	PVT/SEL			**Hours:** Last 24 Hrs - 1	**Total:**	1890
Age:	39 Yrs.	**Instrument:**	Y	Last 30 Dys - UNK	**Type:**	16
Medical:	Y	**Waivers:**	N	Last 90 Dys - 67	**Instmt:**	560
BFR:	Y	**Months Since:**	13	**Aircraft:** UNKNOWN	**M. Eng:**	Unk

Emergency Occurred During: CLIMB

The aircraft was on climb-out on an IFR flight plan in VMC conditions when the engine failed. A restart was attempted, and the engine ran for a minute or less. Subsequent attempts were unsuccessful. The aircraft was over Lake Michigan and had insufficient altitude to reach the shoreline. A successful water landing was made, and the occupants were picked up by the Coast Guard unharmed. Subsequent examination of the engine revealed that the crankshaft had fractured.

Probable Cause: Engine assembly, crankshaft - Fatigue, failure, total.

Factors:

ASF Comments:

The pilot ditched the airplane successfully, but the report does not include any information about the weather, aircraft configuration, or its behavior at water entry. This is regrettable, as successful ditchings seldom occur; lessons learned could be passed along to other pilots if properly documented.

The AOPA Air Safety Foundation — Aircraft Accident Summary Report

Reference Number: 86-2449 **Data Provided By NTSB**

Date & Time	Aircraft Data	Registration No.	Type Operation	Phase Occurred	Aircraft Damage
86.11.08 1830 PST	PA-46 (SERP) 310 HP	N4323N	INSTRCTNL	LANDING	SUBSTNTL

Injuries:	Fatal	Serious	Minor	None
Crew:	0	0	0	2
Pass:	0	0	0	0
Other:	0	0	0	0

Location: Bremerton, WA **Flight Plan:** NONE
Itinerary: Seattle, WA, to Bremerton, WA
Airport: KTSAP **Runway:** 01, 5000/150, Asphalt, Dry

Weather:	VMC			**Clouds:**	5000 ft. Scattered
Visibility:	20.0 SM, None	**Precip:**	None	**Ceiling:**	None
Wind:	00/00	**Gusts:**	0	**Lighting:**	DUSK
Briefing:	FSS	**Type:**	Unknown	**Complete:**	U

Pilot:	COMM/SMEL			**Hours:** Last 24 Hrs - 3	**Total:**	850
Age:	29 Yrs.	**Instrument:**	Y	Last 30 Dys - UNK	**Type:**	460
Medical:	Y	**Waivers:**	N	Last 90 Dys - 15	**Instmt:**	108
BFR:	U	**Months Since:**	UN	**Aircraft:** UNKNOWN	**M. Eng:**	60

Emergency Occurred During: LANDING

The nose gear did not turn the full 90 degrees prior to locking for landing. When the aircraft's nose was lowered during roll, this caused the aircraft to veer to the side of the runway. The nose gear had become stiff due to the fact that the manufacturer had not provided any method to lubricate the trunion.

Probable Cause:
Landing gear, nose gear assembly - Failure, partial. Manufacturer - Aircraft/ equipment inadequate design, Insufficient standards/requirements airman. PIC - Ground loop/swerve uncontrolled.

Factors:
PIC - Directional control not possible.

ASF Comments:
Failure of the linkage nose gear may be caused by towing an aircraft beyond turn limits. This is a preflight item, although fatigue damage may not be evident.

The AOPA Air Safety Foundation — Aircraft Accident Summary Report

Reference Number: 86-2754 **Data Provided By NTSB**

Date & Time	Aircraft Data	Registration No.	Type Operation	Phase Occurred	Aircraft Damage
86.08.15 2247 EDT	PA-46 (SERP) 310 HP	N27EE	BUSINESS	MANEUVER	DESTROYED

Injuries:	Fatal	Serious	Minor	None
Crew:	0	1	0	0
Pass:	2	1	0	0
Other:	0	0	0	0

Location: West Mifflin, PA **Flight Plan:** IFR
Itinerary: Pittsburgh, PA, to Philadelphia, PA
Airport: Off Airport **Runway:** N/A, N/A/N/A, Concrete, Wet

Weather: VMC **Clouds:** 3000 ft. Scattered
Visibility: 5.0 SM, Haze **Precip:** None **Ceiling:** 10000 ft.
Wind: 190/06 **Gusts:** 0 **Lighting:** NIGHT
Briefing: NWS **Type:** Telephone **Complete:** U

Pilot: COMM/CFI/SMEL **Hours:** Last 24 Hrs - 1 **Total:** 1166
Age: 26 Yrs. **Instrument:** Y Last 30 Dys - 127 **Type:** 127
Medical: Y **Waivers:** N Last 90 Dys - 284 **Instmt:** 97
BFR: Y **Months Since:** 10 **Aircraft:** CE 172RG **M. Eng:** 187

Emergency Occurred During: CLIMB

At 2232 EDT, the aircraft was climbing to 15,000 feet when the pilot reported a low oil pressure light. Air traffic control advised Jimmy Stewart Field is about eleven thirty and 15 miles. After the pilot asked, "Is that a tower field?," air traffic control advised he did not know, Westmoreland County is at two o'clock and about 15 miles, turn right 180 degrees, descend and maintain 4,000 feet. At 2233 EDT, air traffic control said that they believe Westmoreland County Tower is closed down. The pilot said that he was thinking of where he should go, and air traffic control advised Pittsburgh's 35 miles away if you can make that. At 2234:35 EDT, the aircraft was returning to Pittsburgh when the pilot reported zero oil pressure and an oil light. At 2237:27 EDT, the pilot reported an emergency. Flight was cleared to Allegheny County Airport and advised Monroeville Airport 230 heading and 5 miles. The aircraft crashed at 2247 EDT. The investigation showed a loose flange nut on left turbocharger feed line finger tight. A test produced a steady leak. At site, oil covered bottom of fuselage and empennage.

Probable Cause:
Lubricating system, oil tubing - loose. Fluid, oil - exhaustion. Engine assembly - failure, partial. Other maintenance personnel - inadequate maintenance. PIC - poor in-flight planning/decision.

Factors: PIC - Delayed emergency procedure.

ASF Comments:
This accident apparently stemmed from mechanical failure. It appears, however, that the pilot exercised poor judgment by passing up suitable airports while trying to reach Pittsburgh. Zero oil pressure is always followed by engine failure; therefore, getting the airplane on the ground safely should be priority one.

The AOPA Air Safety Foundation — Aircraft Accident Summary Report

Reference Number: 86-5004 **Data Provided By NTSB**

Date & Time	Aircraft Data	Registration No.	Type Operation	Phase Occurred	Aircraft Damage
86.03.17 1910 PST	PA-46 (SERP) 310 HP	N4360V TEST FLT	OTHER WORK	CRUISE	NONE

Injuries:	Fatal	Serious	Minor	None
Crew:	0	0	0	2
Pass:	0	0	0	0
Other:	0	0	0	0

Location: Reno, NV
Itinerary: San Jose, CA, to Local
Airport: Off Airport
Flight Plan: IFR
Runway: N/A

Weather: VMC
Visibility: 50.0 SM, None **Precip:** None
Wind: 340/09 **Gusts:** 0
Briefing: UNK **Type:** UNK
Clouds: Clear Clear
Ceiling: None
Lighting: DAY
Complete: U

Pilot: COM/ATP/CF/SMEL
Age: 32 Yrs. **Instrument:** Y
Medical: Y **Waivers:** Y
BFR: U **Months Since:** UN
Hours: Last 24 Hrs - 2
Last 30 Dys - UNK
Last 90 Dys - 96
Aircraft: UNKNOWN
Total: 4238
Type: 249
Instmt: 388
M. Eng: 984

Emergency Occurred During: CRUISE

At FL250, the engine ceased operating due to a failed fuel pump. A restart was successful at 10,000 feet msl with an uneventful landing. This fuel pump (a Model G) had a total time of three hours. It was a replacement for a Model C fuel pump which had previously failed because of a crack in the aneroid bellows. The Model G failed due to tolerances being too close.

Probable Cause:
Fuel system, pump - total failure, incorrect.

Factors:

ASF Comments:
The narrative does not mention pilot use of the auxiliary fuel pump to restart the engine. According to the POH, use of the auxiliary pump on HIGH will enable the engine to develop 75 percent power, provided there is fuel in the tank and loss of fuel pressure caused the loss of power. The successful outcome attests to the pilot's ability to keep his head under stress.

The AOPA Air Safety Foundation — Aircraft Accident Summary Report

Reference Number: 87-2653 **Data Provided By NTSB**

Date & Time	Aircraft Data	Registration No.	Type Operation	Phase Occurred	Aircraft Damage
87.11.29 1843 PST	PA-46 (SERP) 310 HP	N4369V INSTRCTNL	AIR TAXI	DESCENT	DESTROYED

Injuries:	Fatal	Serious	Minor	None
Crew:	1	1	0	0
Pass:	0	0	0	0
Other:	0	0	0	0

Location: Long Beach, CA **Flight Plan:** IFR
Itinerary: Carlsbad, CA, to San Jose, CA
Airport: Long Beach **Runway:** 30, 10000/200, Asphalt, Dry

Weather: VMC **Clouds:** Clear Clear
Visibility: 10.0 SM, None **Precip:** None **Ceiling:** None
Wind: 00/00 **Gusts:** 0 **Lighting:** NIGHT
Briefing: None **Type:** N/A **Complete:** N

Pilot: ATP/CFI/SMEL/GLI **Hours:** Last 24 Hrs - UN **Total:** 4782
Age: 62 Yrs. **Instrument:** Y Last 30 Dys - UNK **Type:** 237
Medical: Y **Waivers:** Y Last 90 Dys - UNK **Instmt:** 409
BFR: Y **Months Since:** 10 **Aircraft:** PA 28 **M. Eng:** 878

Emergency Occurred During: CRUISE

During the return flight to San Jose and subsequent descent and approach to the Long Beach Airport, the two pilots experienced, in succession, a failure of the turbocharger system, loss of an alternator, loss of engine oil pressure, an unsafe landing gear indication, and an in-flight fire followed by the loss of engine power during a nighttime circling approach to an unfamiliar airport in visual meteorological condition. The aircraft crashed onto the southbound lanes of the San Diego freeway at Long Beach after making a flyby of the tower to confirm the landing gear position. The investigation revealed an improperly installed turbocharger, a cracked manifold exhaust, a burned main power lead, a separated cylinder, and a low fluid level in the hydraulic reservoir. Two years prior to this accident, the instructor pilot made an unintentional gear-up landing in another aircraft. One year prior to this accident, the FAA revoked the mechanic's inspection authorization.

Probable Cause: Company maintenance personnel - improper maintenance, installation. PIC (CFI) - intentional low pass, encountered stall/mush. Hydraulic system, accumulator - Low level. Engine assembly, cylinder - fatigue.

Factors: Exhaust system, turbocharger - disengaged. Engine installation, mounting bolt - separation. Electrical system, electric wiring - burned. Fluid, oil - starvation. PIC (CFI) - anxiety/apprehension, poor judgment.

ASF Comments:
Turbocharger system failure preceded an incredible series of other mechanical failures. It's easy to fault the pilot after the fact, but in view of the compound emergency, he would have been better served to land the airplane on the airport with the gear up rather than doing a flyby to confirm landing gear position.

The AOPA Air Safety Foundation — Aircraft Accident Summary Report

Reference Number: 91-1773 **Data Provided By NTSB**

Date & Time	Aircraft Data	Registration No.	Type Operation	Phase Occurred	Aircraft Damage
91.08.07 1615 EDT	PA-46 (SERP) 310 HP	N9094Z	BUSINESS	CRUISE	SUBSTNTL

Injuries:	Fatal	Serious	Minor	None
Crew:	0	0	0	1
Pass:	0	0	0	1
Other:	0	0	0	0

Location: Cartersville, GA
Flight Plan: UNK
Itinerary: Chamblee, GA, to Chattanooga, TN
Airport: Off Airport
Runway: N/A

Weather:	VMC			**Clouds:**	3500 ft. Scattered
Visibility:	5.0 SM, Haze	**Precip:**	None	**Ceiling:**	None
Wind:	250/02	**Gusts:**	0	**Lighting:**	Day
Briefing:	None	**Type:**	N/A	**Complete:**	N

Pilot:	COMM/CFI/SMEL			**Hours:** Last 24 Hrs - UN	**Total:**	2200
Age:	26 Yrs.	**Instrument:**	Y	Last 30 Dys - 40	**Type:**	400
Medical:	Y	**Waivers:**	N	Last 90 Dys - 80	**Instmt:**	90
BFR:	Y	**Months Since:**	12	**Aircraft:** CE 172	**M. Eng:**	50

Emergency Occurred During: CLIMB

During the climb to cruise flight, the fuel flow decreased, cylinder head temperature and oil temperature increased, and an odor of overheating was detected. When the engine sputtered, the fuel pump was engaged, and the engine quit. A forced landing was made in a pasture, where the gear collapsed during the landing roll. Evidence of a fire was found, which resulted from a leak at the main fuel line B-nut in the engine compartment. Investigation revealed that the B-nut had been loosened, and not replaced tightly, during replacement of the standby vacuum pump. The QC inspector who examined the repair did not examine the area surrounding the replaced standby vacuum pump.

Probable Cause:
FBO Personnel - Maintenance - improper replacement, inadequate inspection of aircraft.

Factors:
Fuel system, line fitting - Loose.

ASF Comments:
Poor maintenance and substandard quality control caused this accident.

The AOPA Air Safety Foundation — Aircraft Accident Summary Report

Reference Number: 91-2255 **Data Provided By NTSB**

Date & Time	Aircraft Data	Registration No.	Type Operation	Phase Occurred	Aircraft Damage
91.09.08 0930 EDT	PA-46 (SERP) 350 HP	N350MM	PERSONAL	TAKEOFF	SUBSTNTL

Injuries:	Fatal	Serious	Minor	None
Crew:	0	0	0	1
Pass:	0	0	0	5
Other:	0	0	0	0

Location: Dayton, OH **Flight Plan:** IFR
Itinerary: Dayton, OH, to Olathe, KS
Airport: Dayton International **Runway:** 24, 7000/150, Concrete, Dry

Weather:	VMC			**Clouds:**	25000 ft. Scattered
Visibility:	10.0 SM, None	**Precip:**	None	**Ceiling:**	None
Wind:	140/05	**Gusts:**	0	**Lighting:**	Day
Briefing:	UNK	**Type:**	UNK	**Complete:**	U

Pilot:	COMM/SEL			**Hours:** Last 24 Hrs - UN	**Total:**	11250
Age:	69 Yrs.	**Instrument:**	Y	Last 30 Dys - UNK	**Type:**	162
Medical:	Y	**Waivers:**	N	Last 90 Dys - UNK	**Instmt:**	UNK
BFR:	Y	**Months Since:**	3	**Aircraft:** PA-46	**M. Eng:**	UNK

Emergency Occurred During: TAKEOFF

During the takeoff roll, the nose of the airplane came off the ground prematurely. The pilot tried to correct by electrically applying nose down trim, but did not get any response. The airplane climbed about 50 feet off the ground, and the pilot could not lower the nose. The pilot elected to abort the takeoff, the airplane landed hard on the runway, veered to the right, departed the runway, and struck three taxiway lights and a taxiway sign. Examination of the airplane's electric elevator trim indicator revealed that the indicator had malfunctioned because a guide/lodging pin was binding, which resulted in the indicator disconnecting from the track. The indicator was reading full nose down, at the same time the elevator trim tab was in the full nose up position.

Probable Cause:
Flight control system, elevator trim indicator - binding (mechanical), disconnected.

Factors:
PIC - Directional control not possible.

ASF Comments:
This experienced pilot was apparently the victim of a mechanical malfunction. The accident might have been prevented had the pilot reacted to the full nose up trim by aborting the takeoff early on rather than attempting to correct the trim problem with the electric trim. If manual trim was unavailable, then the pilot made the second best choice—abort before getting too high.

The AOPA Air Safety Foundation — Aircraft Accident Summary Report

Reference Number: 92-0061 | **Data Provided By NTSB**

Date & Time	Aircraft Data	Registration No.	Type Operation	Phase Occurred	Aircraft Damage
92.01.30 1110 EST	PA-46 (SERP) 310 HP	N9103Q USE	OTHER WK	TAKEOFF	SUBSTNTL

Injuries:	Fatal	Serious	Minor	None
Crew:	0	0	0	2
Pass:	0	0	0	0
Other:	0	0	0	0

Location: Baltimore, MD
Flight Plan: IFR
Itinerary: Baltimore, MD, to White Plains, NY
Airport: Martin State
Runway: 14, UNK

Weather:	VMC			**Clouds:**	UNK Overcast
Visibility:	2.000 SM, Fog	**Precip:**	None	**Ceiling:**	Overcast
Wind:	00/00	**Gusts:**	0	**Lighting:**	Day
Briefing:	FSS	**Type:**	UNK	**Complete:**	Y

Pilot:	ATP/CFI/SMEL			**Hours:** Last 24 Hrs - 0	**Total:** 5300
Age:	27 Yrs.	**Instrument:**	Y	Last 30 Dys - 85	**Type:** 550
Medical:	Y	**Waivers:**	N	Last 90 Dys - 250	**Instmt:** 500
BFR:	Y	**Months Since:**	6	**Aircraft:** JETSTRE	**M. Eng:** 1700

Emergency Occurred During: TAKEOFF

During initial climb-out from Runway 14 at Martin State airport, Baltimore, Maryland, at approximately 300 feet above ground level, the airplane's engine experienced total power loss and a fire. The pilot said he declared an emergency and made an approximate 280-degree turn back to the airport. The gear was extended, but due to the fire, the nose gear was disabled and did not extend. An emergency landing was made on Runway 32. Post accident investigations revealed a fuel leak in the engine's vapor return line. Due to the severe fire damage incurred by the fuel line, a failure mode could not be determined.

Probable Cause: Fuel system, line - Partial failure.

Factors: Fuel system, line - Leak. Engine assembly - Fire.

ASF Comments:

This is similar to the November 29, 1987, Long Beach, California, accident (#87-2653) in that multiple failures—engine, landing gear, electrical, cabin smoke—all occurred. The common link is fire. This stresses the importance of not troubleshooting, but immediately landing when multiple systems fail. Fire is likely, and the best antidote is to be on the ground and out of the airplane. One cannot argue with a safe on-field landing. It seems unlikely the pilot accomplished the landing from 300 feet agl, however. Return to the runway for a forced landing should only be considered above 1,000 feet agl. Even then, it is dicey. All too often, attempts to return to the airport result in stall/spin/crash accidents. Whenever the engine fails catastrophically on takeoff, first adjust pitch angle to maintain flying speed, then quickly evaluate the situation. It's better to land straight ahead under control than attempt to return to the airport and stall/spin/crash out of control.

NTSB Special Investigation Report

The five fatal U.S. accidents under this heading are those that prompted the National Transportation Safety Board's special investigation of the PA-46 Malibu/Mirage airplanes in 1990. These accidents are included in the 35 PA-46 accidents referred to in the introduction (page V) for which the NTSB has determined a probable cause.

Additional information about the **Investigation** and abbreviated reports of two fatal foreign accidents (Hermosillo, Mexico, and Tottori, Japan) that occurred in the same time frame are included in the ***Appendix: NTSB Piper PA-46 Special Investigation and FAA Certification Review*** (page 3–30). These two reports are also included in ***Foreign Accidents*** (page 2–60).

A complete analysis of the five fatal U.S. accidents and the Ocala, Florida, incident mentioned in the **Investigation** are contained in the NTSB Special Investigation Report (NTSB/SIR-92/03). Copies may be obtained from:

National Technical Information Service
5285 Port Royal Road
Springfield, Virginia 22161
Telephone: (703) 487-4600

ASF Comment:
NTSB comments regarding four of the five fatal accidents (numbers 90-2173, 90-2174, 90-2290, and 91-0472; pages 2–40 through 2–51) addressed in the Investigation focus on pilot error; specifically, improper or nonuse of pitot heat in IMC and freezing temperatures. It should be noted, however, that moderate to severe turbulence associated with convective weather could have been a factor in all of these accidents. The summaries do not indicate whether or not the aircraft were radar or stormscope equipped, and the pilots may not have been aware of the convective activity in their vicinity.

89-1308
Bristol, IN

90-2173
Bakersfield, CA

90-2174
Lakeville, MI

90-2290
Naylor, MO

91-0472
Bronson, FL

NTSB Comments
(Excerpted from NTSB/SIR-92/03):

Probable Cause:

Twelve persons died in the five U.S. accidents and all five airplanes were destroyed. The National Transportation Safety Board investigations and analyses of the accidents disclosed that one occurred because the pilot entered a very strong thunderstorm, lost control of the airplane, and overstressed critical structural components, which separated in flight. The causes of the other four accidents involved probable failure to use pitot heat during flight in freezing instrument meteorological conditions, possible misuse of integrated flight guidance and control systems, loss of control, and in-flight airframe failures due to loads and stresses that substantially exceeded design limits. The Safety Board issued six safety recommendations to the Federal Aviation Administration related to more stringent pilot training requirements for pilots of small pressurized airplanes, the addition of a pitot heat operating light in PA-46 and similar airplanes, revision of check lists in the pilot operating handbook and the airplane flight manual for PA-46 and similar airplanes, and improved training material for integrated flight guidance and control systems.

Pitot Icing:

Although somewhat of an odd coincidence that four of the five U.S. accidents discussed in the report (NTSB/SIR-92/03) probably involved ice blockage of the pitot tube, it is perhaps not unexpected given the backgrounds and experience of the pilots involved. None of the airplanes most recently flown by these pilots before transition to the PA-46 was certificated for flight into known icing conditions, nor were any of those airplanes equipped with significant ice protection equipment. Consequently, when flying those airplanes in IMC, the pilots probably would have avoided forecast icing conditions and flying in visible moisture near and above the freezing level.

NTSB Comments (Excerpted from NTSB/SIR-92/03) continued:

With the transition to the PA-46 airplanes, all of which were equipped for flight into known icing conditions, the pilots probably would have been relatively unconcerned about encountering light to moderate icing conditions in flight. Also, the higher altitude capabilities of the turbocharged and pressurized PA-46 airplanes would have provided an improved capability to avoid IMC in freezing conditions, which may have reinforced their relative lack of concern about flight into forecast or actual icing conditions. Further, with relatively little experience in icing conditions, the pilots may have equated visible ice accretion on the windscreen or on the leading edges of the wings as the indication that the ice protection equipment, including pitot heat, should be activated.

However, pitot tubes, because of design and location on airplanes, are efficient collectors of ice and will ingest ice crystals that can block the tube but that will not otherwise accrete as airframe ice. Further, as evidenced by estimates provided by a major manufacturer of pitot tubes, blockage of an unheated pitot tube can occur rather quickly, even in light icing conditions. Therefore, pitot tubes should be heated whenever the airplane is in visible moisture and the ambient temperature is +5 degrees centigrade or less.

The Safety Board tends to believe that the pilots involved in the Bakersfield, Naylor, Lakeville, and Bronson accidents, and the pilot involved in the Ocala incident, may have misunderstood or may have forgotten the above aspects related to pitot tube icing in IMC near or above the freezing level and, as a consequence, failed to activate the pitot heat in a timely manner. Also, there was no item in the pretakeoff, climb, or cruise checklists for the PA-46 airplane to remind the pilots that pitot heat should be activated during flight in visible moisture with the ambient temperature at 5 degrees centigrade or less. Finally, the pilots apparently were not aware of the effects of pitot tube icing and, therefore, reacted improperly to the erroneously low airspeed indications caused by blockage of the pitot tubes with atmospheric icing.

Editor's Note: *The current status of Safety Board recommendations and the FAA's response thereto are described in the* AOPA Pilot *magazine "Pilot Briefing" articles contained in Part 3 (pages 3-48 and 3-49).*

Special Investigation Report

The AOPA Air Safety Foundation — Aircraft Accident Summary Report

Reference Number: 89-1308 **Date Printed: 94.03.24**

Date & Time	Aircraft Data	Registration No.	Type Operation	Phase Occurred	Aircraft Damage
89.05.31 1606 EST	PA 46 (SERP) 310 HP	N9114B	BUSINESS	DESCENT	DESTROYED

Injuries:	Fatal	Serious	Minor	None
Crew:	1	0	0	0
Pass:	2	0	0	0
Other:	0	0	0	0

Location: Bristol, IN **Flight Plan:** IFR
Itinerary: Tullahoma, TN, to Kalamazoo, MI
Airport: Off Airport **Runway:** N/A

Weather:	UNK			**Clouds:**	UNK Broken
Visibility:	UNK, UNK	**Precip:**	None	**Ceiling:**	2500 ft.
Wind:	0/0	**Gusts:**	0	**Lighting:**	Day
Briefing:	FSS	**Type:**	Telephone	**Complete:**	N

Pilot:	PVT/SMEL			**Hours:** Last 24 Hrs - 5	**Total:** - 1619
Age:	54 Yrs.	**Instrument:**	Y	Last 30 Dys - 7	**Type:** - 17
Medical:	Y	**Waivers:**	N	Last 90 Dys - 18	**Instmt:** - 441
BFR:	Y	**Months Since:**	20	**Aircraft:** PA 34	**M. Eng:** - 585

Emergency Occurred During: DESCENT

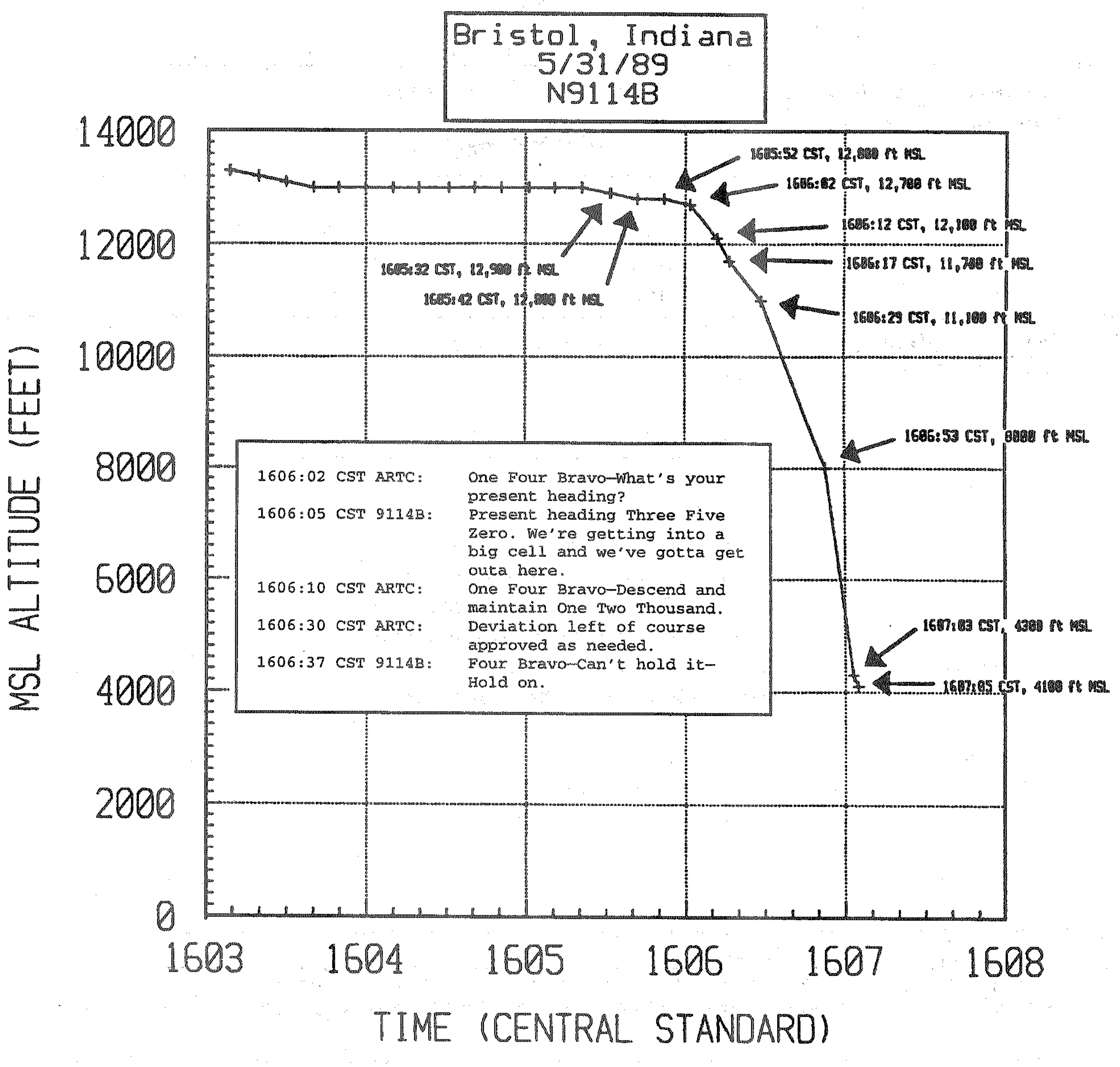
After being cleared to descend to 12,000 feet and to deviate around a "big cell," the aircraft entered an area of level two and three thunderstorms. Subsequently, an in-flight breakup occurred and wreckage was scattered over a 4-mile area. During the breakup, the right wing and empennage separated from the aircraft. The left wing and spar also failed at the same location as the right wing, but the left wing remained with the fuselage. No pre-accident failure, malfunction, or metal fatigue of the aircraft was found during the investigation.

Probable Cause:
PIC - Continued flight into known adverse weather, exceeded design stress limits of the aircraft.

Factors:
Weather condition - Thunderstorm. PIC - Airspeed(V_A) - Above, lack of total experience in type of aircraft. Wing, spar/stabilizer - Overload, separation.

NTSB Comments on page 2–40.

89-1308
Bristol, Indiana



Special Investigation Report

The AOPA Air Safety Foundation — Aircraft Accident Summary Report

Reference Number: 90-2173 **Date Printed: 94.03.24**

Date & Time	Aircraft Data	Registration No.	Type Operation	Phase Occurred	Aircraft Damage
90.02.06 1548 PST	PA 46 (SERP) 350 HP	N8888M	BUSINESS	CLIMB	DESTROYED

Injuries:	Fatal	Serious	Minor	None
Crew:	1	0	0	0
Pass:	1	0	0	0
Other:	0	0	0	0

Location: Bakersfield, CA **Flight Plan:** IFR
Itinerary: Porterville, CA, to Redlands, CA
Airport: Off Airport **Runway:** N/A

Weather: UNK **Clouds:** 3700 ft. Scattered
Visibility: UNK, None **Precip:** None **Ceiling:** 6000 ft.
Wind: 310/10 **Gusts:** 0 **Lighting:** Day
Briefing: FSS **Type:** Telephone **Complete:** Y

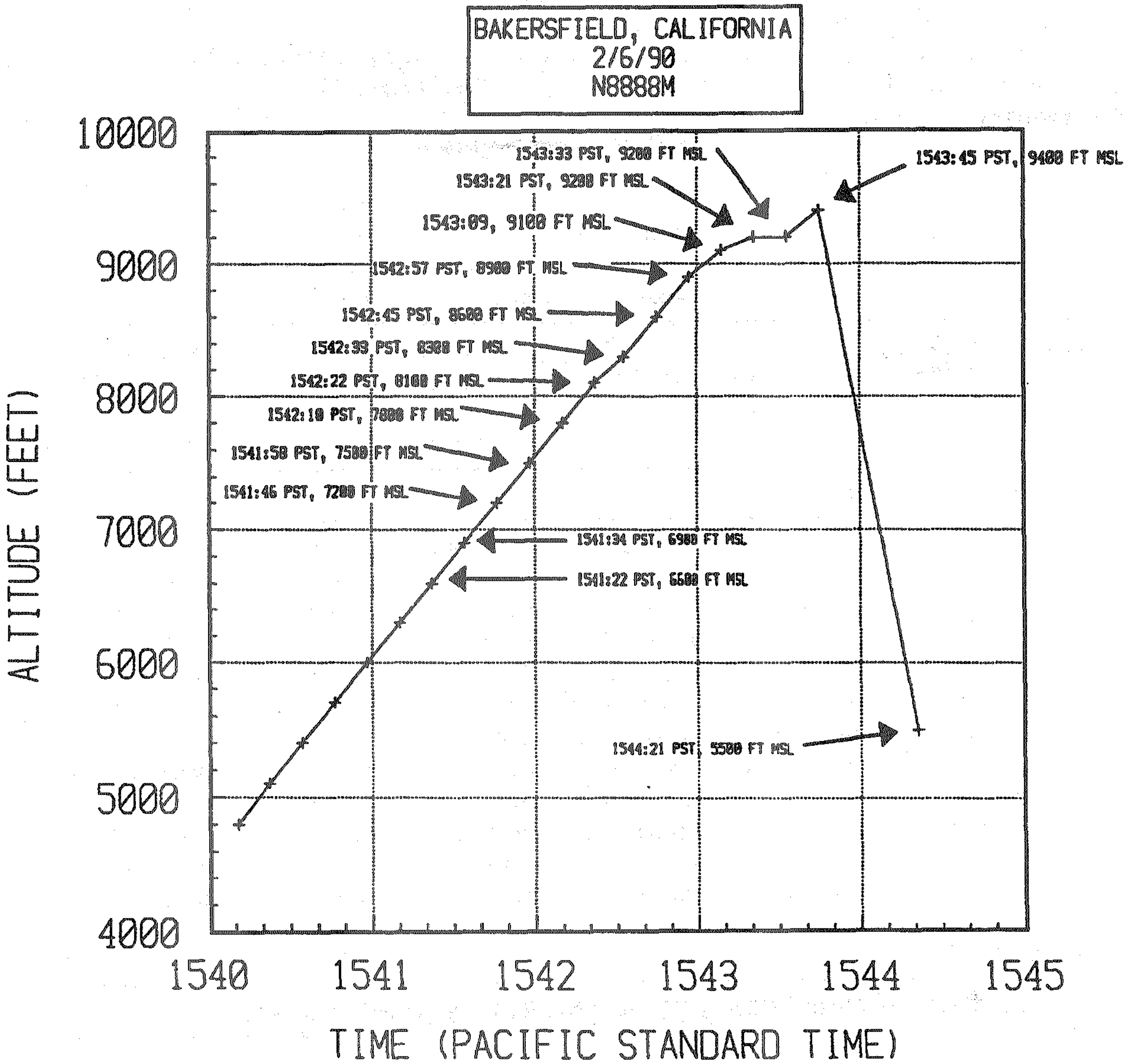
Pilot: PVT/SEL **Hours:** Last 24 Hrs - 1 **Total:** - 8155
Age: 74 Yrs. **Instrument:** Y Last 30 Dys - 18 **Type:** - 51
Medical: N **Waivers:** N Last 90 Dys - 64 **Instmt:** - 1569
BFR: Y **Months Since:** 19 **Aircraft:** PA-24 **M. Eng:** - UNK

Emergency Occurred During: CRUISE
Before takeoff, pilot was advised of IFR conditions along first part of route, with flight precautions for occasionally moderate turbulence below 15,000 feet and mixed icing from freezing level (6,000 feet) to 18,000 feet. He filed an IFR flight plan with a cruise altitude of 11,000 feet. During departure, pilot was cleared to climb to 9000 feet and told to expect clearance to 11,000 feet. Five minutes later, radar data showed aircraft climbed at about 1,500 feet per minute and 100 knots, slowing slightly above 8,000 feet. At about 9,000 feet, aircraft started to level and accelerate. It then climbed momentarily, deviated laterally from course, and entered steep descent. In-flight breakup occurred and wreckage was scattered over 4,100 foot area. Trajectory study showed breakup occurred between 4,500 feet and 6,500 feet as aircraft was in steep descent in excess of 266 knots. Metallurgical exam of wings and stabilizers revealed features typical of overstress separation; no preexisting cracks or defects were found. The aircraft was recently purchased. Pilot's son indicated principal problem was "twenty-year leap in technology" from previously owned PA-24, that pilot had difficulty with avionics and flight director/autopilot, and that he lacked detail training in autopilot emergencies.

Probable Cause: Pitot/static system - Ice.

Factors: Weather condition - Icing conditions. PIC - Spatial disorientation, exceeded design stress limits of aircraft.

NTSB Comments on page 2-40.


BAKERSFIELD, CALIFORNIA
2/6/90
N8888M
ALTITUDE (FEET)
TIME (PACIFIC STANDARD TIME)
10000
9000
8000
7000
6000
5000
4000
1540
1541
1542
1543
1544
1545
1543:33 PST, 9200 FT MSL
1543:45 PST, 9400 FT MSL
1543:21 PST, 9200 FT MSL
1543:09, 9100 FT MSL
1542:57 PST, 8900 FT MSL
1542:45 PST, 8600 FT MSL
1542:33 PST, 8300 FT MSL
1542:22 PST, 8100 FT MSL
1542:10 PST, 7800 FT MSL
1541:58 PST, 7500 FT MSL
1541:46 PST, 7200 FT MSL
1541:34 PST, 6900 FT MSL
1541:22 PST, 6600 FT MSL
1544:21 PST, 5500 FT MSL

Special Investigation Report

The AOPA Air Safety Foundation — Aircraft Accident Summary Report

Reference Number: 90-2174 **Date Printed: 94.03.24**

Date & Time	Aircraft Data	Registration No.	Type Operation	Phase Occurred	Aircraft Damage
90.06.26 1616 EDT	PA 46 (SERP) 310 HP	N315RC	BUSINESS	CLIMB	DESTROYED

Injuries:	Fatal	Serious	Minor	None
Crew:	1	0	0	0
Pass:	0	0	0	0
Other:	0	0	0	0

Location: Lakeville, MI **Flight Plan:** IFR
Itinerary: Flint, MI, to Akron, OH
Airport: Off Airport **Runway:** N/A

Weather:	VMC			**Clouds:**	N/A Broken
Visibility:	7.0 SM, None	**Precip:**	None	**Ceiling:**	6000 ft.
Wind:	220/12	**Gusts:**	0	**Lighting:**	Day
Briefing:	FSS	**Type:**	Telephone	**Complete:**	N

Pilot:	PVT/SEL			**Hours:** Last 24 Hrs - 1	**Total:** - 983
Age:	57 Yrs.	**Instrument:**	Y	Last 30 Dys - 17	**Type:** - 197
Medical:	Y	**Waivers:**	Y	Last 90 Dys - 45	**Instmt:** - 166
BFR:	Y	**Months Since:**	10	**Aircraft:** PA 46	**M. Eng:** - 0

Emergency Occurred During: CLIMB

During IFR departure, pilot received progressive altitude clearances to climb to 15,000 feet. At 1607 EDT, he was vectored for "a good rate of climb" through 14,000 feet with clearance to proceed on course after leaving 14,000 feet for 15,000 feet. Radar data indicated a steady climb until aircraft was above 13,000 feet. As it climbed from 13,900 feet (maximum recorded altitude), its speed slowed from about 115 knots to below 80 knots. At 1613 EDT, pilot was cleared to proceed direct and change frequency. Radar data showed that after reaching 13,900 feet, aircraft deviated from course and entered steep descent. Radar contact was lost and in-flight breakup occurred. Pieces of wings and stabilizers were found up to 1.5 miles from fuselage. Trajectory study disclosed breakup occurred between 6,000 feet and 9,000 feet msl. Exam of fractures on major components revealed characteristics typical of overstress; no preexisting cracks were found. No autopilot failure or bird strike was found. Clouds were layered to 20,000 feet; freezing level was about 12,500 feet. There was evidence aircraft was in or near convective precipitation above freezing level for about 1.5 minutes before rapid descent. Found pitot heat switch "off" and induction air door in its primary position.

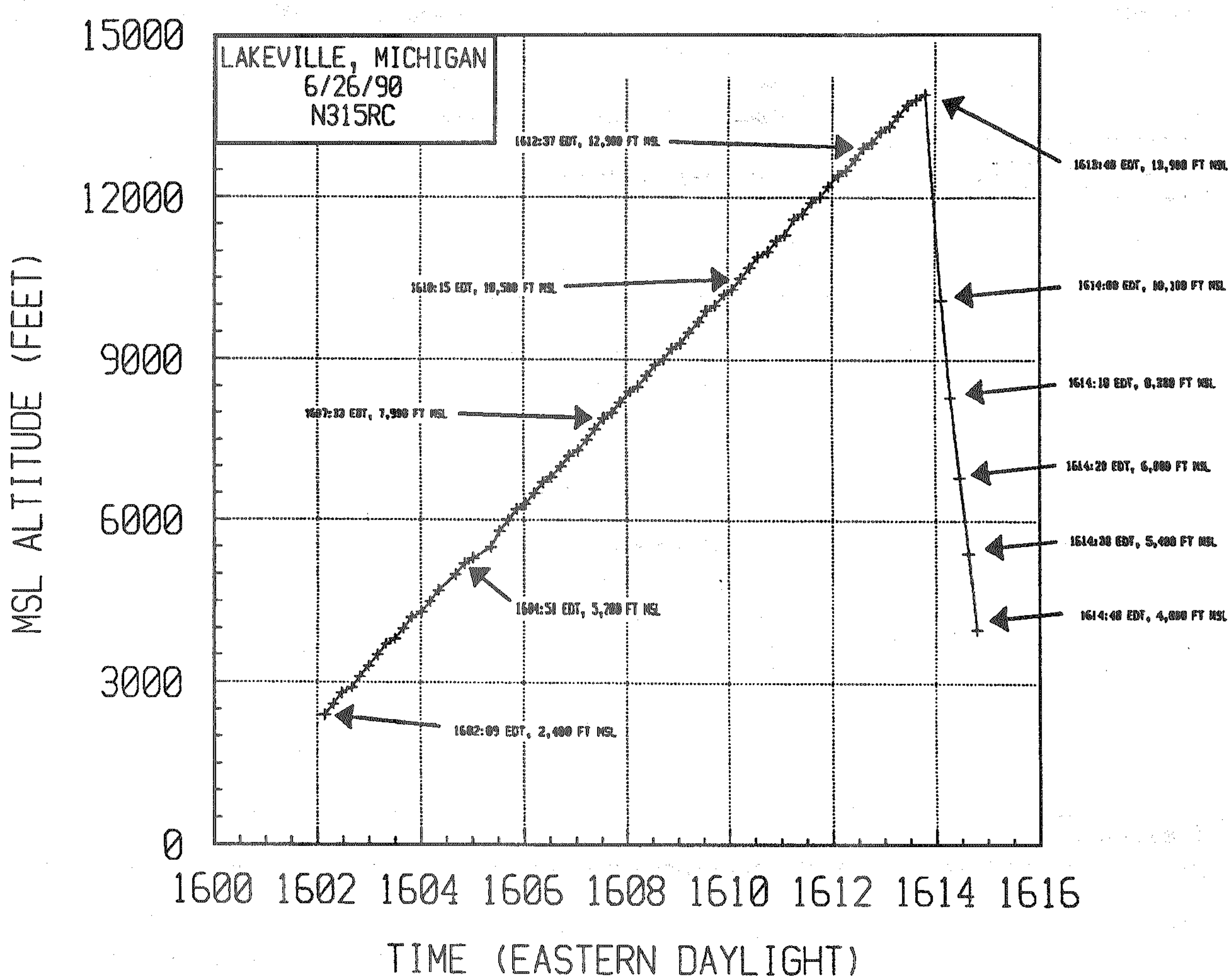
Probable Cause: Pitot/static system - Ice. PIC - Anti-ice/deice system - Not used.

Factors:
Wx condition - Icing. Flight/navigation instruments, airspeed indicator - False indication. Fuel system, ram air/induction air/propeller system/accessories - ice. PIC - Airspeed not maintained, inadvertent stall, improper remedial action.

NTSB Comments on page 2–40.

90-2174
Lakeville, Michigan

1605:27 EDT N315RC:	Ah Center—Malibu Three One Five Romeo Charlie at Six Ah Ah climbing to Eight
1605:34 EDT FMT:	Malibu Three One Five Romeo Charlie Cleveland Center—climb and maintain One Five Thousand.
1605:39 EDT N315RC:	One Five Thousand—Five Romeo Charlie
1607:23 EDT FMT:	Three One Five Romeo Charlie—A good rate of climb through One Four Thousand and Ah when you leave Fourteen for Fifteen, you're cleared direct Windsor on course coming around.
1607:33 EDT N315RC:	Ah Direct Windsor on course after Fourteen. Thank you.
1609:42 EDT FMT:	Three One Five Romeo Charlie—Fly heading One Three Zero.
1609:47 EDT N315RC:	One Three Zero Five Romeo Charlie.
1613:36 EDT FMT:	Five Romeo Charlie direct to Windsor now and contact Cleveland Center on One Two Five Point Six. Good day.
1613:43 EDT N315RC:	One Two Five Point Six. Thank you.



Special Investigation Report

The AOPA Air Safety Foundation — Aircraft Accident Summary Report

Reference Number: 90-2290 **Date Printed: 94.03.24**

Date & Time	Aircraft Data	Registration No.	Type Operation	Phase Occurred	Aircraft Damage
90.05.27 1034 CDT	PA 46 (SERP) 310 HP	N22EK	PERSONAL	DESCENT	DESTROYED

Injuries:	Fatal	Serious	Minor	None
Crew:	1	0	0	0
Pass:	1	0	0	0
Other:	0	0	0	0

Location: Naylor, MO
Itinerary: Sewanee, TN, to Springfield, MO
Airport: Off Airport
Flight Plan: IFR
Runway: N/A

Weather:	VMC			**Clouds:**	1200 ft. Scattered
Visibility:	5.0 SM, UNK	**Precip:**	UNK	**Ceiling:**	2100 ft.
Wind:	020/08	**Gusts:**	0	**Lighting:**	Day
Briefing:	FSS	**Type:**	Telephone	**Complete:**	Y

Pilot:	PVT/SEL			**Hours:** Last 24 Hrs - UN	**Total:** - 1603
Age:	64 Yrs.	**Instrument:**	Y	Last 30 Dys - UNK	**Type:** - 182
Medical:	U	**Waivers:**	U	Last 90 Dys - UNK	**Instmt:** - 380
BFR:	Y	**Months Since:**	15	**Aircraft:** PA-46	**M. Eng:** - UNK

Emergency Occurred During: CLIMB

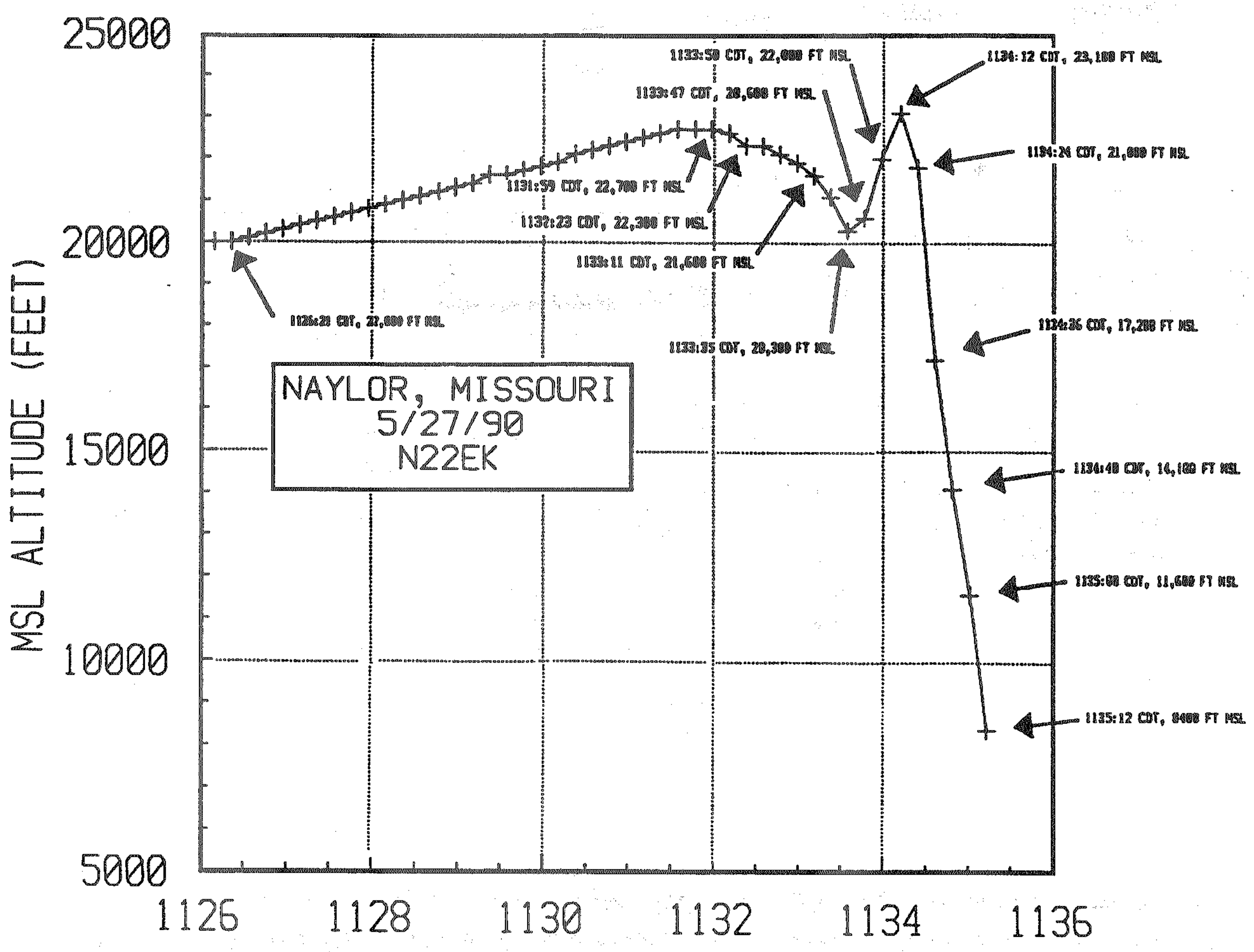
After takeoff, the pilot received progressive altitude clearances to FL200. While cruising at FL200, he reported "moderate chop." At about 1125 CDT, he requested and received clearance to FL220. About 3 minutes later, he inquired about cloud tops and said he was "in a layer right now at about Flight Level 200 to 210." Soon thereafter, the aircraft began altitude deviations and went above the assigned altitude of FL220 (22,000 feet). It then descended to about 20,500 feet, where it pitched up to an altitude of about 23,000 feet. The aircraft then went into a steep descent. Subsequently, an in-flight breakup of the aircraft occurred at about the time it emerged from the clouds near the 2,000-foot level. Pieces of wreckage were found over a wide area. The left wing was found about .2 miles from the fuselage; pieces of the rudder and stabilizers were found about 100 yards from the fuselage. An examination of the fractures on major structural components revealed features typical of over-stress separation. No preexisting cracks were found. An area forecast had flight precautions for IFR, thunderstorms, icing in the vicinity of convective activity. The pitot heat switch was found in the "off" position.

Probable Cause:
Pitot/static system - Ice. PIC - Anti-ice/deice system - Not used.

Factors:
False indication - Flight/navigation instruments, airspeed indicator. PIC - Aircraft control not maintained, exceeded design stress limits of aircraft.

NTSB Comments on page 2–40.

90-2290
Naylor, Missouri



1106:01 CDT N22EK:	Uh Memphis Center—Malibu Two Two Echo Kilo—Request flight level Two Two Zero.
1126:06 CDT ARTC:	November Two Echo Kilo—Climb and maintain flight level Two Two Zero.
1126:10 CDT N22EK:	Two Echo Kilo out of Two Zero Zero to Two Two Zero.
1127:50 CDT ARTC:	Two Echo Kilo—contact Memphis Center Uh One Two Seven Point Four-Say Tops again.
1127:58 CDT N22EK:	Uh Memphis—Uh Two Echo Kilo Uh Memphis Center—One Two Seven Point what?
1128:06 CDT ARTC:	Contact Memphis on One Two Seven Point Four. Two Echo Kilo say the Tops again.
1128:13 CDT N22EK:	Uh Two Echo Kilo—Uh One Two Seven Point Four and also the Tops—Uh I was in the clouds. I'm in a layer right now at about Uh Two flight level Two Zero Zero to Two One Zero. I was going to try to get over it. Uh Over.
1128:31 CDT ARTC:	Roger.
1128:40 CDT N22EK:	Uh Memphis Center—Malibu Two Two Echo Kilo with you. Flight level Two One Three going to Two Two Zero.
1128:49 CDT ARTC:	Malibu Two Two Echo Kilo—Memphis Center—Roger.
1129:10 CDT N22EK:	Columbia Flight—Watch Malibu Two Two Echo Kilo—Over.
1129:17 CDT FW:	Malibu Two Two Echo Kilo—Columbia Flight Watch.
1129:22 CDT N22EK:	Two Two Echo Kilo—I'm at Ah flight le— Going to flight level Two Two Zero Ah enroute to Springfield, Missouri. Ah Could you give me Ah Topeka weather at Ah for about an hour from now?
1129:49 CDT FW:	Malibu Two Two Echo Kilo—Current Topeka weather Two Thousand...
1131:01 CDT N22EK:	Two Echo Kilo—How does Springfield look now?
1131:09 CDT FW:	Scattered Ah light rain showers...
1131:24 CDT N22EK:	Ah Two Echo Kilo Ah Roger. Be a little better off going into Ah Topeka. That still looks clear up there.
1131:38 CDT FW:	Yes, Topeka looks real good right now.
1132:02 CDT ARTC:	Two Two Echo Kilo—I don't think he meant to do that. I'm going to ask him what he's doing there.
1133:39 CDT ARTC:	November Two Two Echo Kilo—Memphis.
1133:39 CDT N22EK:	Two Echo Kilo—I'm having a little bit of trouble. I'm trying to level out at Ah flight level Two Zero Zero.
1133:46 CDT ARTC:	Malibu Two Two Echo Kilo—Memphis.
1134:05 CDT ARTC:	Malibu Two Two Echo Kilo—Memphis Center.
1134:15 CDT N22EK:	Two Echo Kilo—I've lost my Ah—Echo Kilo Mayday Mayday Mayday [End of Transmission]
1135:02 CDT FW:	Two Two Echo Kilo.
1135:03 CDT UNK:	Kilo Kilo—I think [Unintelligible].
1135:24 CDT UNK:	Oh shoot.

Special Investigation Report

The AOPA Air Safety Foundation — Aircraft Accident Summary Report

Reference Number: 91-0472 **Date Printed: 94.03.24**

Date & Time	Aircraft Data	Registration No.	Type Operation	Phase Occurred	Aircraft Damage
91.03.17 1036 EST	PA 46 (SERP) 310 HP	N9112K	PERSONAL	CLIMB	DESTROYED

Injuries:	Fatal	Serious	Minor	None
Crew:	1	0	0	0
Pass:	3	0	0	0
Other:	0	0	0	0

Location: Bronson, FL **Flight Plan:** IFR
Itinerary: St. Petersburg, FL, to Bedford, MA
Airport: Off Airport **Runway:** N/A

Weather:	IMC			**Clouds:**	UNK Overcast
Visibility:	2.000 SM, Fog	**Precip:**	Rain	**Ceiling:**	700 ft.
Wind:	070/12	**Gusts:**	0	**Lighting:**	Day
Briefing:	None	**Type:**	N/A	**Complete:**	N

Pilot:	COMM/SEL			**Hours:** Last 24 Hrs - UN	**Total:** - 2252
Age:	48 Yrs.	**Instrument:**	Y	Last 30 Dys - 19	**Type:** - 268
Medical:	Y	**Waivers:**	Y	Last 90 Dys - 44	**Instmt:** - 166
BFR:	Y	**Months Since:**	16	**Aircraft:** PA-46	**M. Eng:** - UNK

Emergency Occurred During: CLIMB

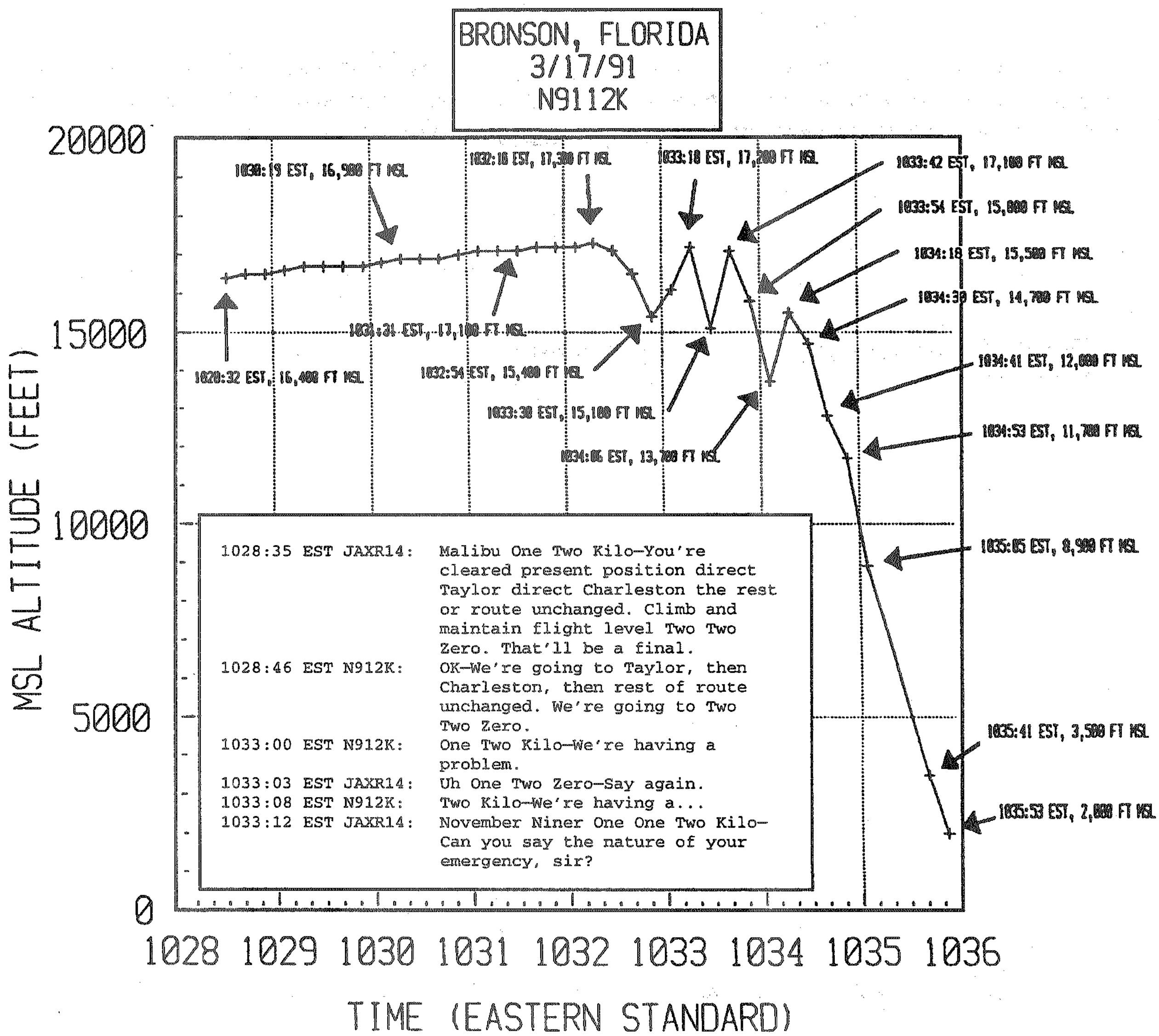
The pilot was on an IFR flight in IMC and received clearance to climb and maintain FL220. During climb, he informed ARTCC, "...we're having a problem." When asked to say again, he began the same reply, then no further radio communication was received from the aircraft. Subsequently, an in-flight breakup occurred and wreckage was scattered over a wide area. The right outboard wing panel, horizontal stabilizer, elevators, right aileron, and parts of the rudder were found at a distance from the main wreckage. These displayed evidence of overstress failure. No preexisting cracks or fatigue was found. Radar and weather data showed deviation from normal flight began at or near moderate convective weather echo (VIP 2) as the aircraft was climbing thru 17,300 feet in freezing conditions. At that time, the rate of climb was about 200 feet/minute and the groundspeed was 150 to 160 knots. At 1032:18, a descent began. During the next 2 to 3 minutes, the aircraft's altitude, heading, and speed deviated. At 1035:17, other primary radar targets appeared, then radar contact was lost. Gross weight of the aircraft was estimated to be 4,311 pounds; maximum allowable weight was 4,100 pounds. CG was estimated to be 1.59" behind the aft limit.

Probable Cause:
Pitot/static system - Ice. PIC - Improper use of anti-ice/deice system.

Factors:
Weather condition - Icing conditions.

NTSB Comments on page 2–40.

91-0472
Bronson, Florida



NTSB Preliminary Accident Reports

There are eight NTSB Preliminary Accident Reports under this heading for which the Board had not determined a probable cause at press time. Four of the aircraft were destroyed and four sustained substantial damage. Two accidents resulted in three fatalities, two others resulted in minor injuries to eleven persons, and four were injury free.

While the NTSB has not yet determined the probable cause, it appears that the eight accidents involve: one case of fuel starvation, one downwind/aborted takeoff, one unsuccessful go-around, one unsuccessful short/soft field takeoff, two in-flight engine failures, one weather related accident, and one accident that occurred under mysterious circumstances.

The distribution of these preliminary reports roughly parallels that of the 35 final NTSB reports addressed in Part 1. Therefore, it appears that no new PA-46 accident trends have developed in the past 18 to 24 months.

Preliminary Accident Report

NTSB Accident Number: LAX92WA231 **Data Provided By NTSB**

Location: Yokota AFB **State: N/A** **Date: 06/03/92** **Time: 2005 LCL**

Aircraft: Registration No.: N4391B Class: R Homebuilt: N
Manufacturer: Piper Model: PA-46-310P Name: Malibu

Phase of Flight: Emergency: Approach Accident: Landing

	Injuries:	Fatal	Serious	Minor	None
Aircraft Damage:	**Crew:**			1	
Substantial	**Passenger:**			3	
	Other:				

Pilot: City: Van Nuys State: CA
Operator: City: Yokota State: XX

Flight Operation: Personal Flight Plan: Unknown

Departure: City: Yokota AFB State: XX
Destination: City: Yokota AFB State: XX

Weather: VMC Lowest Clouds: Unknown
Precipitation N Lowest Ceiling: 20000 Ft Broken (Day) Visibility: 15.00 SM
Wind: Direction: 180 Speed: 14 Gusts: N/A

Pilot: Certificate: Commercial Instrument: U Instructor: U

Suspected Reason: Unknown Causes
Power malfunction/loss for unknown reason. (Probable Cause will be determined by the NTSB.)

Narrative:
A Piper PA-46-310P Malibu lost engine power while on short final approach to land at Yokota AFB, Japan, at about 2005 local time on Wednesday, June 3. VMC existed at the time for the local flight. The pilot had been cleared to land on Runway 36 and he was on final approach when ATC told him to go around because of conflicting military traffic. The pilot tried to comply but the engine suddenly lost power. He then made a forced landing in the runway's approach zone but the touchdown was hard and the landing gear collapsed. The airplane was substantially damaged and the commercial pilot and the three passengers received minor injuries.

ASF Comments:
Unconfirmed reports indicate that this accident may have stemmed from fuel starvation.

Preliminary Accident Report

NTSB Accident Number: MIA93LA161 **Data Provided By NTSB**

Location: Vero Beach **State: FL** **Date: 07/22/93** **Time: 1845 EDT**

Aircraft: Registration No.: N888CD Class: R Homebuilt: N
Manufacturer: Piper Model: PA-46 Name: Malibu

Phase of Flight: Emergency: Takeoff Accident: Takeoff

	Injuries:	Fatal	Serious	Minor	None
Aircraft Damage:	**Crew:**				1
Substantial	**Passenger:**				
	Other:				

Pilot: City: Dallas State: TX
Operator: City: Dallas State: TX

Flight Operation: Personal Flight Plan: IFR

Departure: City: Vero Beach State: FL
Destination: City: Myrtle Beach State: SC

Weather: IMC Lowest Clouds: 1200 Ft Scattered
Precipitation Y Lowest Ceiling: 10000 Ft Broken (Day) Visibility: 1.00 SM
Wind: Direction: 360 Speed: 10 Gusts: N/A

Pilot: Certificate: Private Instrument: U Instructor: N

Suspected Reason: Pilot - Takeoff/Initial Climb
Attempted downwind takeoff. (Probable Cause will be determined by the NTSB.)

Narrative:
A Piper PA-46 Malibu overran the runway during an aborted takeoff at Vero Beach, Florida, at about 1845 EDT on Thursday, July 22. IMC prevailed and an IFR flight plan was filed for the planned personal cross-country flight to Myrtle Beach, South Carolina. The pilot reported that there was a thunderstorm near the airport when he received clearance to taxi to Runway 22. He stated that he did an engine run-up and watched the weather conditions. The pilot then requested to taxi to Runway 11L because he saw other traffic depart from Runway 11R. After he began his takeoff roll on Runway 11L, however, he realized that he did not have enough runway to complete the takeoff because of a tailwind. He then aborted the takeoff but the airplane ran off the end of the runway. Its main landing gear broke off and the airplane slid to a stop. The pilot stated that "there was nothing wrong with the airplane. I simply tried to take off from a 3,504-foot runway with a tailwind. I could not reach rotation speed before I ran out of runway so I aborted the takeoff that I never should have started in the first place." The wind was from 360 degrees at 10 knots. The airplane was substantially damaged, but the private pilot was not injured.

ASF Comment:
It appears this pilot allowed himself to be influenced by the actions of others and failed to maintain situational awareness. Shifting winds are common in the vicinity of a thunderstorm. Windsocks are placed on airports to alert pilots to present wind direction and velocity. It's not clear what part, if any, the tower played here, but it's just possible that an alert local controller could have helped prevent this accident.

Preliminary Accident Report

NTSB Accident Number: BFO93LA158 **Data Provided By NTSB**

Location: Block Island **State: RI** **Date: 09/05/93** **Time: 1109 EDT**

Aircraft: Registration No.: N46DK Class: R Homebuilt: N
Manufacturer: Piper Model: PA-46-350P Name: Mirage

Phase of Flight: Emergency: Other Accident: Landing

	Injuries:	Fatal	Serious	Minor	None
Aircraft Damage:	**Crew**				1
Destroyed	**Passenger**				3
	Other				

Pilot: City: Bedford State: NH
Operator: City: Bedford State: NH

Flight Operation: Personal Flight Plan: None

Departure: City: Manchester State: NH
Destination: City: Block Island State: RI

Weather: VMC Lowest Clouds: 25000 Ft Scattered
Precipitation N Lowest Ceiling: None (Day) Visibility: 10.00 SM
Wind: Direction: 140 Speed: 7 Gusts: N/A

Pilot: Certificate: Unknown Instrument: U Instructor: U

Suspected Reason: Pilot - Go-around
Hit trees/object during go-around/touch-and-go landing. (Probable cause determined by the NTSB.)

Narrative:
A Piper PA-46-350P Mirage collided with terrain while trying to go around from landing at Block Island, Rhode Island, at about 1109 EDT on Sunday, September 5. VMC prevailed at the time for the cross-country flight from Manchester, New Hampshire. The pilot reported that while on final approach, over the approach end of the runway, he noticed another airplane on the active runway at its approach end. He stated that his flaps and landing gear were already down for the landing. He said that he decided to go around and retracted the flaps. The pilot reported that when the flaps retracted, however, the airplane settled downward and its right wing struck the runway. The airplane then cartwheeled and its right wing was torn away from the fuselage, rupturing the fuel tank. The wreckage came to rest off the runway and burned. The airplane was destroyed but the pilot/owner and the three passengers were not injured.

ASF Comment:
This accident should not have happened! The POH clearly states:

4.33 GO-AROUND (4.5n)
To initiate a go-around from a landing approach, the mixture should be set to full RICH, the propeller control should be at full INCREASE, and the throttle should be advanced to full power while the pitch attitude is increased to obtain the balked landing climb speed of 80 KIAS. Retract the landing gear and slowly retract the flaps when a positive climb is established. Allow the airplane to accelerate to the best-angle-of-climb speed (81 KIAS) for obstacle clearance or to the best-rate-of-climb speed (110 KIAS) if obstacles are not a factor. Reset the longitudinal trim as required. As power is increased to full and speed increases, the nose will tend to pitch upward. Care must be taken to avoid the departure stall while trim is reset. During the go-around, it's important to move to the right and parallel the active runway keeping the conflicting traffic in sight at all times to avoid a midair collision.

Preliminary Accident Report

NTSB Accident Number: SEA94FA034 **Data Provided By NTSB**

Location: Mountain Home **State: ID** **Date: 11/22/93** **Time: 0111 MST**

Aircraft: Registration No.: N84PM Class: R Homebuilt: N
Manufacturer: Piper Model: PA-46-310P Name: Malibu

Phase of Flight: Emergency: Cruise Accident: Descent

	Injuries:	**Fatal**	**Serious**	**Minor**	**None**
Aircraft Damage:	**Crew**	1			
Destroyed	**Passenger**				
	Other				

Pilot: City: Twin Falls State: ID
Operator: City: Twin Falls State: ID

Flight Operation: Personal Flight Plan: None

Departure: City: Twin Falls State: ID
Destination: City: Unknown State: UN

Weather: VMC Lowest Clouds: Unknown
Precipitation N Lowest Ceiling: 12000 Ft Broken (Night) Visibility: 30.00 SM
Wind: Direction: UNK Speed: UN Gusts: UNK

Pilot: Certificate: Private Instrument: Y Instructor: N

Suspected Reason: Unknown Causes
Crashed for unknown reasons. (Probable Cause will be determined by the NTSB.)

Narrative:
A Piper PA-46-310P Malibu collided with terrain during an uncontrolled descent 10 miles north of Mountain Home, Idaho, at 0111 MST on Monday, November 22. Night VMC prevailed in the area for the flight that had departed Twin Falls, Idaho, at about 2230 MST bound for an unknown destination. According to ARTCC, the aircraft was spotted climbing to 25,000 feet while squawking a transponder code of 1200. It was tracked through northern Nevada and back into south central Idaho, eventually passing over Boise, Idaho. Radio communications were not established during this time, although the pilot did acknowledge radio calls by "identing" on his transponder. Two-way radio communication was eventually achieved between Approach Control and the pilot, and he was cleared to descend and turn to a heading of 280 degrees. The pilot acknowledged the clearance in a normal voice but the aircraft did not change heading. Radar tracking showed that it was in a high-speed descent during the radio transmission. Law enforcement personnel reported that the pilot was under significant personal stress immediately before the accident. The aircraft was destroyed and the instrument-rated private pilot/owner was fatally injured.

ASF Comment:
All indications in this accident point to it being pilot induced. The preliminary report does not mention aircraft malfunction or weather as being a suspected reason.

Preliminary Accident Report

NTSB Accident Number: MIA94LA037 **Data Provided By NTSB**

Location: Fort Myers **State: FL** **Date: 12/07/93** **Time: 1530 EST**

Aircraft: Registration No.: N4391C Class: R Homebuilt: N
Manufacturer: Piper Model: PA-46-310P Name: Malibu

Phase of Flight: Emergency: Takeoff Accident: Takeoff

	Injuries:	**Fatal**	**Serious**	**Minor**	**None**
Aircraft Damage:	**Crew**			1	
Destroyed	**Passenger**			4	
	Other				

Pilot: City: Homestead State: FL
Operator: City: Homestead State: FL

Flight Operation: Personal Flight Plan: None

Departure: City: Fort Myers State: FL
Destination: City: Miami State: FL

Weather: VMC Lowest Clouds: 25000 Ft. Scattered
Precipitation: N Lowest Ceiling: None (Day) Visibility: 7.00 SM
Wind: Direction: 120 Speed: 5 Gusts: N/A

Pilot: Certificate: Unknown Instrument: UNK Instructor: UNK

Suspected Reason: Pilot - Takeoff/Initial Climb
Hit trees/pole/wires during takeoff climb. (Probable Cause will be determined by the NTSB.)

Narrative:
A Piper PA-45-310P Malibu collided with trees while trying to take off at Fort Myers, Florida, at about 1530 EST on Tuesday, December 7. VMC prevailed for the planned cross-country flight to Miami, Florida. The pilot stated that he was trying to take off from a 2,700-foot sod runway and hit a soft spot roughly halfway down it during his takeoff roll. He said that he did not abort the takeoff but continued it. As the airplane lifted off, however, both wings hit trees and the airplane fell to the ground and burst into flames. The occupants evacuated the wreckage immediately without getting burned. The airplane was destroyed, and the pilot and the four passengers received minor injuries.

ASF Comment:
PA-46 aircraft are not routinely operated from sod fields. Pilots should exercise sound judgment and extreme caution before choosing to operate from dirt, sod, gravel, or other marginal landing areas.

Preliminary Accident Report

NTSB Accident Number: NYC94LA039 **Data Provided By NTSB**

Location: Wilkes-Barre **State: PA** **Date: 12/15/93** **Time: 1745 EST**

Aircraft: Registration No.: N92GP Class: R Homebuilt: N
Manufacturer: Piper Model: PA-46-350P Name: Mirage

Phase of Flight: Emergency: Cruise Accident: Approach

	Injuries:	Fatal	Serious	Minor	None
Aircraft Damage:	Crew:				1
Substantial	Passenger:				
	Other:				

Pilot: City: Great Falls State: VA
Operator: City: Great Falls State: VA

Flight Operation: Personal Flight Plan: IFR

Departure: City: Bedford State: MA
Destination: City: Manassas State: VA

Weather: VMC Lowest Clouds: Unknown
Precipitation N Lowest Ceiling: 2000 Ft Overcast (Night) Visibility: 10.00 SM
Wind: Direction: 30 Speed: 4 Gusts: N/A

Pilot: Certificate: Unknown Instrument: U Instructor: U

Suspected Reason: Mechanical/Maintenance - Oil System
Oil pressure lost, power loss. (Probable Cause will be determined by the NTSB.)

Narrative:
A Piper PA-46-350P Mirage made a forced landing near Wilkes-Barre, Pennsylvania, at 1745 EST on Wednesday, December 15. Night VMC prevailed, and an IFR flight plan was filed for the cross-country flight that had departed Bedford, Massachusetts, bound for Manassas, Virginia. While in cruise flight, however, the pilot noticed a decrease in engine oil pressure, followed by a rough running engine. He asked ATC to give him vectors to land at the Wilkes-Barre airport, but the available engine power decreased during the descent. Overcast clouds covered the airport, but the pilot found the runway visually and maneuvered for a landing. While trying to land on Runway 22, however, the continued loss of engine power prevented the pilot from reaching the runway. The airplane then struck trees roughly one-half mile east of the airport. The wind was from 030 degrees at 4 knots. The airplane was substantially damaged, but the pilot/owner was not injured.

ASF Comment:
All indications are that the pilot did everything right when faced with a major problem. There are times, however, that no matter what you do, you end up with a bent airplane.

Preliminary Accident Report

NTSB Accident Number: MIA94FA044 **Data Provided By NTSB**

Location: Destin **State: FL** **Date: 01/01/94** **Time: 1420 CST**

Aircraft: Registration No.: N243KW Class: R Homebuilt: N
Manufacturer: Piper Model: PA-46-310P Name: Malibu

Phase of Flight: Emergency: Approach Accident: Descent

	Injuries:	**Fatal**	**Serious**	**Minor**	**None**
Aircraft Damage:	**Crew:**	1			
Substantial	**Passenger:**	1			
	Other:				

Pilot: City: Austin State: TX
Operator: City: Austin State: TX

Flight Operation: Personal Flight Plan: IFR

Departure: City: Naples State: FL
Destination: City: Destin State: FL

Weather: IMC Lowest Clouds: Unknown
Precipitation Y Lowest Ceiling: 700 Ft Broken (Day) Visibility: 3.00 SM
Wind: Direction: 80 Speed: 6 Gusts: N/A

Pilot: Certificate: Private Instrument: U Instructor: N

Suspected Reason: Pilot - Weather
Hit terrain during instrument approach in IFR/icing. (Probable cause will be determined by NTSB.)

Narrative:
A Piper PA-46-310P Malibu collided with terrain while circling to land at Destin, Florida, at about 1420 CST on Saturday, January 1. IMC prevailed at the time and an IFR flight plan was filed for the cross-country flight that had departed Naples, Florida, at about 1230 EST. Witnesses reported seeing the airplane flying toward the northwest roughly one-half mile west of Runway 32. It was then seen to bank to the left, during which its bank angle increased. Its nose dropped and the airplane descended into trees, collided with a fence and the ground, and then erupted on fire. The airplane was substantially damaged and the private pilot/owner and the passenger were fatally injured.

ASF Comment:
At this stage of the investigation it is too soon to tell as to the primary cause. It looks as though weather could have played a major part in this accident.

Preliminary Accident Report

NTSB Accident Number: FTW94LA146 **Data Provided By NTSB**

Location: Houston **State: TX** **Date: 05/07/94** **Time: 2306 CST**

Aircraft: Registration No.: N3648E Class: R Homebuilt: N
Manufacturer: Piper Model: PA-46-310P Name: Malibu

Phase of Flight: Accident: Descent

	Injuries:	Fatal	Serious	Minor	None
Aircraft Damage:	**Crew:**			1	2
Substantial	**Passenger:**			1	
	Other:				

Pilot: City: Houston State: TX
Operator: City: Houston State: TX

Flight Operation: Unk Flight Plan: IFR

Departure: City: Unk State: Unk
Destination: City: Houston State: TX

Weather: IMC Lowest Clouds: Thin
Precipitation N Lowest Ceiling: 800 Ft Broken (Day) Visibility: xx
Wind: Direction: 1613 Speed: x Gusts: N/A

Pilot: Certificate: Private Instrument: U Instructor: N

Suspected Reason:

Narrative:
Pilot experienced engine roughness, then loss of oil pressure. Pilot established descent and leveled, held in the vicinity of an oil rig until engine stopped, then ditched.

ASF Comment:
The pilot, realizing that a loss of oil pressure is in most cases followed by an engine seizure, displayed acute awareness of this critical situation and was able to successfully ditch the aircraft with none to minor injuries to all onboard. At the time of this report, the aircraft has not been, or will not be, recovered. Therefore, the cause of the engine stoppage may never be known.

Foreign Accidents

The Air Safety Foundation has learned of five accidents that occurred in foreign countries. Reports are included here to make this review as complete as possible. Information is quite complete for some accidents; for others, it is sketchy. Accuracy of these reports has not been verified.

Hermosillo, Mexico

On September 3, 1990, a Piper PA-46-310P, Mexican registry XB-EWP, enroute from Los Noaches, Mexico, to Tijuana, Mexico, on a visual flight rules (VFR) flight plan crashed near Hermosillo, Mexico. The pilot and three passengers were killed, and the airplane was destroyed. Information supplied by the Mexican civil aviation authorities indicates that witnesses saw the airplane fly into a large storm cloud and pieces of the airplane fell to the ground.

ASF Comment

In Malibu versus Thunderstorm, the weather frequently wins. An aircraft may pass through a thunderstorm without more than unpleasant turbulence. However, as shown in this instance, the results can be fatal.

Tottori, Japan

On November 17, 1990, a Piper PA-46-310P, Japanese registry JA3990, enroute from Tottori, Japan, to Yao, Japan, on a night visual flight rules (VFR) flight plan crashed near the Tottori Airport. The pilot and two passengers were killed. Information provided by the Japanese Aircraft Accident Investigation Commission (AAIC) indicates that after departure from Tottori Airport, the pilot orbited above the field while climbing to cruise altitude in order to cross a coastal mountain range. The AAIC investigation estimated that the airplane achieved an altitude of 5,500 feet msl when it suddenly entered an uncontrolled descent and crashed about 2.5 kilometers south-southeast of the airport. The accident occurred during the hours of darkness. Weather conditions in the area consisted of scattered to broken clouds based near 5,000 feet msl.

Based on interviews with the pilot's associates and his flight instructor, the AAIC concluded that the non-instrument-rated pilot was using the autopilot during the climb phase of the flight. Examination of the wreckage disclosed in-flight structural failures from excessive loads and stresses on the airframe.

The pilot of JA3990, age 46, held a Japanese private pilot certificate with an airplane single-engine land rating; he had no instrument rating. His second class medical certificate was issued on October 3, 1990. He had about 440 flight hours of which 150 were in the PA-46.

ASF Comment

This is really not a Malibu accident, but rather a pilot looking for an accident in any aircraft he might have chosen to fly that night. VFR night flight is not allowed in Japan without an instrument rating. Tottori is an unlikely airport to try a scud run with obscured high terrain nearby, whether or not instrument rated.

Enroute Abo, Finland, August 1992

The experienced private, instrument-rated pilot was the former owner of the accident PA-46 aircraft. He filed for FL120. About 25 minutes into the flight and shortly before reaching cruising altitude, the aircraft disappeared from radar. The weather was overcast with light rain; freezing level was reported to be about 6,000 feet. The aircraft was fueled to near capacity, and five people were on board—none survived the crash.

ASF Comment

Newspaper photographs taken at the crash site show the fuselage basically intact, and there was no reported damage to the trees about the scene of the crash. This is typical of a flat spin and suggests adverse loading—an aft CG. With five passengers and almost full fuel, the aircraft may have been over gross.

Prior to the accident, the aircraft had repeated malfunctions of the altitude indicator despite a normal vacuum system. The gyro was replaced more than once. The attitude indicator is the primary autopilot sensor. It can fail insidiously and the autopilot will follow it. The autopilot will not disengage until an unusual attitude or rapid rate of attitude change occurs. At that point, the aircraft will be mistrimmed and may be difficult to recover, especially if in IMC and icing.

Akeslund, Broma, Sweden

On December 3, 1992, PA-46, Swedish registry SE-IUE, crashed while climbing between 2,200 and 4,000 feet on a flight to the United Kingdom. The pilot and two passengers were killed.

ASF Comment

Circumstances surrounding the accident indicate that failure of the attitude gyro, as in the Finland, August 1992, crash, may have been a factor.

Guaymas, Mexico

PA-46 N4367K operating in VMC conditions was ditched in the Gulf of Mexico—reason unknown. The pilot and his passenger were rescued uninjured.

ASF Comment

This is the second successful Malibu ditching. Unfortunately, there are too few details to allow us to learn from this accident. Included in this publication is a section devoted to water landings during an emergency.

PA-46 Maintenance Summary

The Piper PA-46 Malibu aircraft series was introduced in 1984 as the first new design in its class in nearly a decade. As a new design, the Piper suffered from some unforeseen problems. Piper supported the aircraft aggressively trying to correct each problem as it developed and even paying the cost of most fixes. A description of major problems follows.

Engine Problems

The Continental TISO-520BE engine was the source of many early problems. Some can be traced to installation design, manufacturing tolerances, and operator technique. Continental responded positively in each case with service bulletins, and technical and material support. An early rash of fuel pump failures was traced to improperly nitrided shafts. Most of the later engine failures were attributed to starter drive adapter splines, particularly on aircraft equipped with air conditioning; piston pins; crankcase through-bolt torque values; air/oil separators; and oil pump suction tubes.

In 1987, Piper "strongly" recommended that all Malibu owners and operators "refrain from flying their aircraft for the next 30 days" until a series of engine stoppages were explained. The subsequent explanation was related to failures of the aforementioned piston pins. Approximately five such failures occurred, prompting Teledyne Continental Motors to issue a Service Bulletin calling for the immediate replacement of the existing piston pins. An Airworthiness Directive was subsequently issued that made compliance with the TCM Service Bulletin mandatory.

The most prominent and well-known engine event was related to the torque value of the engine through-bolts. The TSIO-520-BE engine uses torque on the through-bolts to hold the main bearings in place. Consequently, the torque value of the bolts themselves becomes very significant. Left unattended, or maintained by inexperienced mechanics, the bearings could have moved, causing the possibility of their touching the crankshaft. Friction created in that event could have caused a heat buildup over time that could cause the crankshaft to become brittle. On June 29, 1989, TCM issued Service Bulletin M89-14, which called for a preflight check of the aircraft's crankshaft by the pilot, a torque reading taken at the prop every 25 hours by a licensed mechanic, and physical inspection of the #2 main bearing every 200 hours. The bulletin later became an Airworthiness Directive, and applied to the first 337 TSIO-520-BE engines that TCM had shipped.

The depth and repetition of the inspections caused Continental to offer Malibu owners the opportunity to (1) buy a remanufactured engine at an opportunistic price, or (2) send their existing engine to TCM for modification of the through-bolts and crankcase. Either action would relieve the AD, and the owner also had the option of continuing the repetitive inspections. Today, nearly 100 percent of the first 337 engines have been replaced with updated units.

The Malibu's 310-hp Continental TISO-520BE is designed to be leaned to 50 degrees on the lean side of peak in cruise; any other procedure is forbidden. The engine has no cowl flaps, which reduces pilot work load, but it tends to run hot in climb unless speed is kept above 120 knots. There were also reports of high CHTs in cruise, especially on warm days. In late 1988, Piper issued a service bulletin detailing a "cooling improvement kit" to fix the problem. The FAA, noting that "incidents have occurred that indicate excessive operating temperatures which have resulted in engine damage," followed up with AD-88-25-08, making installation of the cooling kit mandatory.

The Lycoming-powered Mirage was introduced in the fall of 1988. Concurrently, Piper stopped production of the Malibu. The Mirage incorporated many of the system improvements made to the Malibu over time and replaced the windshield hot plate with a one-piece heated windshield. Other changes were made to the cabin door mechanism, panel layout, and interior amenities of the aircraft. Several minor airframe changes were incorporated to make the aircraft more accessible for maintenance technicians, with special attention given the glareshield and the magnetos. However, the larger T10-540-AE2A engine installed in the Mirage caused part of the environmental system to be moved into the baggage area. The aggregate of the changes was that the Mirage and the original Malibu take roughly equivalent man hours for inspection and maintenance. The Piper-authorized inspection guide for either the Malibu or Mirage calls for 39 man-hours to accomplish an annual inspection.

The Textron Lycoming T10-540-AE2A engine has not been free of problems. The exhaust system has required compliance with a number of service instructions including modifications to the exhaust crossover, replacement of the tailpipe links, adjustment and replacement of turbo clamps, and replacement of the wastegate and controller.

Repetitive failures and cracks of alternator brackets have resulted in the design of stronger brackets. Several crankcase and oil pan cracks have been reported which have required replacement. There have been a few turbo failures.

Many operators report high oil consumption. Lycoming and Piper have run a series of tests and may issue a service bulletin entitled "engine modification to improve oil usage."

A number of Malibu and Mirage owners have elected to install aftermarket engine analyzers. These allow simultaneous monitoring of individual exhaust gas temperatures (a function not available on the stock Malibu), and, as well, have the ability to simultaneously measure and display cylinder head temperatures. Other owners have added additional turbine inlet (TIT) probes better situated to accurately indicate gas temperatures reaching the turbochargers. The stock Mirage TIT probe is in the exhaust crossover and may be 50 degrees cooler than indicated by a better placed aftermarket probe. Thus, the turbos may be exposed to higher than redline exhaust temperature if the Piper gauge is the only source of information.

Hydraulic System Problems

Early Malibu aircraft had both hydraulically-activated gear and flaps powered by a single hydraulic pump built by Gar-Kenyon. Throughout 1984 and 1985, Piper incorporated several reliability improvements into the system and made them available to the rest of the fleet as Service Letters #965 and #792 and Service Bulletin #808. Nevertheless, the rigging of the hydraulic valves is particularly sensitive, and in an effort to reduce the number of valves in the system, the 1986 model Malibus began rolling off the production line with electric flaps. Later in 1986, beginning with Serial Number 4608008, the hydraulic system was replaced with one utilizing a reversible pump. It was manufactured by Parker-Hannifan, and is used in all Malibus and Mirages manufactured after late 1986. The new system is essentially the same design, but incorporates a reversible hydraulic pump and different pressures. The new hydraulic system is not retrofittable to older Malibus. Although deemed to be a better overall system, Service Bulletin #964 requires the replacement of several of the Parker-Hannifan pumps.

Service Bulletins

Not all of the Malibu's problems are associated with the hydraulic system. Piper has issued numerous service letters and bulletins on the airplane. Not all letters and/or bulletins apply to every Malibu. Early models will probably be affected by most of them, however.

Piper considers all Service Bulletins mandatory. The following bulletins are applicable to the Malibu/Mirage:

- SB 780 - Flap drive
- SB 781 - Aft rudder cable
- SB 782 - Magneto switch guard
- SB 783 - Elevator binding
- SB 784 - Pressurization outflow lines
- SB 786 - Brake cylinders
- SB 790 - Turbo oil scavenger reservoir
- SB 791 - Oxygen system wiring
- SB 792 - Fuel line
- SB 793/808 - Nose gear
- SB 794 - Fuel boost pump
- SB 796 - Wing rivets
- SB 799 - Landing gear safety switch
- SB 803 - De-ice pressure control valve
- SB 805 - Propeller
- SB 807 - Main/Nose landing gear actuator seal
- SB 809 - Nose landing gear steering rotator
- SB 810 - Gear safety solenoid
- SB 820 - Aft wing attach fitting
- SB 824 - Electric flap motor
- SB 837 - Main landing gear torque link
- SB 852 - Alternate air control linkage
- SB 853 - Fuel drain
- SB 854A - Deice timer
- SB 858 - Nose landing gear steering rotator horn attach bolt
- SB 862A - Flap actuator tube
- SB 863 - Aileron cable chafing
- SB 865 - Freon compressor
- SB 871 - Certification ceiling, leaning procedures, oil requirements, alternate air assembly, mod. tach accuracy, oil pump tube, engine through-bolt torque, air/oil separator mod
- SB 876B - Engine mods
- SB 883 - Additional post lighting
- SB 884 - Lock wiring, V-band couplings
- SB 892 - Engine cooling
- SB 894 - Nose gear emergency downspring mechanism
- SB 895 - Shoulder harness
- SB 900 - Missing upper fuselage rivets
- SB 913A - Malibu return to service
- SB 917 - Angle support forward baggage compartment
- SB 919 - Carpet runner retainer
- SB 921 - Aileron inspection
- SB 928 - Inspection of exhaust transition bolts
- SB 930 - Inspection of emergency exit window fit
- SB 934 - Manifold pressure line
- SB 939 - Weight & Balance plotter
- SB 941 - Engine baffle support
- SB 943 - Landing gear locking actuator end gland
- SB 944 - Empennage rivet
- SB 947A - Low vacuum annunciator
- SB 948 - Inboard wing rib
- SB 949 - Wing rib
- SB 951 - Mixture control cable
- SB 953 - Elevator trim cable guide tube splice
- SB 958 - Horizon stabilizer drain hole
- SB 959 - Fuselage rivet
- SB 960 - Engine mount heat shield
- SB 961 - Alternate air door
- SB 962 - Corrosion inspection
- SB 963 - Electric flap cam assembly
- SB 964 - Hydraulic system

Partial list of Piper nonmandatory but important service letters:

- SL 938 - Baggage door
- SL 967 - Airstair door
- SL 968 - Oil filler door
- SL 970 - Landing gear doors
- SL 971 - Engine cooling baffles
- SL 973 - Cabin door
- SL 974 - Cowling replacement
- SL 975 - Cabin door seal
- SL 976 - Seat pan
- SL 1001 - Engine mount
- SL 1007 - Engine air/oil separator
- SL 1010 - Engine baffle

Service Difficulty Reports

Service difficulty reports (SDRs), while not official government reports, may identify potential problems. SDRs reflect recurring problems in the following areas identified by aircraft maintenance technicians in the field, not by aircraft manufacturers. These reports emphasize the importance of proper preflight inspections and periodic maintenance. As aircraft age, this becomes increasingly critical to flight safety.

In early Malibus, hydraulic landing gear and engine problems got the most attention, but the largest number of SDRs dealt with exhaust and turbocharger systems: cracked exhaust tee systems, leaking crossover tubes, and cracking turbo intercooler mounting flanges. Cracked fuel tank cap seals allowed water to leak into the tank, causing at least one engine failure in flight. According to the Air Safety Foundation, cracked or deteriorated fuel tank cap seals account for most instances of water contamination of avgas. The Malibu's fuel pump was blamed for at least two engine failures early on. Problems continued into 1986 when an AD was issued. Pump failures have continued, but at a much diminished rate and not for the same reason. There are several reports of motor mount corrosion caused by proximity to the exhaust system. Piper offered a retrofit heat shield to correct the problem.

A Word About Serial Numbers

Piper, like the FAA and most other manufacturers, issues service updates on the basis of serial numbers. Piper made a change in the numbering system of the Malibus, which sometimes causes confusion among owners and service technicians. The first Malibu manufactured in 1984 was Serial Number 46-8408001, and the first one built in 1985 was labeled 46-8508001. In 1986, the labeling system changed in midyear. The first unit built in 1986 was 46-8608001, and this system was used until it reached the 67th unit manufactured that year, or 46-8608067. The next unit, which is also a 1986 model, carried a serial number of 4608001. The year model designation was deleted out of the sequencing and has never returned. Piper began labeling the year model of the aircraft by stamping the first page of the logbook, and provides annual updates to its distributors about which serial numbers denote which model years. The first Malibu/Mirage that was built carried Serial Number 4622001, and the same system is used today. The first 1995 model Mirage, for example, is Serial Number 4622172.

Airworthiness Directives

PA-46 Malibu/Mirage series aircraft have been the subject of numerous airworthiness directives. A current list compiled by AeroTech Publications, Inc., Freehold, NJ, follows:

Ad Number	Type*	Subject
77-12-06R2	R	Hartzell Propeller
84-19-04	N	Continental Engine
84-25-05	R	Continental Engine
84-26-02	R	Induction Air Filters
86-08-07	N	Engine Fuel Pump Assembly
86-13-04R3	R	Continental Engine
87-04-01	N	Alternate Air Valve Linkage
87-06-09	N	Mechanical Products Circuit Breakers
87-14-02	N	Continental Engine
87-23-08	R	Continental Engine
87-26-08	NM	Continental Engine
88-03-06	N	Continental Oil Filters
88-17-03	N	Continental Engine
88-25-08	N	Engine Cooling System
89-14-01	R	Continental Engine
89-15-10	N	Lycoming Engine
90-09-10	N	Texas Instrument Circuit Breakers
91-07-08R2	N	Flight Operating Limitations - AD Rescinded
91-08-07	NM	Lycoming Engine
91-10-04	N	Lycoming Engine
91-14-22	R	Lycoming Engine
91-19-03	N	Champion Oil Filter
92-12-05	N	Lycoming Engine
92-13-06	N	Elevator Trim Cable Guide
92-13-07	N	Loose Empennage Rivets
92-15-14	N	Vacuum Gauge Markings
92-18-08	N	Flight Control System
93-02-05	R	Lycoming Engine
93-08-17	N	Continental Engine
93-10-02	N	Continental Engine

***Type:** N = Non-repetitive; R = Repetitive; NM = Non-repetitive, but has more than one compliance requirement

Part 3

A training outline for instructors and pilots to use in incorporating risk management techniques into transition and recurrent training.

Emphasis is given to those areas that have historically been shown as probable causes for accidents.

Piper PA-46 Malibu/Mirage Training Course Outline

Introduction

This outline will serve as a guide for pilots and flight instructors. Because of variables involving pilot experience and proficiency, training should be flexible. The depth of instruction in areas of IFR procedures, high altitude operations, and regulations will vary depending upon the individual pilot and his or her needs. For more proficient pilots, instruction may stress less common areas like complex avionics, advanced trouble shooting, and storm avoidance using radar and stormscope.

Portions of this outline are derived from the General Aviation Manufacturers Association (GAMA) Transition Training Master Syllabus, and their support is gratefully acknowledged.

Piper PA-46 Malibu and Mirage are complex, high-performance, pressurized single-engine airplanes. PA-46 pilots should be instrument rated, proficient in instrument operations, and knowledgeable with respect to the aircraft's systems and their use in IMC and icing conditions in the low, mid, and high altitude environment. The Air Safety Foundation believes that instructors administering this training should have received formal training specific to the PA-46 (factory or equivalent), logged at least 10 hours of pilot in command (PIC) time as sole manipulator of the controls in PA-46 model airplanes, three to five hours in the corresponding Malibu/Mirage model, and hold an instrument instructor rating. Allowances for PA-46 PIC time may be made for instructors experienced in the operation of turbocharged and pressurized airplanes and/or have received PA-46 specific simulator training.

At the satisfactory conclusion of training, the pilot should receive Instrument Competency Check (ICC) and Biennial Flight Review (BFR) logbook endorsements. While not required for the PA-46 Malibu and Mirage, which are only certified to Flight Level 250, training suitable for a high altitude endorsement is also recommended. Those pilots not having a high performance aircraft endorsement will require one prior to solo.

This training course outline is divided into five blocks of instruction. Prior to each, the pilot should complete the study assignment. Instructors should ensure that pilots meet the completion standards located at the beginning of each block before moving to the next one. Rigorous use of check lists should be stressed during all phases of flight.

The first block consists of ground orientation and concentrates on the PA-46, its systems, and pilot procedures. The second block reviews normal and emergency VFR procedures and elementary IFR procedures. The third block reviews instrument flight operations, and the fourth block concentrates on cross-country and mid-altitude procedures. The fifth block concerns analysis of past accidents, cockpit resource management (CRM), and decision making.

The time required to complete this training will vary with pilot experience and proficiency. Average time to complete each block is presented in the table below:

Block	Ground	Flight
1. Ground Orientation	3.0 Hours	-0-
2. General Flight Operations	1.0 Hour	2.5 Hours
3. IFR Operations	1.5 Hours	2.0 Hours
4. High-Altitude, Cross Country	1.0 Hour	2.0 Hours
5. Accidents, CRM, Judgment	2.0 Hours	-0-
Total: 15 hours	**8.5 Hours**	**6.5 Hours**

At the conclusion of blocks one through three, a section based on specific accident experiences is included. This section, called "Areas of Special Emphasis," should be discussed in detail.

The lesson content for each block is presented in an orderly sequence. Individual instructors may determine the order of presentation that works best for them, but should ensure all sections are covered. All items should be completed by transitioning pilots. The instructor and pilot will determine which items to cover during recurrency training. Check marks may be used to aid in evaluating pilots.

NOTE: While this training course outline is comprehensive, there are certain emergencies that should be discussed only, e.g., engine failue after takeoff. Simulator training is recommended for those who wish to practice those procedures that cannot be safely performed in flight, e.g., propeller overspeed. At publication time, there was only one available Malibu/Mirage simulator. It is located at Vero Beach, Florida, and is under contract to Piper but is owned by Attitudes International, Inc. While a generic simulator will be satisfactory for the practice of instrument procedures, it is less helpful in simulating emergencies peculiar to the aircraft.

Questions from the open-book test should be assigned as appropriate during the course of training.

Piper PA-46 Malibu/Mirage Training Outline

Block 1–Ground Orientation

Objective:

The pilot will thoroughly review the Pilot's Operating Handbook and all supplementary information covering optional equipment and modifications. There should be a detailed walk-around inspection of the aircraft. In-cockpit familiarization will be accomplished. Operation of specific avionics installed should be covered. If external power is available, avionics can be operated for extended periods without the engine running. Even the autopilot can be operated, and some autopilot situations simulated. This is a valuable exercise.

Completion Standards:

This lesson will be complete when the pilot is able to accurately describe PA-46 systems—their operation, emergency procedures, aircraft limitations (including airspeeds for various operations), performance determination, and proper aircraft servicing. The pilot will also be familiar with the accident history of the airplane.

Note: *The pilot should complete the open-book test that begins on page 3-22 and review the answers (page 3-25) with the instructor before commencing this block. This critical phase of pilot standardization must be completed prior to flight and not reduced to a homework assignment. The pilot must have a solid understanding of the aircraft and its systems before attempting to operate it.*

Ground - 3.0 Hours

Comments

- [ ] **Airplane and Systems**

  Aircraft Construction

  Flight Controls

  Instruments

  Landing Gear & Hydraulic System

  Brakes

  Seats, Seat Controls, Seat Belts and Harness, Adjustment and Use to Minimize Injury in an Accident

  Doors, Normal and Emergency Exit Operation

  Engine & Engine Instruments

  Engine Operation
  - Power Settings
  - Shock Cooling

Ground continued

Comments

Turbocharging
  Critical Altitude, Boot Strapping,
  High Altitude Manifold Pressure Limitations

Fuel System

Electrical System, APU Plug

Lighting Systems

Environmental (heating and air conditioning)

Pressurization System

Pitot-Static System & Instruments

Vacuum System & Instruments

Anti-ice & Deice Systems

Supplemental Oxygen System (if installed)

☐ Avionics and Optional Instruments

Note: *Most Malibus and Mirages are equipped with extensive avionics and optional instruments. The operation and failure modes of these must be thoroughly discussed and understood. During the VFR flight portion, all installed equipment should be operated.*

Autopilot
  Altitude/Vertical Speed Select
  Flight Director
  Yaw Damper

Storm Avoidance
  Stormscope
  Radar

Radar Altimeter

EFIS

Second Glideslope

Multi-cylinder EGT and CHT

Intercom

Copilot Instruments

☐ Aircraft Servicing

Required Inspections

Ground Handling

Fueling, Oil, Hydraulic

Oxygen Canister Replacement

Ground continued

☐ Performance

Use of Performance Charts
- Takeoff Distance, Time, Fuel, and Distance to Climb Charts
- Cruise Performance Charts
- Range and Endurance Charts
- Landing Distance Chart
- Pressurization Profiles

☐ Weight and Balance Determination

Review of Aircraft Equipment List
- Determination of Weight & Balance
- Sample Loading Situations (Should include loading for maximum payload, maximum range, and maximum endurance.)

☐ Limitations

Airspeed Limitations

Powerplant Limitations

Fuel System Limitations

Operating Instrument Indications

☐ Normal Procedures

Speeds for Normal Operation

Preflight Inspection

Engine Start & Runup

Taxiing

Normal, Short/Soft Field, and Crosswind Takeoffs

Normal & Maximum Performance Climbs

Cruising Flight
- Power Setting
- Engine Leaning Procedures

Normal Descents

Normal, Short/Soft Field, and Crosswind Landings

Balked Landings & Go-Arounds Including Flap Retraction Procedures

After Landing Procedures
- Securing the Aircraft

Comments

Ground continued

Comments

☐ Emergency Procedures

Airspeeds for Emergency Operations

Engine Failure Procedures

Emergency & Precautionary Landings

Engine and Electric Fires

Turbocharger System Problems:
Overboost, Intake Leak, Exhaust Leak, Waste Gate Failure (open & closed), Turbocharger Overspeed, Seized Turbocharger

Icing

Vacuum System Failures

Pitot & Static System Failures

Electrical System Malfunctions
- Alternator (one or two) Loss
- Overvoltage
- Overload
- Load Reduction
- Battery Dead
- Battery Shorted
- Essential Bus
- Battery Bus

Emergency Descents

Door and Emergency Exit Operation

Pressurization Emergencies

Areas of Special Emphasis:

Pilots cause 71.4% of all PA-46 accidents. A portion of the accidents are due to Fuel Exhaustion (12%). Consequently, a discussion should be devoted to the airplane's fuel system, including fueling safety precautions, preflight visual fuel checks, and unreliable readings from the fuel gauges. PA-46 fuel starvation/exhaustion type accidents should be reviewed and discussed.

The fuel tanks are long and thin, so leaving half an inch or so below the filler neck (for expansion) will significantly decrease the amount of fuel carried—by as much as 10 to 15 gallons. Internal baffles resist sloshing of fuel, but prevent rapid fueling to maximum capacity. There is 1 gallon of unusable fuel in each tank. The maximum allowable fuel imbalance is 10 gallons. In such wing-heavy condition, the aircraft may be out of trim.

Aircraft should be refueled in a wings level condition. At times, this will require alternate filling of left and right tanks until the full condition is reached. If the aircraft is not level when it is fueled, the lower wing will accept more fuel than the higher wing. Due to the extent of the tanks outboard of the fillers and the wing dihedral, there is normally an air pocket outboard of the filler. This will be displaced by fuel if the wing is low. When one wing is entirely filled and the other is empty, the filled wing will drop on the oleo strut, and the empty wing will accept even less fuel.

Performance charts should be covered thoroughly, with conservative takeoff distance estimates (double the published data) and landing distance estimates (1.6 times the published data) used as standards. Similarly, conservative practices should be applied to data obtained from the endurance and range charts.

For the pilot transitioning from smaller aircraft, the larger cabin and heavier feel of the aircraft may lead some to a false sense of security with respect to loading and weight distribution. Weight and balance calculations should be made to familiarize the pilot with both the capacity of the PA-46 aircraft and CG limitations which may be quite different than those previously experienced. If possible, a short gross-weight flight should be planned toward the end of training to demonstrate the reduced performance with full load.

If five or more people are carried, an overweight and out of balance situation can easily arise. Aft baggage is within the pressurized cabin and may be a maximum of 100 pounds. The nose baggage compartment is unheated and unpressurized, also with a 100-pound maximum. Of course, baggage can be carried within the cabin, which may be the best choice for balance reasons. The forward CG limit may be exceeded when the aircraft is lightly loaded with a single occupant. Ballast may need to be added to the rear baggage compartment.

❑ Additional system-related areas of emphasis should include:

Autopilot and electric trim malfunctions

The relationship of vacuum failures to autopilot operation

The electrical system and what to do if the charging system fails

Load reduction and the estimated time of usable battery life

Cold, Hot, and Flooded start procedures

Emergency check lists

EGT, TIT, CHT and fuel flow in climb, cruise, and descent

Cold weather engine start, taxi, crosswind, performance

High elevation field operations
Performance, pressurization, climb gradient

Comments

Piper PA-46 Malibu/Mirage Training Outline

Block 2–General Flight Operations

Objective:

This lesson will acquaint the pilot with the PA-46 Malibu/Mirage aircraft. Preflight, in-flight, and post-flight operations will be discussed and practiced.

Completion Standards:

This lesson will be complete when the instructor determines the pilot is proficient in VFR flight operations of the PA-46 aircraft and performs to the requirements of the applicable Private Pilot FAA Practical Test Standards.

Study Assignment:

In preparation for Block 2, the pilot will review normal and emergency operations sections of the POH and will calculate weight and balance, takeoff, and landing performance data with loading as proposed by the instructor.

Ground - 1.0 Hour	Comments
❑ **Review of Study Assignment** Weight & Balance Calculation for this Flight Takeoff, Climb, Cruise, Landing Performance Data	
❑ **Review of Normal & Emergency Procedures**	
❑ **Flight Portion of Training Outline** Discuss Flight Lesson Items Resolve Pilot Questions	
❑ **Determination of PIC & Transfer of Command**	
Flight - 2.5 Hours	
❑ **Preflight Operations** Takeoff, Climb, Landing Performance Calculation Preflight Line Check	

Flight continued

Starting
- Normal
- Hot
- Fire during Start
- External Power

Pre-takeoff Runup and Checks

☐ Takeoff Operations

Normal

Rejected

Crosswind

Instrument

Short Field

Soft Field

☐ Airwork

Climbs

Turns

Slow Flight

Approaches to Stalls

Steep Turns

Cruise Configuration

Approach/Landing Configuration

☐ Avionics and Optional Instruments

Autopilot
- Altitude/Vertical Speed Select
- Flight Director
- Yaw Damper

Storm Avoidance
- Stormscope
- Radar

Radar Altimeter

EFIS, HSI

Second Glideslope

Multi-cylinder EGT and CHT

Intercom

Copilot Instruments

Comments

Flight continued

Comments

- [ ] **Instrument Procedures**
  - Turns, Climbs, Descents
  - Slow Flight
  - Unusual Attitude Recovery

- [ ] **Emergency Procedures**
  - Engine Failure
  - Fire in Flight
  - Icing
  - Alternator Failure (single & dual)
  - Vacuum Failure (single & dual)
  - Fuel Pump Failure
  - Gear Extension Failure
  - Rapid Depressurization
  - Glide

- [ ] **Landings**
  - Normal
  - Crosswind
  - No Flap
  - Short Field
  - Soft Field
  - Balked (Go Around)
  - Failed Engine

Areas of Special Emphasis

The PA-46 Malibu/Mirage may be a heavier and larger aircraft than the transitioning pilot is accustomed to. The instructor should not conclude that an acceptable performance landing in a calm wind two or three times is indicative of proficiency. **The pilot should be exposed to vigorous crosswinds, various size runways (length and width), and a variety of landing configurations and weights.** It is recommended at least one hour be invested in takeoffs and landings. Prevention of inadvertent gear-up landings should be stressed during this period, i.e., rigorous use of the landing check list and gear-DOWN check on short final approach. PA-46 takeoff and landing accidents should be reviewed and discussed.

Piper PA-46 Malibu/Mirage Training Outline

Block 3–IFR Flight Operations

Objective:
This lesson will review the requirements, regulations, and procedures for IFR flight operations.

Completion Standards:
This lesson will be complete when, through questioning and performance evaluation, the instructor determines that the pilot understands and is proficient in low-altitude IFR procedures. The pilot's abilities should meet or exceed the FAA Instrument Rating Practical Test Standards.

Study Assignment for Block 3:
The pilot will review instrument regulations, requirements, and local approach procedures in preparation for Block 3.

Ground - 1.5 Hours

Review of Study Assignment

☐ Requirements for Instrument Flight

- Pilot
  - Certificates & Ratings
  - High Performance Endorsement
  - Currency
- Aircraft
  - Required Equipment
  - Equipment Certification
  - RNAV/LORAN/FMS
  - Autopilot/Flight Director
  - Other
- Periodic Inspections
  - Transponder/Data Correspondence
  - Pitot/Static System
  - ELT
  - Annual/100 Hour
  - ADs/Service Bulletins
  - Recommended Service Intervals
  - Preflight Line Inspection

Comments

Ground continued

❑ FARs for Instrument Flight

Flight Plan/Clearance Required
  Compliance with ATC Instructions

Alternate Criteria

Lost Communication Procedures

Required Reports

PIC Authority and Responsibility

❑ Charts

SIDS/STARS

Low/High Altitude Enroute

Instrument Approach Procedure

❑ Preflight Briefing

Lesson Content

Instructor/Pilot Roles and Responsibilities
  Transfer of Control

Collision Avoidance Procedures

IMC to VMC transitions

Flight - 2.0 Hours

❑ Clearance

Copy, Readback, Understanding

Appropriate Navigation, Communication

Autopilot Configuration

Takeoff Alternate

SID

IMC Takeoff Considerations

Instrument Departure Procedures

Comments

Note: *If an ATC-issued clearance is not available, the instructor will issue a clearance containing all elements of a standard departure clearance.*

Flight continued

- ☐ **Pre-takeoff Checks**
  - Cockpit Organization
  - Check List Use
  - Instrument Functional Checks
  - Radio Frequencies Set
  - Appropriate Charts
  - Review Departure Procedure

- ☐ **Area Departure**
  - Heading & Altitude
  - Radar Contact
  - Route Interception
  - Amended Clearance
  - Climb, Cruise, & Descent Check Lists

- ☐ **Holding**
  - Holding Clearance Copy, Readback, Understanding
  - Aircraft Configuration Prior to Holding Fix
  - Entry Procedures
  - ATC Reports

- ☐ **NDB Approach**
  - Approach Clearance
  - Check List
  - Aircraft Configuration
  - Tracking
  - Altitudes
  - Timing
  - ATC Coordination

Comments

Flight continued

❑ DME Arc

Arc Interception

Orientation

Lead Radial Identification & Transition

Inbound Interception, Tracking, Orientation

ATC & CTAF Coordination

❑ VOR/GPS*/LORAN* Approach

Approach Clearance

Check List, Aircraft Configuration

Tracking, Orientation

Altitudes, MDA

Timing, MAP Identification

ATC & CTAF Coordination

Autopilot Usage

**Must be done only with IFR-approved equipment*

❑ Circling Approach

Altitude and Patterns

Low Visibility Approach

Distance from Airport

Traffic Avoidance

ATC & CTAF Coordination

❑ ILS, LOC, and BC Approaches

Approach Clearance

Check List

Aircraft Configuration

Navigation (HSI) Configuration

Orientation and Tracking

Altitudes, DH

ATC & CTAF Coordination

Autopilot Usage

Comments

Flight continued

- ❑ **Missed Approach**
  - Aircraft Control
  - Climb, Heading, Altitude
  - Course Interception
  - Climb Check List
  - ATC & CTAF Coordination
- ❑ **Partial Panel and ASR Approaches**
  - Approach Clearance
  - Check List
  - Aircraft Configuration
  - Orientation
  - Altitudes, MDA
  - ATC & CTAF Coordination
- ❑ **Inoperative Equipment**
  - Lost Communication
    - Route and Altitude
    - Position Reporting
  - Lost Navigation Equipment
    - Revised Minima
    - ATC Report
  - Alternator Failure
    - Load Reduction
    - Flight Plan Revision
    - ATC Notification and Coordination
- ❑ **Emergency Procedures**
  - Engine Failure
  - Airframe Ice
  - Vacuum Pump/Gyro Failure
  - Fire in Flight
  - ATC Notification and Coordination

Comments

Areas of Special Emphasis:

Instruction should stress proficiency in all facets of instrument flight and the recognition of weather situations beyond the capability of even the best equipped aircraft. Although the Malibu has a better than average record for night IMC, this is considered a high risk area for all aircraft.

The PA-46 IMC accident history should be reviewed and the hazards of descent below DH and MDA including the circle-to-land maneuver discussed.

Note: *At least one-half of all instrument approaches should be flown manually to assure pilot IFR competency.*

Piper PA-46 Malibu/Mirage Training Outline

Block 4—Cross-Country and High-Altitude Operations

Objective:

In this lesson, the pilot will gain understanding of the elements of cross-country flight and demonstrate proficiency in cross-country operations, IFR or VFR, as appropriate.

Completion Standard:

This lesson will be complete when, through questioning and performance evaluation, the instructor determines the pilot is able to plan and execute cross-country flights, with consideration given to all elements of such operations.

Note: *The flight portion of this block may be completed at one time or on separate days and flights.*

Study Assignment for Block 4:

The pilot will review meteorology, equipment requirements, charts, and aircraft-specific procedures in preparation for Block 4. A cross-country flight of not less than three hours duration will be planned with at least one leg to be flown at or near FL250. The pilot will brief the flight instructor on this flight during the ground portion of this.

Ground - 1.0 Hour

Comments

- ❑ **Review of Study Assignment**
- ❑ **The Flight Environment**
  - Airspace—including current Alphabetical Airspace Designations
  - Part 91 Federal Aviation Regulations
- ❑ **Weather**
  - The Atmosphere
  - Winds and Temperatures Aloft
  - Clear Air Turbulence, Jet Stream
  - Clouds & Thunderstorms
  - Icing, Structural & Induction System

Note: *Weather, of great concern to all pilots, is a subject in itself. It is not within the scope of this training program to comprehensively teach weather, but rather to highlight considerations for operations, especially in the flight levels. As weather is a leading cause of serious accidents, pilots who are not thoroughly familiar with the subject should pursue additional training.*

Ground continued

❑ Flight Planning & Navigation

Flight Planning
- Fuel Reserve Requirements
- Winds Aloft
- Departure and Landing Fields
- Navigation

Charts

Navaids

Planning Descents, Use of VNAV

❑ Physiological Training

Respiration

Hypoxia

Vision

Use of Oxygen Equipment

Altitude Chamber (optional)

❑ Emergency Operations

In-flight Fire

Turbulence and Thunderstorms

Pressurization

Icing

Flight - 2.0 Hours

❑ Preflight Briefing

Preflight Line Check

Charts

Clearance Copy & Readback

❑ Area Departure

❑ Climb

Climb Check List

Comments

Flight continued

☐ Cruise

Check List Use

Power Setting

Cockpit Instrument Check

☐ Emergencies

Rapid Depressurization

Emergency Descent

In-flight Fire (Discuss Only)
- Smoke in the Cockpit/Engine Compartment
- Electrical Fire

Alternator Failure

Comments

Electric Load Reduction

Flight Plan Change

ATC Coordination

☐ Descent

Planning

Use of VNAV equipment

Engine Temperatures

Speed

STAR (if appropriate)

☐ Approach & Landing

Comments

Note: *The choice of approach will be determined by the pilot and flight instructor. It is recommended that a descent be made from high altitude at or above normal cruise speed. This will permit the pilot to gain experience with the rapid transition from the en route structure to the terminal environment.*

Discuss convective weather, anti-ice and deice systems, and proper use of the autopilot in turbulence.

Piper PA-46 Malibu/Mirage Training Outline

Block 5–Accident Review

Study Assignment:

Review the section concerning PA-46 Malibu and Mirage accidents. The instructor may assign particular accidents for consideration.

Ground - 2.0 Hours	Comments
Review of Study Assignment	
❑ **Human Factors**	
Fatigue	
Psychological Factors	
Tobacco, Alcohol, Drugs	
Illnesses	
❑ **Cockpit Resource Management**	
Cockpit Organization	
Pilot and Copilot Coordination	
Check List Strategies	
Management and Utilization of Passengers	
❑ **Decision Making**	
Defining Problems	
Establishing Priorities	
Validating Decisions	

Ground - 2.0 Hours

Comments

☐ Judgment

Situational Awareness

Simplifying Problems

Recognizing Influencing Factors

☐ Accidents

Pilot Post-crash Responsibilities
- To Passengers
- To Aircraft

Reporting Requirements

Accident Investigation

☐ Specific Accident/Incident Reviews

The instructor should choose several specific accidents from this review for discussion. The pilot should be able to discern the multiple factors that lead to the accident/incident. The pilot should develop strategies he/she would consider in like situations.

Piper PA-46 Malibu/Mirage Questions

This is an open-book test. Please complete the questions by referring to the Pilot's Operating Handbook for your aircraft and answer according to the equipment installed. Review your answers with a qualified instructor.

1. Total usable fuel is _________ gallons, _________ gallons in each wing tank. The maximum allowable fuel imbalance is _________ gallons. What is the effect of exceeding the maximum fuel imbalance?
2. What is expected endurance with 20 gallons reserve at cruise altitude, flight level 200 ISA, with tanks full at 75 percent power? With tanks full at 55 percent power? (Include start-up, taxi, takeoff, and climb.)
3. Oil quantity for extended flights should be ______quarts. The recommended minimum oil quantity for flight is _________ quarts. The minimum in-flight oil quantity is _________ quarts.
4. What is the payload of YOUR aircraft with full fuel? What is the maximum zero fuel weight? (Refer to your aircraft weight and balance papers.)
5. How much fuel can you carry with a front-seat payload of 400 pounds; middle-seat 350 pounds; rear seat, 200 pounds; baggage, 150 pounds? What are the alternatives for carrying baggage?
6. Calculate the weight and balance for a single pilot weighing 180 pounds on a ferry flight with 50 gallons of fuel and no baggage.
7. What is the maximum demonstrated crosswind component? What is the maximum wind that can be accepted 30 degrees and 45 degrees off the nose?
8. What is the maneuvering speed at maximum gross weight? What is the maneuvering speed at the end of a flight which began with full fuel and maximum gross weight (assume 20 gallons of fuel remain)? In what situation and configuration is maneuvering speed the slowest in your aircraft?
9. Where is the emergency locator transmitter (ELT) installed? How can it be accessed?
10. Maximum range is obtained at what airspeed and what altitude?
11. What is the maximum pressure differential supported by the pressurization system? To what pressure altitude can a 1,000-foot cabin be maintained? What is the lowest cabin altitude at FL250?
12. What is the speed and configuration for maximum distance glide? Approximately how many nautical miles will the aircraft glide per 1,000 feet of altitude lost?
13. What are the indications of vacuum system failure?
14. What instruments and systems will be affected by a complete vacuum failure?
15. The following questions should be answered by referring to the flight manual supplement pertinent to the King 150 Series autopilot. Refer to the separate section on Autopilot for a discussion and comments.

    A. What are the autopilot operation limitations:

1.) Maximum autopilot airspeed?
2.) Maximum altitude lost during recovery at cruise?
3.) During recovery at approach?
4.) Maximum fuel imbalance?

B. List all the ways to disengage the autopilot. Which of these will also disable electric trim? Which of these allows disconnection of autopilot without loss of electric trim? Which of these leaves the flight director operational?

C. What happens if the pilot manually overrides the autopilot by pulling/pushing on the elevator?

D. What happens if the pilot manually overrides the autopilot with aileron input?

E. What happens if the pilot attempts to override the autopilot with electric trim?

F. What are the indications the autopilot has disengaged?

G. What is the procedure for disengaging electric trim?

H. What is the maximum intercept angle to capture a VOR radial or localizer?

I. What is the procedure to couple to a glideslope?

J. How do you couple to a back course glideslope?

16. How do you identify loss of hydraulic pressure? What systems will be affected?

17. What is the emergency manual gear extension procedure? Why should the hydraulic pump circuit breaker be pulled?

18. Preparing for a landing, you hear a beep-beep-beep-beep (90-cps) tone. What warning is this and what causes (more than one) it to sound? How can it be silenced?

19. What are the recommended tire inflation pressures ?
Mains __________ Nose tire __________

20. Where are the fuel drains? If no fuel can be drained from the engine fuel filter drain (on the right side of the fuselage forward of the wing), what is the most likely cause?

21. Engine fuel flow gauge drops to zero. The digital fuel flow indicator (if installed) also indicates no flow. The engine is still running. What has happened?

22. What are the indications of alternator failure? What must be done next? Why and how should the alternator be brought back on line? What is the procedure if unable to restore the alternator?

23. What is the typical operating voltage rating of the aircraft electrical system? Will the low voltage annunciator illuminate if the battery is fully charged but both alternators are off line?

24. What is the procedure for a short-field takeoff?

What is the procedure for a soft-field takeoff?

25. When will the cabin altitude warning light illuminate?

26. What are the emergency descent procedures?

    A. High speed: "without vibration"

    B. Low speed: "with vibration"

27. If maximum cabin pressure differential stabilizes slightly above redline, what does this indicate?

28. What is the procedure for maximum cabin cooling on a warm day with air conditioning? Without air conditioning?

29. List the following indicated airspeeds V_X, V_Y, V_{LE}, V_{LO}, V_{NE}, V_{NO}, V_{FE} (10, 20, 36 degrees). Which of these is marked on the airspeed indicator?

30. What is the normal no-flaps approach speed? What is the normal full flaps approach speed? Under what conditions would you choose to land no flaps?

31. What is the procedure for a balked landing (go around)?

32. When should the emergency (auxiliary) fuel pump be used?

33. What is the procedure for engine failure immediately after takeoff?

34. What is the effect of the loss of one turbocharger?

35. What is the procedure for start-up using an auxiliary power unit (APU)?

36. What are the hot start and flooded start procedures?

37. What is the effect of turning off the battery Master switch while in flight?

38. What is the emergency procedure for smoke in the cockpit? If smoke appears to be electrical, how should the electrical system be handled?

39. After takeoff at maximum gross weight, it is decided to immediately return to the field for landing. Is the airplane over maximum landing weight? Does it make a difference?

40. What is the maximum ramp weight? What is the maximum zero fuel weight, and why is it important?

41. What is the procedure for a runaway (overspeed) prop?

42. You are about to enter clouds in potential icing conditions. What steps should be taken prior to entering clouds?

43. One vacuum pump has failed, but normal vacuum pressure is being maintained by the second pump. What effect does this have upon your preparation prior to entering the clouds where potential icing conditions exist?

44. What is the effect of a partially blocked static line? What avionics will be affected?

45. What are the indications of a completely blocked pitot tube due to icing? If the aircraft is in a climb on autopilot, what will be the effect?

Answers to Piper PA-46 Malibu/Mirage Questions

Important Notice: Answers to the questions listed here are taken from Piper Malibu/Mirage Information Manuals published in 1984, 1986, and 1988. Pilots should refer to the POH for specific airplanes for accuracy. Answers to autopilot questions assume that the aircraft is equipped with a KFC 150 flight control system. Where the answers are different for PA-46 310P and 350P airplanes, PA-46 310P answers are given first.

1. Total usable fuel is 120 gallons, 60 gallons in each wing tank. The maximum allowable fuel imbalance is 10 gallons. The effect of exceeding the maximum fuel imbalance is to create an out-of-trim condition. Refer to the POH, Section 7, DESCRIPTION AND OPERATION, FUEL SYSTEM.

2. Refer to the POH for your airplane, Section 5, PERFORMANCE, FLIGHT PLANNING EXAMPLE.

3. Oil quantity for extended flights should be 8 and 12 quarts, respectively, for the 310P and the 350P. Recommended minimum oil quantity for flight is 7 and 10 quarts, respectively, and the minimum in-flight oil quantity is 3.5 and 2.75 quarts. Refer to the POH for your airplane, Section 8, AIRCRAFT HANDLING, SERVICING AND MAINTENANCE.

4. The answer to this question is derived from the weight and balance data for each individual aircraft. Refer to the POH for your airplane, Section 6, WEIGHT AND BALANCE, Figure 6-5 Basic Empty Weight, C. G., and Useful Load Data.

5. Same as #4 above.

6. Same as #4 above.

7. The maximum demonstrated crosswind component is 17 knots. Maximum at 30 and 45 degrees off the nose is 34 knots and 24 knots, respectively. Refer to the POH, Section 5, PERFORMANCE, WIND COMPONENTS. Note that this is not a limitation but is good operating procedure.

8. Maneuvering speed (V_A) at maximum gross weight for the 310P (4,100 lbs) is 135 KIAS; for the 350P, 4,300 lbs and 133 KIAS. V_A at 2,450 lbs gross weight is 100 KIAS. Refer to the POH, Section 2, AIRSPEED LIMITATIONS.

   Comment: Maneuvering speed decreases as the weight of the aircraft decreases. The POH gives V_A for weights well below typically equipped Malibus and Mirages. Minimum V_A is at minimum weight with flaps up. Lowering flaps subjects the wings to increased loading and effectively decreases the speed at which possible damage can occur to the wings and flaps. In heavy turbulence, leave the flaps up. The landing gear has no direct effect on V_A, but, in an emergency, extension of the gear can rapidly slow the aircraft to V_A.

9. The ELT transmitter is located in the aft fuselage. It is accessible through the inspection window on the right bottom side of the tail cone.

10. The Malibu attains maximum range at FL250 and 195 knots true airspeed. The Mirage attains maximum range at 7,500 feet and 135 knots true airspeed. In both cases, long-range cruise power is assumed. Refer to the POH, Section 5, PERFORMANCE, RANGE.

11. At maximum pressure differential, 5.5 psi, a 1,000-foot cabin altitude can be maintained to about 13,800 feet. As the aircraft climbs above that altitude, the cabin altitude increases at a rate parallel to the climb; about 1,000 feet of cabin altitude for each 1,000 feet of altitude. At FL250 with maximum differential, cabin altitude is about 8,000 feet. Refer to the POH, Section 7, DESCRIPTION AND OPERATION; BLEED AIR, CONDITIONING AND PRESSURIZATION SYSTEM.

12. The conditions for maximum distance glide are 90 KIAS, propeller control full aft (low rpm), flaps up, gear up, and DOWNWIND. The effect of wind is often neglected. As 90 KIAS is slow, even a modest headwind will significantly affect glide range. In a no wind situation, estimate 2 nautical miles per 1,000 feet. Refer to the POH, Section 3, EMERGENCY PROCEDURES, POWER OFF LANDING.

13. The LOW VACUUM light may have been disconnected in compliance with Piper Service Bulletin No. 947. Even if operational, it does not illuminate until 4.2 psi, while the gyros may fail at 4.5 psi. The most dependable indicator is the suction gauge. Some pilots have replaced their vacuum powered instruments—directional gyros (DGs) and attitude indicators (AIs)—with models containing integral warning flags. Refer to the POH, Section 3, EMERGENCY PROCEDURES, VACUUM SYSTEM FAILURE.

14. Deicing boots, suction-driven gyros (DGs and AIs), and the pressurization system. Because the pilot's attitude indicator is the primary sensor for the autopilot, the autopilot must be disconnected. Otherwise, the aircraft will follow the tumbling attitude gyro until autopilot limits are reached. The autopilot is designed to then disconnect, but leaves the aircraft severely mistrimmed and probably in an unusual attitude. Refer to the POH, Section 3, EMERGENCY PROCEDURES, VACUUM SYSTEM FAILURE.

15. Refer to the POH for your airplane, Section 9, Supplement for KING 150 SERIES FLIGHT CONTROL SYSTEM and Section 3, EMERGENCY PROCEDURES. Also see AUTOPILOT WITH FINESSE by Ian Fries contained in the Appendix to this publication.
    A. (1) 185 KIAS
       (2) 480 Feet
       (3) 50 Feet
       (4) 10 Gallons
       Refer to the POH Section 9, Supplement 1, KFC 150, LIMITATIONS.
    B. (1) Manual Electric Trim Switch
       (2) FD Button
       (3) AP ENG Button
       (4) AP DISC/TRIM (Red yoke) Button
       (5) Radio Master Switch
       (6) AP Circuit Breaker
    C. The autopilot responds with large trim corrections to overcome what it interprets to be an out-of-trim situation.
    D. The autopilot attempts to fight the roll. When the yoke is released, the ailerons will be neutralized unless heading or navigation modes are engaged. Then the airplane will bank to satisfy correction to the heading or navigation information.
    E. The autopilot will disconnect and default to Flight Director Status.
    F. AP annunciator flashes approximately 12 times and an aural alert sounds for two seconds.

G. (1) Press and hold the autopilot/trim disconnect (red yoke) button.
(2) Pull the electric trim circuit breaker.
(3) Turn off the radio master switch (if 1 and 2 are ineffective).
Refer to the POH, Section 9, Supplement 1, KFC 150, EMERGENCY PROCEDURES.

H. On aircraft with an HSI, intercept may be at any angle. On aircraft with a DG, the intercept is fixed at 45 degrees. Refer to the POH Section 9, Supplement 1, KFC 150, NORMAL PROCEDURES.

I. In summary, the localizer must be captured first. The glideslope, preferably, should be intercepted from below, but the glideslope centerline must be crossed before the autopilot will couple for vertical guidance. Refer to the POH, Section 9, Supplement 1, KFC 150, NORMAL PROCEDURES.

J. The KFC 150 is inhibited from coupling to a glideslope when in back course or navigation modes. Refer to the POH, Section 9, Supplement 1, KFC 150, NORMAL PROCEDURES.

16. The hydraulic pump annunciator light illuminates continuously or cycles on and off rapidly. Refer to the POH for your airplane, Section 7, DESCRIPTION AND OPERATION OF THE AIRPLANE AND ITS SYSTEMS and Section 3, EMERGENCY PROCEDURES, HYDRAULIC SYSTEM MALFUNCTION. The flaps and/or landing gear may be affected.

17. Before proceeding with an emergency gear extension, check the day/night dimmer switch (to ensure that the landing gear warning lights are truly off) and the hydraulic pump and pump control circuit breaker. Reset it. If it pops again, leave it out to protect the hydraulic pump which will cycle excessively and may burn out if left on with an emergency extension.

    Proceed with the emergency extension. Refer to the POH, Section 3, EMERGENCY PROCEDURES, EMERGENCY LANDING GEAR EXTENSION.

    Comments: When the emergency gear extend control cable is pulled, apply 25 pounds pressure. This brings the cable past the first stop and farther out than you expect (at least 8 inches). After fishtailing to ensure the mains are down, land the airplane! Do not try to retract the gear or change position of the gear controls. Do not troubleshoot in the air if you have a gear down and locked indication (three green lights). You may only succeed in unlocking the gear and making the landing unsafe.

18. The 90-cps tone is the landing gear warning horn. It sounds in flight when the throttle is reduced below 14 inches HG or the flaps are extended more than 10 degrees with the gear up. It can be silenced by extending the landing gear.

19. Recommended tire inflation pressures are: 310P mains-40 psi, nose-45; 350P mains-55 psi, nose-50 psi. Refer to the POH for your airplane, Section 7, AIRCRAFT HANDLING , SERVICING AND MAINTENANCE.

20. Refer to POH, Section 4, NORMAL PROCEDURES, PREFLIGHT CHECK. If fuel tank switch is OFF, little or no fuel will flow from the engine fuel filter drain.

21. Probable failure of fuel flow sender, which is the sensor for both the analog and digital indicators. See the accident report of N9161K, January 13, 1992, at Bowling Green, KY, on page 2-27.

22. Refer to POH, Section 3, EMERGENCY PROCEDURES, ELECTRICAL FAILURES.
    Comments: If the alternator will not come back on line by recycling the alternator switch and resetting the alternator control circuit breaker, it is best to assume the alternator cannot be used. If the alternator power circuit breaker to the bus has popped, confirming a load over 60 amps, it is usually unwise to reset this breaker.

Isolating an alternator requires pulling the alternator control circuit breaker and the alternator power breaker. If both are not disabled, a short within the alternator could continue to seriously drain power despite the alternator switch being Off.

23. The typical system voltage is 28 volts. Low bus voltage is annunciated at 25 volts (+/- 0.3). The battery is 24 volts maximum. Therefore, if both alternators are off line, the low voltage annunciator may light even with a fully charged battery.

24. Refer to the POH, Section 4 , NORMAL PROCEDURES, SHORT FIELD TECHNIQUE and SOFT FIELD TAKEOFF.

25. If cabin altitude is above 10,000 feet.

26. Refer to POH, Section 3, EMERGENCY PROCEDURES, EMERGENCY DESCENT.
Comment: The need to make an emergency descent normally stems from loss of pressurization (rapid or explosive decompression) at altitude. If the airplane is intact structurally and there is no vibration, the procedure and airspeeds set forth in the POH apply. On the other hand, if vibration that could be caused by structural damage is present, a lower speed (e.g., V_A or 1.3 V_{SO}) consistent with the situation at hand may be appropriate.

27. Probable failure of the normal outflow valve. Pressure is being controlled by the emergency outflow valve which is set at 5.6 psi.

28. In both cases, the manual cabin pressure control should be pulled out. Refer to the POH, Section 7, DESCRIPTION/OPERATION, BLEED AIR, CONDITIONING & PRESSURIZATION.

29. V_{NE}, V_{NO}, and V_{FE} 36 degrees—not V_{FE} 10 or 20 degrees—are marked on the airspeed indicator. Refer to the POH, Section 2, LIMITATIONS, AIRSPEED LIMITATIONS.

30. A no-flaps landing is generally an emergency procedure. It will be necessary if flap extension fails. If the aircraft has significant ice buildup, the pilot may choose to land no-flaps, and thus avoid reconfiguring a wing already aerodynamically compromised by ice. Refer to the POH, Section 3, EMERGENCY PROCEDURES, FLAP SYSTEM MALFUNCTION and INADVERTENT ICING ENCOUNTER.

31. Refer to the POH, Section 4, NORMAL PROCEDURES, GO-AROUND.

32. In general, the emergency fuel pump is used to restore fuel pressure in the event of engine-driven fuel pump failure, but procedures differ from airplane to airplane. Refer to the appropriate POH, Section 3, EMERGENCY PROCEDURES, LOSS OF FUEL FLOW AND ENGINE DRIVEN FUEL PUMP FAILURE, and Section 4, NORMAL PROCEDURES.

33. Engine failure on takeoff requires immediate and decisive action. Fly the airplane (maintain glide speed). Avoid attempting to turn back to the field unless you are certain you have sufficient altitude to reach the field safely, troubleshoot as practicable, and pick the best spot to land. Refer to the POH, Section 3, EMERGENCY PROCEDURES, ENGINE POWER LOSS DURING TAKEOFF.

34. The loss of either turbocharger will result in manifold pressure loss. The engine will become normally aspirated and the cabin will depressurize. The two turbochargers are not redundant. Both are needed for normal operation.

35. Refer to the POH, Section 4, NORMAL PROCEDURES, ENGINE START.

36. Same as #35 above.

37. Assuming one alternator remains on line, there is no obvious effect. However, the battery acts as a capacitor, absorbing electrical spikes. Heavy electrical loading—gear, flaps, heat (prop, electric cabin, pitot, windshield)—may cause spikes which can disturb avionics, especially those with computer chips—loran, radar altimeter, storm avoidance.

38. Refer to the POH, Section 3, EMERGENCY PROCEDURES, CABIN AIR CONTAMINATION/ SMOKE EVACUATION. If the fire appears to be electrical, follow the POH, Section 3, EMERGENCY PROCEDURES, FIRE IN FLIGHT.

39. If you must land the airplane, do so despite being above maximum landing weight. Exceeding that weight decreases the safety margin for structural and tire damage from a hard landing. Land smoothly as the aircraft is less tolerant of being "dropped in." Refer to the POH for your airplane, Section 2, LIMITATIONS, WEIGHT LIMITS.

40. Maximum ramp weight: 310P, 4,118 lbs; 350P, 4,318 lbs. Maximum zero fuel weight: 310P, 3,900 lbs; 350P, 4,100 lbs. All weight added over maximum zero fuel weight must be in the form of fuel loaded into the wing tanks to avoid over-stressing the aircraft. Refer to the POH for your airplane, Section 2, LIMITATIONS, MAXIMUM WEIGHTS.

41. Retard the throttle, check for loss of oil pressure. Move propeller control to full DECREASE RPM and reset. Refer to the POH, Section 3, EMERGENCY PROCEDURES, PROPELLER OVERSPEED.

42. Pitot heat, stall warning heat, prop heat, windshield heat, and alternate induction air should be tested and activated prior to entering icing conditions.

43. Do not enter icing conditions. If one vacuum pump is inoperative, the aircraft is not certified for known icing, and icing conditions should be avoided. There may be too little air pressure to inflate the deicing boots.

44. The altimeter, airspeed, and vertical speed indicators will be erratic. The static line is plumbed to the KC 192 autopilot control unit, thus the autopilot will be affected.

45. The airspeed will indicate the speed at which time the blockage occurred. From that time on, the airspeed will show an increase if the aircraft climbs and a decrease as the aircraft descends. As the primary static port is within the pitot head, it may also be blocked. Therefore, it is reasonable to switch to an alternate static source. Pitot tube blockage has no effect on the autopilot; however, the static line is plumbed to the autopilot and will affect altitude hold. Vertical speed modes will also be affected on those aircraft with altitude preselect, as the preselect obtains altitude and vertical speed information from the altimeter.

Appendix

A summary of the 1992 NTSB Piper PA-46 Special Investigation and FAA Certification Review.

Also contains information on autopilot use and ditching.

NTSB
Piper PA-46 Special Investigation
and
FAA Certification Review

EDITOR'S NOTE: Following a series of fatal accidents[*1] *involving PA-46 Malibu/Mirage aircraft which occurred between May 31, 1989, and March 17, 1991, the FAA issued an emergency airworthiness directive (AD 91-07-08) which restricted operation of PA-46 aircraft to VFR meteorological conditions and required removal of the autopilot vertical speed and altitude preselect panel. After the fourth fatal accident, the NTSB initiated a special investigation into the circumstances regarding the accidents. As part of the investigation, the FAA conducted a special certification review of the Piper PA-46 Malibu.*

The Report of the investigation contains analyses of the five fatal accidents and incident that occurred in the United States and a summary of the special certification review. Copies of the Report (NTSB/SIR-92/03) can be obtained from the National Technical Information Service, 5285 Port Royal Road, Sterling, VA 22161; telephone 703/487-4600. It is recommended reading for all PA-46 Malibu/Mirage pilots. Selected excerpts from the Report follow:

Introduction

On May 31, 1989, a Piper PA-46-310P Malibu, U.S. Registration N9114B[*2], crashed near Bristol, Indiana. The pilot and two passengers were killed in the accident. The Safety Board determined that the probable cause of the accident was "continued flight by the pilot into known adverse weather and his exceeding the design stress limits of the aircraft which resulted in failure of the wing spars and separation of the right wing and empennage (stabilizers)." Contributing factors were "continued flight by the pilot above the maneuvering speed (V_A), his lack of familiarity with the make and model of aircraft, and thunderstorms."

During the 22 months following the above accident, four other fatal accidents occurred in the United States that involved PA-46 airplanes. Also, during this period, two fatal accidents occurred in PA-46 airplanes in foreign countries, and an incident occurred in the United States that involved substantial departures from controlled flight in a PA-46 (Ocala, Florida). The places and dates of the other six accidents and the incident are as follows:

Bakersfield, California

February 6, 1990; PA-46-350P, Mirage, N8888M—2 deaths (see page 2-44)

Naylor, Missouri

May 27, 1990; PA-46-310P, Malibu, N22EK—2 deaths (see page 2-48)

Lakeville, Michigan

June 26, 1990; PA-46-310P, Malibu, N315RC—1 death (see page 2-46)

*1 Brief summaries of the five fatal U.S. accidents are included in Part 2 of this review under the title NTSB Special Investigation Report, pages 2-40 through 2-51.

*2 Detailed information about each accident which occurred in the United States can be found in the factual reports prepared for each accident.

Hermosillo, Mexico

September 3, 1990; PA-46-310P, Mexican registry XB-EWP—4 deaths (see page 2-61)

Tottori, Japan

November 17, 1990; PA-46-310P, Malibu, Japanese registry JA3990—3 deaths (see page 2-61)

Ocala, Florida

March 16, 1991; PA-46-310P, Malibu, N26033—*an incident,* 6 persons on board, no injuries

Bronson, Florida

March 17, 1991; PA-46-310P, N9112K—4 deaths (see page 2-50)

Executive Summary

Between May 31, 1989, and March 17, 1991, Piper PA-46 series Malibu and Mirage airplanes were involved in seven fatal accidents in the United States, Mexico, and Japan following departures from controlled flight. In addition to the seven accidents, another PA-46 airplane was involved in an incident that included substantial departures from controlled flight.

In July 1990, following the fourth U.S. fatal accident, the Safety Board initiated a special investigation of the facts, conditions, and circumstances that led to the loss of the four Malibu/Mirage airplanes in the United States. As other accidents occurred, they were included in the special investigation. Two of the seven fatal accidents occurred in Japan and Mexico, and the available information on the accidents was included in the special investigation. The special investigation included a review of the relevant design features of the Malibu and Mirage airplanes, including structural integrity, flight control systems, and operating limitations. The investigation also focused on the flight experience and training of the pilots of the airplanes, particularly as these factors related to flying the Malibu/Mirage airplanes in instrument meteorological conditions (IMC) at and above the freezing level with relatively sophisticated integrated flight guidance and control systems.

Finally, as a consequence of the accidents, the Federal Aviation Administration, with the Safety Board's encouragement, conducted a special certification review of the airplanes, and the results are included in the report.

The probable causes of the five fatal accidents that occurred in the United States are included in the report. The investigation and analysis of the relevant data indicate that the causes of the accidents involved failure to use pitot heat in freezing IMC, possible misuse of the integrated flight guidance and control systems, loss of control, and in-flight airframe failures due to loads and stresses that substantially exceeded design limits. Factors related to the accidents included the lack of an appropriate check list item for pitot heat in the pilot's operating handbook, and inadequate pilot training in the operation of the integrated flight guidance and control systems.

As a result of the special investigation, the Safety Board made safety recommendations concerning modifications to the PA-46 airplane flight manual, the pilot training needed to operate small pressurized airplanes, the addition of a pitot heat operating light, additional training requirements for the use of integrated flight guidance and control systems in small pressurized airplanes, and the provision of training supplements by manufacturers of integrated flight guidance and control systems.

Findings

1. The Piper Aircraft Corp. model PA-46-310P and PA-46-350P airplanes were properly certificated.

2. The King Radio Corporation KFC 150 series flight control system and KAS 297B vertical speed and altitude selector were properly certificated for use in the PA-46-310P and -350 series airplane; there was no evidence of malfunction or failures in these components in any of the U.S. accidents.

3. The Federal Aviation Administration's special certification review of the PA-46-310P and -350P series airplanes disclosed proper certification of the airplanes and the KFC 150 flight control system, but the review identified a number of modifications to the airplanes that would improve the reliability and safety of the KFC 150 flight control system and the airplanes.

4. The pilots involved in the five U.S. accidents were qualified, in accordance with existing Federal Aviation Regulations, to fly their respective PA-46 airplanes; however, the pilot involved in the Bakersfield accident did not have a current medical certificate, and the pilot involved in the Bronson accident was not current for flight in IMC due to insufficient instrument flight time in the six months that preceded the accident.

5. The airplane structure that separated in flight in the five U.S. accidents failed from airspeeds or load factors, or combinations of both, that substantially exceeded the design limits of the airplanes.

6. The pilots of the airplanes involved in the Bakersfield, Naylor, Lakeville, and Bronson accidents, and the pilot involved in the Ocala incident, were in IMC conducive to atmospheric icing shortly before they lost control of their respective airplanes.

7. The pilots of the airplanes involved in the Bakersfield, Naylor, and Lakeville accidents, and the pilot involved in the Ocala incident had not activated ice protection equipment before or after entering IMC conducive to atmospheric icing.

8. Although the switches were found in the On position, the pilot of the airplane involved in the Bronson accident probably did not activate the ice protection equipment switches until after he had encountered erroneously low airspeed indications due to blockage of the inlet pressure port of the pitot tube with ice.

9. The pilots of the airplanes involved in the Bakersfield, Naylor, and Lakeville accidents, the pilot involved in the Ocala incident, and probably the pilot involved in the Bronson accident responded improperly to erroneously low airspeed indications caused by blockage of the pitot tube by atmospheric icing.

10. The pilot involved in the Bristol accident improperly used a stormscope to penetrate an area of strong to very strong thunderstorms.

11. The PA-46 series airplanes are not equipped, nor are they required to be equipped, with a caution light to identify an inactive heating element in the pitot tube.

12. Because the induction air selector was not positioned to the alternate system before the pilot entered convective IMC at and above freezing level, the PA-46 involved in the Lakeville accident probably incurred induction system icing.
13. Specialized training in high altitude aerodynamics, propulsion, physiology, meteorology, and integrated flight guidance and control systems is needed by the pilots of PA-46 and Mirage aircraft.

Recommendations

As a result of this investigation, the National Transportation Safety Board makes the following recommendations to the Federal Aviation Administration:

Require modifications to the Piper Aircraft Corporation's airplane flight manual and pilot's operating handbook for the PA-46 series airplane to add warnings in the normal procedures check lists for climb, cruise, and descent flight that pertinent ice protection equipment should be turned on if instrument meteorological conditions are encountered near and above the freezing level. (Class II, Priority Action) (A-92-84)

Require modification to the PA-46 series airplanes to provide for a pitot heat operating light similar to the light required by 14 CFR 25.1326 for Transport-category airplanes. (Class II, Priority Action) (A-92-85)

Consider application of the first and second safety recommendations above to all models of small airplanes certificated to operate in icing conditions and at altitudes of 18,000 feet msl and above. (Class II, Priority Action) (A-92-86)

Amend 14 CFR 61.31 to require the ground and flight training specified in paragraph (f) for pilots in command of pressurized airplanes that have service ceilings or maximum operating altitudes, whichever is lower, at and above 18,000 feet msl. (Class II, Priority Action) (A-92-87)

Amend 14 CFR 61.31 (f) to include integrated flight guidance and control systems as part of the ground and flight training requirements specified in subparagraphs (f) (1) (i) and (ii). (Class II, Priority Action) (A-92-88)

Require the manufacturers of integrated flight guidance and control systems, for which supplements to the airplane flight manual and pilots operating handbook must be provided, to develop and make available to operators detailed training information that will enable pilots to diagnose system failures, understand pilot-induced flight control system problems, and use the system in a safe and proficient manner. (Class II, Priority Action) (A-92-89)

EDITOR'S NOTE: In a concurring and dissenting statement, Member Christopher A. Hart concurred with the report and its recommendations, but dissented with the recommendation to "amend 14 CFR 61.31 to require ground and flight training specified in paragraph (f) for pilots in command of pressurized airplanes that have service ceilings or maximum operating altitudes, whichever is lower, at and above 18,000 feet msl."

As an alternative action, Hart cited a recommendation of the FAA Special Certification Review that reads as follows: "Recommendations: An in-depth review should be conducted by the industry and the FAA to update the pilot certification rules (FAR 61) for small airplanes operating above 18,000 feet to adequately consider all the aspects of the pilot, the aircraft, and the operating environment."

Appendix B: KFC 150 Flight Control System

All Piper Malibu/Mirage series airplanes involved in the accidents reviewed by the Safety Board's special investigation team were equipped with a King Radio Corporation* KFC 150 flight control system. The following system description information was excerpted from the KFC 150 pilot guide and technical manuals.

The system was certified by the King Radio Corporation under Federal Aviation Administration (FAA) supplemental type certificate number SA1778CE-D as approved and installed in the Malibu/Mirage series airplanes by Piper Aircraft Corporation. The KFC 150 system is approved for two-axis (pitch and roll) or three-axis control if the optional yaw damper is installed. The yaw axis control provides yaw damping and turn coordination with or without engaging the autopilot. The KFC 150 autopilot system also has an electric pitch trim system which provides autotrim during autopilot operation and manual electric trim.

The KFC 150 system is composed of the KC 192 Autopilot and Flight Director Computer, KI 256 Flight Command Indicator, KAS 297B Altitude Vertical Speed Selector; KS 270A Pitch Servo, KS 271A Roll/Yaw Servo, KS272A Trim Servo, KM 275 Pitch, Roll, and Trim Servo Mounts (see Figures B-1 and B-2).

The FAA approved flight manual supplement for the KFC 150 system contains the following operating limitations:

A. During autopilot operation, a pilot with seat belt fastened must be seated at the left pilot position.

B. The autopilot and yaw damper must be OFF during takeoff and landing.

C. The system is approved for Category I operation only. (Approach mode selected).

D. Autopilot maximum airspeed limitation: 185 KIAS.

E. Maximum fuel imbalance: 10 gallons.

NOTE: In accordance with FAA recommendation 9AC00-24A0, use of basic "pitch attitude hold" mode is recommended during operation in severe turbulence.

Fundamentals of Operation

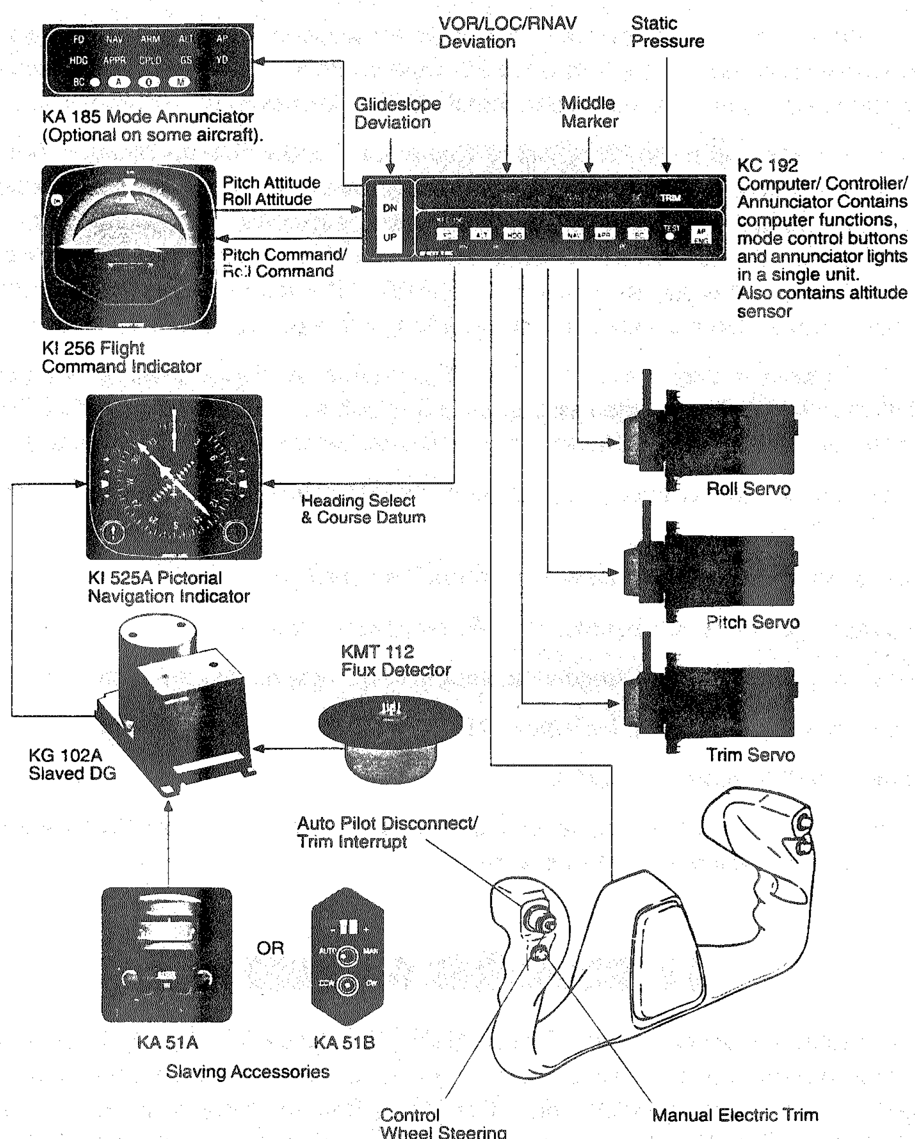
The KFC 150 autopilot assists the pilot in the control of the airplane's flightpath. The system operates in the pitch and roll axes and with the optional yaw damper, in the yaw axis. The system is driven by signals from: (1) attitude reference sensors, such as the attitude indicator and directional gyros, (2) altitude sensors, such as the altimeter (includes encoding altimeter) and an internal pressure sensor located in the KC 192, and (3) navigation sensors, such as VOR, RNAV, and LORAN. The KFC 150 system does not have provisions to sense or control the speed or engine power settings of the airplane. Speed control is a pilot function.

The attitude, altitude, and navigation signals are processed by microprocessors in the KC 192 Mode controller/computer/annunciator. Errors or deviations in the intended flight path are sensed, and corrective action is taken to resolve the error by signals to the flight director indicator and/or autopilot servos which operate the airplane's flight control surfaces. Each axis (yaw optional) uses servos to drive the flight control surface in parallel with the airplane's control system. Each servo incorporates a slip clutch to allow the pilot to overpower the autopilot command signals. The flight control system engages pitch, pitch trim, and roll servos when the autopilot is activated. The roll axis cannot be engaged without pitch axis engagement. The yaw damper may function independently of pitch and roll control.

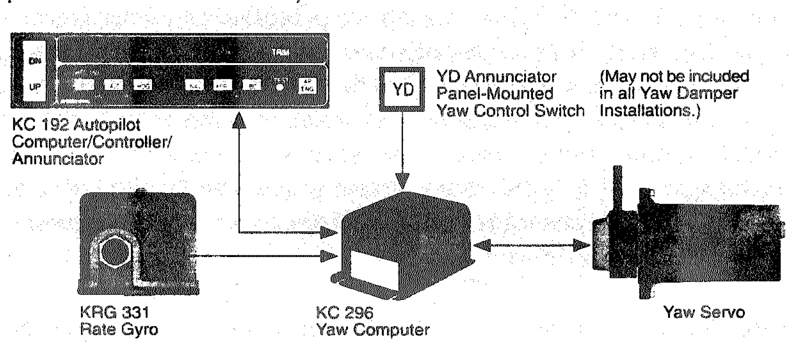
**Now the Bendix/King Avionics Division of the AlliedSignal Aerospace Corporation.*

Typical KFC 150 Flight Control System

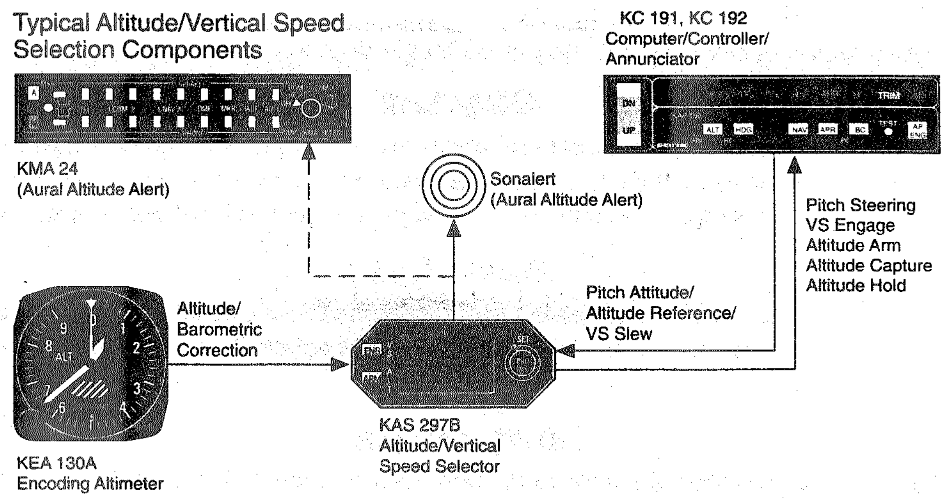
Two Axis (Pitch & Roll) System

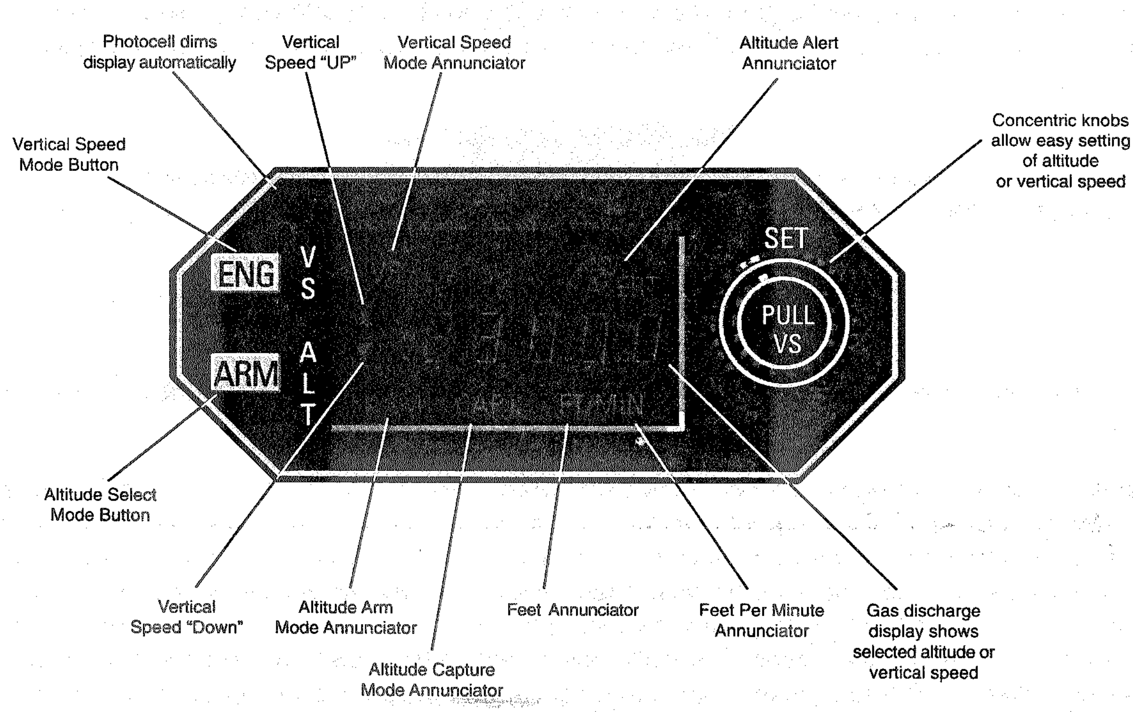


Third Axis Yaw Damper System (Optional on some aircraft.)



Optional KAS 297B Altitude and Vertical Speed Selector





Autopilot System Modes of Operation

The following autopilot system modes are discussed by airplane control axis and explained in detail below.

Roll Axis

The following modes operate about the airplane's longitudinal (roll) axis.

Wings Level

The wings level mode provides guidance to the pilot (or the autopilot) to maintain a wings-level attitude. The airplane's roll attitude is sensed by the KI 256 attitude gyro and corrected to wings level. Roll rates between attitudes of 30 degrees and 0 degrees cannot exceed 14 degrees per second without disengaging the autopilot.

Heading (HDG)

The heading mode provides for the airplane's track as selected by the heading bug on the directional gyro (DG) or horizontal situation indicator (HSI) to be monitored and corrected relative to the heading as displayed on the DG or HSI.

Navigation (NAV)

The navigation mode provides guidance to the pilot (or autopilot) in intercepting and tracking VOR and RNAV courses. When the navigation mode is selected, two signals are fed into the roll microprocessor to begin computation for navigational correction. The first signal is the navigational deviation coming from the navigation receiver. The second is from the compass system. Course deviation is sensed by information from the navigation receiver or LORAN and corrected.

Approach (APR)

The approach mode provides guidance to the pilot and autopilot in intercepting and tracking ILS (both localizer and glideslope), and VOR and RNAV courses. Course deviation is calculated from information sensed by the NAV receiver.

Back Course (BC) Approach

The back course mode provides guidance to the pilot (or autopilot) in intercepting and tracking a reverse localizer course. During a back course approach, the glideslope is locked out.

Pitch Axis

The following modes operate about the airplane's lateral (pitch) axis and are explained in detail below:

Pitch Attitude Hold

The pitch attitude hold mode is controlled by a pitch microprocessor in the KC 192. The pitch attitude existing at the moment the flight director is called for is held as the reference pitch attitude which the autopilot will fly. Any deviation from the pitch attitude is sensed by the attitude gyro and converted to command signals. The pitch attitude mode has two sub-modes which can change the attitude of the aircraft. One is the vertical trim switch (located on the front of the unit), with which the pilot can vary the pitch attitude either up or down at a rate of approximately 0.9 degrees per second when not in altitude hold. When operating in altitude hold, operating the vertical trim switch will command an approximate 500 feet per minute rate of change. The other method of changing pitch attitude is through control wheel steering. Pitch control limits are imposed at 15 degrees up and 10 degrees down.

Altitude Hold

The altitude hold mode will command the autopilot to maintain the engaged altitude. The altitude hold mode is operated by the KC 192 internal pressure detector. An altitude hold transducer continuously monitors the atmospheric static pressure. When the altitude hold mode is called for by the pilot, the altitude existing at the time the mode is selected becomes the reference altitude. Any deviations from that altitude result in commands generated by the pitch microprocessor which cause the aircraft to return to the reference altitude. The pilot may alter the altitude which he is flying and still remain in the altitude hold mode by depressing the control wheel steering switch or by selecting an altitude in the KAS 297B altitude selector.

Glideslope

The glideslope mode is a sub-mode of the approach mode. Glideslope is not allowed if the approach mode has not been called for or the LOC ENGAGE signal has not been received. The glideslope mode is also not allowed if the back course mode has been selected. Glideslope deviation is sensed by the navigational receiver and acted on by the pitch microprocessor.

Altitude Select

The altitude select function operates by comparing the altitude sensed by the KC 192 internal pressure detector/encoding altimeter and KAS 297B altitude selector and correcting to a preselected altitude on the KAS 297B.

Vertical Speed Select

The vertical speed function operates through a selection made on the KAS preselector. The vertical speed rate of change is sensed by the encoding altimeter and KC 192 internal pressure detector and corrected by the KAS 297B.

Control Wheel Steering (CWS)

When the autopilot system is engaged, the pilot may take control of the airplane by pressing the CWS switch on the control wheel. Depressing the CWS switch disengages the servo clutches giving the pilot full control while the switch is depressed. Autopilot system-generated flight path correction information is displayed by the flight director. The CWS switch provides flight director synchronization for vertical speed, pitch attitude, and altitude hold modes when the flight director is active.

Autotrim System

The KFC 150 includes as standard equipment an automatic and manual electric trim. This allows the system to trim off elevator control surface pressures when the autopilot is controlling the elevator through a pitch servo. If the autopilot is not engaged and the pilot is flying the airplane, the manual electric trim switch on the yoke can be used to trim off elevator control pressures.

The autotrim mode receives its command signals from the pitch microprocessor. Signals from sense switches in the pitch servo enter the microprocessor, indicating that trim is needed in one direction or the other. The error is resolved by sending the appropriate command to the trim servo motor. If flaps have been selected, speed of servo motor operation is increased.

The autotrim system also includes a proportional rate feature which varies trim servo commands with a variable servo motor speed based on the magnitude of error correction calculations.

KAS 297B Vertical Speed and Altitude Select System

The KAS 297B provides independent control and display of altitude and of vertical speed selection. The two modes—altitude select and vertical speed—are not related.

Altitude select is strictly an ARM function, which means that it provides altitude alerting and transfer to altitude hold mode. Altitude alerting occurs whether the mode is armed or not. An alert annunciation illuminates and a two-second aural tone sounds when the airplane reaches 1,000 feet from the selected altitude. If the autopilot is engaged and the altitude select is activated, another vertical mode is required to provide guidance to that selected altitude. If vertical speed select is not activated and the autopilot is engaged, the default vertical mode, pitch attitude hold, is active and must be pilot adjusted to provide guidance to the selected altitude. Altitude select does not provide vertical guidance.

Vertical speed is a guidance mode. Unless altitude arm has been activated, the airplane will not capture a selected altitude. If a vertical speed is displayed when the ENG button is pushed, that vertical speed will be the commanded vertical speed and pitch angle will be adjusted to maintain the selected vertical speed. If a vertical speed is not displayed, the current airplane vertical speed will become the reference value.

Preflight Test KFC 150 Flight Control System

The KFC 150 system incorporates a system self-test function which is activated by a test button on the KC 192. The test must be performed before the autopilot portion of the system can be engaged, but it need not be performed before using the flight director. A failure of any test prohibits the autopilot from being engaged. The preflight test determines, before takeoff, that the system is operating normally.

The preflight test mode in the KC 192 is activated by the test button on the face of the unit. Items tested during the five-second test mode are as follows:

A. Presence of the top and bottom adapter boards in the KC 192 in their correct locations.

B. Operation of the three microprocessors and the communications bus which links them together.

C. Operation of the mode select input and mode annunciation output serial data lines which are connected to the logic microprocessor.

D. Presence of proper voltage to operate the manual trim.

E. Operation of the autotrim drive and monitor circuits.

F. Operation of the roll and pitch rate monitors.

G. Operation of the autopilot aural and visual warning indicators.

KFC 150 System Safeguards

The KFC 150 flight control system provides the system safeguards to help prevent a failure of the system from affecting the controllability of the airplane. The following conditions will cause the autopilot to automatically disengage:

A. Power failure.

B. Internal KFC 150 flight control system failure.

C. With the KCS 55A Compass System installed, a loss of compass valid signal disengages the autopilot when a mode using heading information is engaged.

D. Roll rates in excess of 14 degrees per second will cause the autopilot to disengage except when the CWS switch is depressed and held.

E. Pitch rates in excess of 8 degrees per second will cause the autopilot to disengage except when the CWS switch is depressed and held.

F. Failures of manual and autotrim systems are monitored. Failures are aurally and visually annunciated.

Appendix C: FAA Special Certification Review

Executive Summary

The following information was extracted from an FAA report dated December 1991, entitled: Results of Special Certification Review of the Piper PA-46-310P (Malibu) and PA-46-350P (Mirage).

The Special Certification Review (SCR) was initiated by the FAA to review the certification of the Piper PA-46-310P Malibu. The review was started as a result of seven in-flight structural breakups. The accidents occurred in a period of about 22 months and involved six PA-46-310P (Malibu) airplanes and one PA-46-350P (Mirage) airplane. After the seventh accident, the FAA issued Airworthiness Directive (AD) 91-07-08 which restricted operation of the PA-46 airplanes. The restrictions were based upon some common environmental conditions the airplanes encountered prior to the accidents.

An SCR team was assembled using FAA National Resource Specialists and technical specialists from several Aircraft Certification Offices. The team reviewed the type certification, including airframe structures, ice protection, systems and equipment, propulsion, production certification and service history. Other appropriate factors were also reviewed that were pertinent to the operation of the airplane, such as airspeed control, pilot training, and proficiency in operating a complex, high altitude, pressurized, turbocharged, single-engine airplane, all with the goal of determining if an unsafe condition exists for the airplane and/or autopilot installation. The charter of the SCR team did not include determining the cause of the seven accidents.

The recommendations contained in this report are divided into four categories: Category 1 are recommendations considered mandatory to relieve the operational restrictions contained in AD91-07-08; Category 2 are recommendations for design changes to correct an unsafe condition; Category 3 are recommendations considered to be product improvements; and Category 4 are recommendations addressed to the FAA for action such as rule changes or clarification of policy and guidance.

The major design feature of the Malibu/Mirage airplane or Bendix/King autopilot was found to be in compliance with the certification requirements; however, several areas were identified for improvement of design and clarification of operational instructions.

The PA-46 Series airplanes have the ability to operate up to 25,000 feet. This increases the exposure of the pilot and the airplane to more severe physiological, psychological, and environmental conditions than are associated with flight at lower altitudes. The air traffic control environment above 18,000 feet requires additional demands on the pilot. This, coupled with the complexity of the airplane and its systems, requires that the pilot be constantly attentive and proficient. If not operated properly, the airplane can deviate from the approved flight envelope with potentially disastrous consequences. The team believes that the most likely accident scenario is one in which the pilot loses control of the airplane at altitude, the airplane descends at increasing speed and breaks up as a result of dynamic pressure, or aerodynamic loads outside the certified flight envelope. For these reasons, the team is recommending that special training be required for complex airplanes operated above 18,000 feet and that more detailed information on the proper use and consequences of misuse of autopilots and systems be highlighted to pilots. In addition, the team recommends that consideration be given for providing drag-producing devices, such as speed brakes or gear extension at high speed, to assist the pilot in keeping the airplane within its design flight envelope.

The team identified a possible deficiency in the regulations with respect to using the simplified criteria for establishing empennage flight loads. NASA expertise was utilized to help conduct a rational analysis to determine if calculated loads exceeded the loads Piper used (simplified criteria) in the design substantiation of the PA-46 series airplanes. The team concluded that the structural substantiation for the PA-46-310P and PA-46-350P is adequate for all conditions within the approved flight envelope. The use of the simplified criteria is no longer allowed for developing empennage flight loads on new projects. However, the team recommends that the FAA conduct a review of empennage structural integrity on those high performance airplanes which have used FAR 23 Appendix B for certification.

The team identified some potential failures within the autopilot system which could cause hazardous conditions to the airplane in flight. To reduce the effects of autopilot malfunctions in the PA-46-310P/350P, the team recommends that the installation be changed to automatically disconnect the autopilot if the stall warning activates or if airspeed exceeds 185 knots. However, these failures are not unique to the KFC 150 autopilot, and they are conditions not normally considered when certifying autopilots for FAR 23 airplanes. For this reason, the team is recommending that the FAA reconsider how autopilots are certified and consider that an autopilot hardover is not necessarily the most critical failure condition.

The autotrim system is also a concern. The team has recommended that a "Trim in Motion" alerting system be installed or the authority of the autotrim system be reduced or that both changes be made in the PA-46-310P/350P.

The team has recommended that the primary induction air system be modified so that when alternate air is selected, only air from a sheltered source be available to the engine induction system. The current system design allows saturated air to enter the induction system through the primary air source even though the alternate source is selected.

The team has made numerous recommendations to clarify FAA policy, establish new rules and revise some existing rules for various design and operational aspects for complex, pressurized, single-engine, high-altitude operation airplanes.

A summary of all the recommendations can be found under Recommendations.

Recommendations (Only those pertaining to pilot operations are included here.)

11. It is considered important to assist the pilot in keeping the airplane within its design flight envelope. Therefore, consideration of speed brakes, or the ability to extend the landing gear up to the design dive speed, is recommended. (Category 3)

ASF Comment: Landing gear operation is permitted up to 165 knots indicated. This is well above indicated cruise airspeed at altitude, even with full power. Even if the aircraft exceeds landing gear operating airspeed, the gear may still be used as a speed brake in an emergency situation.

12. The effects of autopilot and electric trim malfunctions and the need for constant monitoring when the autopilot is engaged should be added to the PA-46-310P/350P airplane flight manual. Errors and inconsistencies in the Piper and Bendix/King airplane flight manuals for the autopilot should be corrected. The airplane flight manual should be revised to prohibit the use of normal electric trim after a trim warning and require that the TRIM circuit breaker be opened. (Category 3)

16. Bendix/King should develop an improved monitor for vertical gyro excitation failures to prevent single failures from causing a multi-axis autopilot malfunction. (Category 3)

ASF Comment: This amounts to a warning flag indicating gyro failure. The attitude gyro is vacuum powered, and the vacuum gauge may be placed well outside the normal pilot scan.

19. The FAA should consider creating an additional set of requirements in FAR 23 applicable to airplanes capable of flight at and above altitudes of 18,000 feet. For this category of airplane, the following rules and policy material should be reviewed for possible changes. (Category 4)

    a. FAR 23.1331(a)(3) should be changed to incorporate the requirements of FAR 25.1331(a)(1) for an integral power failure indication within each instrument rather than permitting a separate power indication such as a vacuum gauge. Perhaps this change should be made for all FAR 23 airplanes. See detailed discussion in Section IV, Attitude Indicator.

    b. The installation of a standby attitude instrument system should be required.

    c. FAR 23.1329(e) should be revised to require that a single malfunction will not produce a signal in more than one axis which will produce a hazardous deviation in the flight path.

       AC 23.1329-2 should define what constitutes a hazardous deviation to the flight path when considering multi-axis malfunctions.

    d. The time delays associated with autopilot malfunctions should be reviewed with respect to realistic values for single-pilot operation in instrument flight conditions. For this category of airplanes, perhaps a monitored autopilot, which alerts the pilot to malfunctions and disconnects before exceeding specified deviations from the flight path, should be required.

    e. FAR 23.677 should be reviewed and additional requirements considered to limit the maximum trim authority of powered trim systems to less than the maximum transient control forces of FAR 23.143, to require a trim in motion alert for both manual and autopilot operation and to require the ability to manually override the powered trim system.

ASF Comment: A Malibu/Mirage operator can easily add a second attitude instrument, and replace existing instruments with ones including integral warning flags. An exception is the pilot's vacuum-powered attitude indicator which is the primary sensor for the autopilot. An alternative instrument with a warning flag was not available at publication time.

20. The Flight Standards Service should consider developing requirements for a new rating for private and commercial pilots applicable to airplanes capable of operating at altitudes above 18,000 feet. The training program for this rating should include air traffic control procedures in positive control airspace, planning for normal descent, high altitude weather, and the operation and monitoring necessary for the complex systems found in these airplanes such as pressurization, anti-ice, powered controls, autopilot, flight director, and complex navigation systems. (Category 4)

ASF Comment: Of the 40 accidents documented in this ASF report, only one occurred at or above 18,000 feet. The NTSB made a similar recommendation. However, in his minority opinion, Mr. Christopher Hart also noted there was little data to support this recommendation.

24. It is recommended that for the PA-46-310P the minimum oil quantity (7 quarts) be established as a limitation as required by Piper SB 871, the airplane flight manual and the POH should be revised by AD, and the AD should require a placard adjacent to the engine oil service port. (Category 2)

29. The FAA should consider developing a regulation similar to FAR 25.1331(a)(1) requiring an "integral" annunciator (flag) for all flight instruments that are vacuum operated for use in instrument meteorological conditions. (Category 4)

ASF Comments: See recommendation 16.

30. It is recommended that PAC develop a change to the basic POH to inform the pilot that the pitot heat should be on during all operations in visible moisture when outside air temperature (OAT) is less than 5° C. (Category 3)

ASF Comments: This is a wise recommendation and easy to do.

31. It is recommended that the FAA develop a regulatory change for small airplanes that are approved for flight into known icing that would require pitot heat operating light similar to FAR 25.1326. (Category 4)

32. It is recommended that Piper develop a SB to provide a "guarded" manual pressurization control for the PA-46-310P airplane. This guarded control should be similar to the installation in the PA-46-350P airplane. (Category 3)

40. Reduced power descent procedures should be reviewed for both emergency and normal conditions to ensure that they are compatible and practical for a general aviation pilot with average skills. Configurations, power settings, airspeeds, and their management should be addressed in detailed steps that are considered practical for expected operation of this type airplane. Use of flaps for high-speed descent should be discouraged. (Category 3)

41. The emergency procedures section of the AFM should include unusual attitude recovery procedures. Procedures should be prescribed for both nose high (low airspeed) cases and nose low (high airspeed) cases. This information would enhance safe operation of this airplane. (Category 3)

42. Allowed optional locations for equipment items in the cockpit should be specified in the installation instructions. In particular, the locations allowed for the KAS 297B display/control unit should be specified. The locations should be within the pilot's instrument cross-check field of view and within easy arm's reach such as on or near the glare shield (adjacent to the standby compass) or in the upper area of the pilot's instrument panel (near the altimeter). This recommendation should be implemented prior to reinstallation of the KAS 297B as removed by AD 91-07-08-R-1. (Category 1)

44. Information should be provided in the approved supplements to properly inform the pilot of the possible misuse of the KAS 297B capability for pre-selecting an altitude opposite to the engaged vertical speed direction (climb and descent carets) and to caution against selecting large climb/descent rates that may result in exceeding the airplane performance capabilities (especially when expecting an automatic pilot level-off after a prolonged climb/descent to a preselected altitude). (Category 3)

45. The design and/or interface for the encoding altimeter and vertical speed altitude selector (KAS 297B) should be modified to preclude any sensing by the autopilot that permits control inputs to the servos as a result of resetting the altimeter barometric pressure settings. This has been accomplished by Bendix/King in accordance with Modification 3. (Category 3)

ASF Comment: This has been accomplished by Bendix/King in modification #3 for the KAS 297B.

46. In addition to the present caution note, information should be presented in the approved supplements about the hazards associated with large mistrim conditions occurring as a result of autotrim operation associated with improper procedures when the autopilot is engaged. It should be emphasized that proper trimming (especially directional) of the airplane should be maintained prior to autopilot engagement and for each phase of flight (climb, cruise, descent, and approach). (Category 3)

47. Proper emergency use of the radio Master switch should be defined (especially as a backup method for disabling the electric trim system in the Model 350P). Emergency use of the switch would be contingent upon the assurance that the minimum equipment needed to maintain airplane control during instrument flight conditions is retained. (Category 3)

ASF Comment: Use of the radio master is not the preferred method to disable electric trim. Better options are the use of the red control wheel disconnect switch, and the trim circuit breaker.

51. The manufacturer should consider publishing a recommended turbulent air penetration airspeed based upon the minimum maneuvering airspeed that is likely to be encountered in service rather than the currently listed maneuvering airspeed schedule versus weight. (Category 3)

ASF Comment: Each pilot can determine the minimum V_A by referring to the empty weight of his aircraft and adding the minimum load (for example, the pilot's weight and 20 gallons of fuel). V_A is directly proportional to aircraft weight, so the V_A for any weight can be easily calculated.

52. The AFM should warn against the use of the installed visor checklist for all operations and the fact that revised procedures could conflict with it. (Category 3)

53. Flight Manual Supplement preflight procedures must clearly ensure the following mandatory checks:

   a. Normal operation of the electric pitch trim servo motor.
   b. Proper engagement and disengagement of the trim servo clutch.
   c. Normal function of the AP Disc/Trim Inter Switch.

57. The PAC PA-46-310P/350P initial training course should be revised to include additional emphasis on recovery from unusual attitudes while under the "hood." (Category 3)

58. A training syllabus for the PA-46-310P/350P should be developed to ensure coverage of all systems with emphasis on use and consequences of misuse of the autopilot, electric trim, and the KAS 297B altitude preselect. (Category 3)

ASF Comment: See Part 3 of this report.
The following direct quotes from the FAA Special Certification Review report are illuminating.

Page 36

"...although a disruption of the vertical flight path could be caused by failure or improper mode selection of the KAS 297B selector, the effects on the pitch axis are limited by the control laws of the KC192 computer/controller in both pitch rate and pitch attitude. Therefore any effects caused by the KAS 297B selector would be less severe than those caused by problems with the KC192 computer/controller, and a detailed review of the KAS 297B selector was not conducted."

Page 42

"Normal operation of the autopilot and autotrim function can cause a large pitch mistrim to occur when there is any restraint on motion of the control wheel, either by pilot action or through a control system jam, such as could be caused by icing."

"...a large pitch mistrim (can occur) if the autopilot is commanded to climb at a rate which exceeds the performance capability of the airplane, and the airplane enters a stall."

Page 43

"Airplane autopilot or engine malfunctions or improper operation of the airplane with the autopilot engaged can result in hazardous deviations from the flight path..."

"The electric autotrim with the autopilot engaged can produce hazardous mistrim conditions and excessive control wheel forces greater than 100 pounds in the pitch axis if not recognized by the pilot in a timely manner."

"Failures affecting the vertical gyro sensor for the autopilot can result in hazardous deviations in the flight path."

"The three-second delay applied to autopilot malfunctions originally developed for transport airplanes with two pilots may not be appropriate for single-pilot operations...in high-performance airplanes at high altitude."

Page 44

"An AD should be issued (to require)...interlock stall warning sensors with the autopilot to disconnect the autopilot if the stall warning activates. Also disconnect sensors if indicated airspeed exceeds 185 knots."

Page 51-52

An "amber vacuum annunciator located in the instrument panel, activated whenever the vacuum system pressure drops below 4.0 inches plus or minus 0.25." There is "no normal operating arc on the vacuum gauge which should be indicated from 4.8 to 5.2 inches of mercury."

Page 66

"None of the installations of the KAS 297B were considered to have suitable location. The small push-pull concentric control knobs were found to be easily misused during conditions of high work load and in turbulent air..."

Page 67

"...manual rudder trim changes by the pilot with the yaw damper ON should be avoided. The trim effect is not evident, and when the yaw damper is disconnected, a mistrimmed yaw excursion may result."

"Control wheel pull force needed to counteract a full nose down trim condition never exceeded approximately 60 pounds. The control wheel push force needed to counteract a full nose up trim varied significantly with increasing airspeed, and could be in excess of 100 pounds at airspeeds above 150 KIAS."

Page 67 continued

"The model 350P trim circuit breaker location was not readily accessible to the pilot (right side, lower panel)."

"The pilot could not manually override an engaged pitch trim servo clutch by physically moving the trim wheel."

Page 77

PA-46 WARRANTY CLAIMS. Discussion...Review of PA-46 warranty records 1984 to May 1991. "The most warranty activity was for engine nacelles, a total of 509 claims for cracks in aluminum skins, fiberglass panels, and attached fittings. One hundred thirty one turn and bank indicators, 67 horizontal gyros, 112 voltage regulators, and 62 stall warning indicators were reported to be either inoperative, defective, or intermittent."

Special Certification Review Flight Test

Appendix II Page 29 L "It was significant that during autopilot coupled climb (V/S 1,000 fpm engaged) an actual failure condition occurred that caused the commanded pitch to abruptly increase to a V/S of 2,000 foot per minute, and then abruptly to decrease toward level flight. The acceleration was significantly noticeable during the observed pitch excursions. This failure occurred several times on the same flight, but was considered intermittent. A ground check by Bendix/King did not identify any failure conditions in the installed equipment."

Appendix III - Owner/Operator Survey Results

Two hundred forty nine (249) surveys were returned. 50.2 percent of the operators reported inadvertent autopilot attitude/heading change. 76 percent of the operators gave written comments, but none were published by the FAA.

The NTSB acknowledging the FAA SCR report concluded "...there was no evidence of malfunction or failure (of the King KFC series flight control system and KAS 297B vertical speed and altitude selector) in any of the U.S. accidents."

Pilot Briefing

NTSB Blames Pilot Error, Training in Series of Malibu/Mirage Crashes

(Reprinted from *AOPA Pilot* magazine, October 1992)

On July 21, the National Transportation Safety Board released its long-awaited recommendations pertaining to the safety of the Piper Malibu (PA-46-310P) and Malibu Mirage (PA-46-350P) series of airplanes.

The recommendations capped a two-year-long investigation into the cause of seven fatal Malibu/Mirage accidents. The accidents shared certain similarities in that most occurred at altitude, in instrument conditions, and involved pilot loss of control, ending with structural failure. The pattern and frequency of these accidents had drawn the attention of both the aviation community and the general public.

In an effort to examine the roles that the PA-46's airframe and systems played in the accidents, the FAA conducted a special certification review (SCR). After an exhaustive review, the SCR determined, in its December 5, 1991, report, that the PA-46 was in compliance with every applicable certification standard, though the SCR team did make 60 recommendations for improving the airplane's safety (see "Piper Malibu/Mirage: Back from the Edge," July *Pilot*). (Part 4 of this review)

Subsequently, the FAA published four airworthiness directives affecting PA-46-series airplanes—each of them borrowed from portions of the SCR's recommendations.

The NTSB report acknowledged the PA-46's compliance with certification requirements—but agreed with certain SCR observations by noting that "the review identified a number of modifications... that would improve the reliability and safety of the KFC 150 flight control system and the airplanes."

However, the NTSB placed the greatest blame on the pilots themselves. In particular, the NTSB report singled out "pilot failure to use pitot heat in freezing instrument flight conditions, possible misuse of the autopilot, and loss of control leading to in-flight structural failure" as probable causes of the accidents. Contributing factors included "the lack of an appropriate pilot checklist item to use pitot heat, and inadequate training in the operation of the autopilot and related components."

A common thread in five of the accidents "probably was a loss of accurate airspeed indications because of ice-blocked pitot systems," according to the NTSB.

The NTSB report went on to make six safety recommendations affecting the Malibu/Mirage. They are, in summary:

1. Modify the PA-46 airplane flight manual to add warnings to normal procedures check lists, advising that "pertinent ice protection equipment... be turned on if instrument meteorological conditions are encountered near and above the freezing level."
2. Require a pitot-heat operating light.
3. Consider applying both the above recommendations to all models of small airplanes certified to operate in icing conditions at and above 18,000 feet msl.
4. Amend FAR 61.31(f) to require ground and flight training for pilots in command of pressurized airplanes that have service ceilings or maximum operating altitudes, whichever is lower, at and above 18,000 feet msl.
5. Amend FAR 61.31(f) to include integrated flight control systems as part of ground and flight training.
6. Require manufacturers of integrated flight control systems...to develop and make available to operators detailed training information that will enable pilots to diagnose system failures, understand pilot-induced flight control system problems, and use the system in a safe and proficient manner.

Pilot Briefing

FAA Responds to NTSB Suggestions on Malibu

(Reprinted from *AOPA Pilot* magazine, February 1993)

The FAA has commented on the National Transportation Safety Board's September 1992 safety recommendations concerning the Piper PA-46 Malibu and Mirage airplanes. A series of seven Malibu and Mirage accidents (which occurred between May 1989 and March 1991) prompted a special investigation by the NTSB, as well as a certification review by the FAA. Though the accidents all seemed to share certain similarities—flight into adverse weather, followed by airframe failure—the FAA and NTSB found little blame in either the airframe or the autopilots.

In July 1992, the NTSB concluded that a common thread in five of the U.S. accidents was a probable loss of accurate airspeed indications because of ice-blocked pitot systems. In four of the accidents, it was determined that the airplanes were in instrument meteorological conditions conducive to airframe icing before control was lost. Accident investigation revealed that the pitot heat switches of three of these airplanes were not in the On position at the time of impact. In the fifth accident, the NTSB said that the pilot probably did not activate his ice protection switches until after icing had occurred. Probable misuse of the Malibu/Mirage's Bendix/King KFC 150 may also have taken place in three of the accidents, the NTSB said.

The NTSB made six separate safety recommendations:

A-92-84 asked that warnings to activate ice protection equipment in IMC near or above the freezing level be added to the airplane's normal procedures check lists. The FAA responded by noting that the Malibu/Mirage's flight manual had been changed to require a preflight test of the ice protection equipment, if flight into icing conditions is anticipated. It said it was still reviewing the flight manual to see if a warning to activate ice protection equipment was necessary.

A-92-85 asked that PA-46s be fitted out with a pitot-heat operating light. The FAA responded by saying that this action was unwarranted but also said it was considering such a requirement in the future.

A-92-86 suggested that the above two recommendations be applied to all small airplanes certificated to operate in icing conditions and at altitudes of 18,000 feet msl and above. The FAA said that implementation of such a move can't be justified but that it was considering a change to AC 23.1419-2 to include a warning to activate ice protection equipment if flying near or in icing conditions.

A-92-87 was a request to require special gound and flight training for pilots of pressurized airplanes with service ceilings or maximum operating altitudes at or above 18,000 feet msl. The FAA replied by agreeing with this recommendation and said that it will consider and recommend such training as part of its ongoing regulatory review of FAR Part 61.

A-92-88 is similar to the previous NTSB recommendation. It asks for an amendment to Part 61 to include special pilot ground and flight training in the operation of flight guidance and control systems. In response, the FAA stated that type-specific systems training is necessary in today's technologically advanced aircraft and said that this training might be required in the future. The FAA went on to mention that it had formed a joint FAA/industry working group to examine the scope of what might be an appropriate course of training for pilots of small, complex, high-performance airplanes. The goal of this group, it said, is to develop a non-regulatory training program that would be part of a master training curriculum for these pilots. The FAA promised to publish this master training curriculum, make it available to the aviation industry, and encourage its adoption as an industry standard.

Recommendation A-92-89 called on manufacurers of integrated flight guidance and control systems to beef up their operating handbooks, to include detailed information on diagnosing system failures, and the understanding of pilot-induced flight control system problems. The FAA agreed in part, saying that it is considering revising AC 23-8A ("Flight Test Guide for Certification of Part 23 Airplanes") and AC 23.1309-1A ("Equipment, Systems, and Installations in Part 23 Airplanes"). The revisions would emphasize that complex integrated systems may necessitate cockpit warning indicators, along with detailed emergency procedures information in FAA-approved flight manuals.

Autopilot with Finesse

By Ian Blair Fries, M.D., ATP, CFI, A, II

Malibu/Mirage aircraft have been certified with Bendix/King Series 150 autopilots. The majority of aircraft are also delivered with an optional flight director (KFC 150) and an altitude/vertical speed preselect (KAS 297B). Many Malibu/Mirages also have an optional yaw damper.

Most pilots receive less than adequate training in the use of the autopilot. Until recently, even the Piper Factory School in Vero Beach did not include intensive attention to autopilot function. In response to the need for additional training, King has published a Flight Control System KFC 150 training supplement which may be more useful than the supplement contained in the POH. The problem is the machine-man interface. The Bendix/ King 150 autopilot is not intuitive. Proper operation requires analysis and practice. Inattention or over dependence upon the autopilot can result in an accident.

Setting Up the Attitude Indicator and Autopilot

Proper adjustment of the attitude indicator (AI) is essential to efficient use of the integrated flight guidance and control system. The attitude bar (red triangle) should be adjusted in flight so the apex lies exactly on the horizon line. Adjustment is necessary if the pilot changes seat height, or a pilot with a different eye level assumes the left seat. During straight and level flight, pitch varies with airspeed. Thus the straight and level indication in cruise may not match that during an approach. A pilot must mentally add or subtract a few degrees of pitch attitude to correct for airspeed and configuration (flaps) changes.

The attitude bar can be raised or lowered using the adjustment screw in the lower right bezel using a small screwdriver or the King Autopilot Adjustment Tool Part # 088-0706-00. The adjustment does not affect the autopilot or flight director. Banking until either upper side of the red triangle parallels the horizon will produce a 15-degree bank and approximately a standard-rate turn.

Two additional adjustments of the flight director require the King tool or a long thin screwdriver to tune potentiometers accessible through the front panel of the KC 192 autopilot control unit. They are labeled "RC" (roll command) and "PC" (pitch command).

First match the yellow command bars to parallel the peak of the red attitude triangle. Then raise the command bars using the "PC" (pitch command) potentiometer so they precisely straddle the red attitude triangle when the aircraft is in straight and level flight. These adjustments do not affect autopilot operation.

The last adjustment to the right of the KC 192 control panel is "RN" (roll null). This assures the aircraft is held wings level when the autopilot is engaged. Adjustment of this may also affect the centering of aircraft heading to the DG autopilot bug. **It is best adjusted by an experienced technician, and King would prefer even RC and PC be adjusted professionally.**

Preflight

A new amendment to the POH supplement warns autopilot and trim must be tested on the ground prior to engagement in flight. The FAA has suggested a new placard to remind the pilot, but the autopilot enforces the test sequence. It cannot be engaged until the test sequence is successfully completed. Additionally, the pilot should test pilot and copilot manual electric trim operation. A pilot command should override the copilot command. Activation of both parts of the split switch are necessary: activation of only one half the switch should not produce trim motion.

If the test sequence ends with the TRIM annunciator steadily illuminated, there was a failure in the autotrim test. The autopilot circuit breakers should be pulled, but the manual electric trim may still be operational. A blinking TRIM annunciator means a fault in the manual electric trim system. The trim circuit breaker should be pulled, and any trim change should be made using the trim wheel.

See the report of the IMC accident (#92-0462) of December 11, 1992, at Twin Falls, Idaho.

How to Turn the Autopilot Off

Perhaps the most frightening specter is an autopilot gone wild, and a pilot unable to disconnect it. However, there is little evidence this occurs. Usually the pilot errs in autopilot operation and assumes the autopilot has malfunctioned. Nevertheless, **emergency disconnect procedures should be well understood and practiced.**

POH SECTION 3 - EMERGENCY PROCEDURES reads as follows:

(a) In case of Autopilot malfunction: (accomplish items 1 and 2 simultaneously)

(1) Airplane Control Wheel - GRASP FIRMLY and regain aircraft control.

(2) AP DISC/TRIM Inter Switch - PRESS and HOLD.

(3) AP DISC/TRIM Inter Switch - RELEASE while observing pitch trim wheel. If pitch trim wheel is in motion, follow the Electric Trim Malfunction Procedure.

(b) In case of Electric Trim Malfunction (either manual electric or autotrim):

(1) AP DISC/TRIM Inter Switch - PRESS and HOLD throughout recovery.

(2) PITCH TRIM Circuit Breaker - PULL.

(3) Aircraft - RETRIM manually.

Caution: When disconnecting the autopilot after a trim malfunction, hold the control wheel firmly: Up to 45 pounds of force on the control wheel may be necessary to hold the aircraft level."

The autopilot can be overridden by enough pressure on the controls. Clutches permit the autopilot servos to slip. Overriding the autopilot in a turn is easily done. When the controls are released, the airplane rights itself on a new heading if in attitude mode, or returns to the previous heading or radio course depending upon the mode.

The override in pitch is less benign. The autopilot responds with large trim corrections, attempting to overcome what it interprets as an out of trim situation. If the controls are released, the aircraft may experience dramatic oscillations before correcting to the original attitude or altitude. Oscillations may be severe enough to overspeed or stall the aircraft. The autopilot may disconnect if pitch limits are exceeded. If the autopilot is either manually or automatically disconnected, roll control is immediately recovered, but the pilot may assume the autopilot is still engaged as heavy pitch control pressures are needed to overcome the excessive trim. If the manual electric trim has also been disconnected, the pilot may assume the autopilot failure included loss of trim control. It may take several valuable seconds before a pilot realizes manual electric trim is not responding to control switch pressures. The manual mechanical trim wheel can always be used, but full up or down trim to neutral takes seven full strokes. Even using the manual electric trim, several seconds are required for correction during which heavy control wheel pressure must be maintained.

As an exercise—in VFR practice conditions and at a safe altitude—overpower autopilot pitch allowing it to autotrim up or down until significant control pressure is required to maintain the new attitude. Disconnect the autopilot, maintain control of the aircraft, and manually correct trim to establish hands-off level flight. It's not something to try for the first time in IMC near the ground; the control pressures are substantial!

The moral is **never to add pitch pressures to the control wheel while the autopilot is engaged.**

It is useful to retain operation of the manual electric trim when the autopilot is disconnected. This can be accomplished if the autopilot is disconnected using one of three methods: depressing the far right autopilot button on the control panel, momentarily activating the electric trim switch (you only need to activate the left hand part of the split switch), or momentarily pushing the red yoke disconnect button.

Pulling the autopilot circuit breaker, turning off the radio master switch, or holding the red autopilot disconnect will disconnect the autopilot, but also will disable manual electric trim. These three methods are appropriate for emergency disengagement of runaway trim, but may not be the preferred method to disconnect the autopilot. Pulling the trim circuit breaker will not be annunciated by the autopilot as a fault until autotrim is required. After pulling the autopilot circuit breaker, trim circuit breaker, or radio master switch, a full test sequence is required before electric trim can be used or autopilot can be reengaged.

The best way to disable an autopilot that is not doing what you want is the red disconnect (or Interrupt) button. This effectively prevents the autopilot from activating any of the servos. The airplane can be flown manually while this button is held depressed. Releasing the button will under normal conditions return manual electric trim function, but will leave the autopilot and flight director off. The flight director can then be activated, and the command bars carefully regarded prior to thoughts of reengaging the autopilot.

King sent a letter to pilots which erroneously suggested the battery Master switch would disable the autopilot. It will not—unless both alternators are also off line so there is no electric source.

Modes

It is important to be continually aware of the operation mode of the autopilot. Some Malibu/Mirages were delivered with a separate Autopilot Mode annunciator placing this information closer to the center of the pilot's scan. There are ten Flight Director and ten Autopilot modes. These may be categorized as Horizontal (roll) and Vertical (pitch) Modes.

Horizontal (roll) Modes: None are reset by CWS

- Wing level either [FD] or [AP] only
- Heading Hold [HD]
- Navigation Tracking (VOR, LORAN, GPS) [NAV]
- Heading to Intercept Navigation Tracking [HD] + [NAV]
- Approach (LOC) Intercept and Tracking [HD] + [APP]
- Back Course (BC) Intercept and Tracking [HD] + [BC]

Vertical Modes: The first three are reset by CWS

- Attitude Hold either [FD] or [AP] only
- Altitude Hold [ALT]
- Vertical Speed <VS>
- Preselected Altitude Capture <ARM>
- Glideslope Capture and Tracking [APP] + [GS]

Each of these modes are available in Flight Director [FD], or Autopilot[AP] status. The annunciators for each mode are indicated between brackets [ ]. Preselected altitude hold, and vertical speed modes (marked with <>) are only available if the Altitude Preselect Module KAS 297B is installed, and are annunciated on that module.

Roll and Pitch

The Wings Level (roll) and Attitude Hold (pitch) are always activated and disengaged simultaneously. When they are chosen only the [AP] annunciator is lighted.

Heading Hold and Intercepts

The bug on the directional gyro or HSI commands the heading. It may be moved while coupled. While the autopilot is following heading [HD] commands, [NAV], [APP], or [BC] can be armed as confirmed by the appropriate annunciator blinking. The aircraft will continue on the heading matching the bug until intercepting the radio course. The aircraft then turns to track the radio course, and the blinking annunciator is solidly lighted. The maximum intercept angle is 45 degrees.

Altitude Hold

The static line is plumbed to the autopilot control panel KC 192, and pressure is monitored to maintain altitude hold. Changes in the altimeter, while setting the Kolsman window, do not affect altitude hold.

Glideslope

Glideslope coupling requires the following parameters. The autopilot must already be coupled and tracking a localizer. An armed localizer is not sufficient. The GS button must be pressed and the annunciator should respond with blinking [GS]. The glideslope must be approached from below, and the centerline of the glideslope must be reached. At that point, the glideslope couples and the aircraft begins to descend. The pilot must adjust power, flaps, and gear as appropriate to control airspeed. The autopilot has no airspeed input.

The glideslope cannot be coupled in Back Course even though there are several back course approaches with valid usable glideslopes.

Navigation Tracking

Assume you are manually tracking a VOR radial with a wind correction. If you engage the autopilot in NAV mode the plane will abruptly turn to the course heading, and then gradually add wind correction as it recognizes drift. A smoother way to engage the autopilot is to enter the flight director mode first [FD] + [NAV]. In several seconds when the command bars match the attitude bar, engage the autopilot. It will match the flight director for a seamless capture.

Turbulence

Unlike more complex autopilots, the King 150 series does not have a dedicated turbulence mode. The best strategy is to turn off any vertical mode (vertical speed or altitude hold) and allow the autopilot to default to Pitch Attitude Mode. The autopilot will retain control of pitch and roll, but allow altitude excursions. This best protects the aircraft from overstress. The pilot must also reduce power to attain maneuvering speed (V_A). In an emergency it may be prudent to extend the landing gear. "Turbulence mode" while not specifically annunciated, can be confirmed by the absence of "ALT" on the autopilot control box and the absence of "VS" on the altitude preselect.

When the autopilot is engaged, the quickest way to handle turbulence is to press the ALT button either once or twice as necessary to extinguish the "ALT" annunciator.

Changing Altimeter Setting

Small changes in altimeter setting which lead to a variation in altitude of a hundred feet or less are easily corrected using the up/down rocker switch, or adjusted with the yoke after depressing the CWS switch. Larger changes in altimeter setting, as typically needed passing through 18,000 feet, will substantially change attitude or vertical speed. In vertical speed mode (climbing or descending), before changing the altimeter, activate and hold CWS, and maintain attitude manually. Delay releasing CWS to assure the attitude and vertical speed reengaged is appropriate. If the CWS is released too soon, the attitude and vertical speed captured will be that simulated by the altimeter setting change.

A smoother transition is to disconnect vertical speed (VS), so the autopilot defaults to attitude mode. Then change the altimeter setting, which will not affect aircraft attitude. Wait several seconds and confirm the command bars match the desired attitude before reengaging vertical speed (or releasing CWS).

A few pilots have installed Modification 3 of the KAS 297B which eliminates the influence of altimeter setting change on the autopilot.

The Flight Director

It is best to engage the flight director and observe the command bars before engaging the autopilot. Disengagement should be the opposite - autopilot to flight director. The flight director displays the same cues the autopilot uses to correct to the desired attitude. The pilot can manually match needles to satisfy the commands. Flight director mode is "half the autopilot," the command bars indicating the attitude that will satisfy the commands. The pilot then substitutes for the servos.

Never engage the autopilot until the flight director command bars indicate the correction or attitude you wish the autopilot to follow.

The flight director can be turned on using the {FD} button on the control panel or momentarily pushing the yoke CWS. It is also turned on by depressing the {VS} or {ARM} on the altitude preselect. The flight director is turned off using the FD button on the control panel or the red disconnect button on the yoke.

Once in Flight Director status, the autopilot can be turned on using the autopilot engage button {AP ENG} on the control panel. This will light the {AP} annunciator. You can return to Flight Director status by tripping the electric trim switch, or using the {AP ENG} button. The {FD} button on the control panel has no effect in such a situation. Using the red yoke button will turn off both autopilot and flight director.

When switching between autopilot and flight director, the horizontal and vertical mode(s) selected remain the same.

What the Autopilot Cannot Do

The primary input sensor to the autopilot is the **pilot's vacuum powered Attitude Indicator KI 256. If this instrument fails, or if the vacuum pressure fails, the autopilot is unusable.** The AI requires at least 4.5 " Hg to function, and it has no warning flag. The low vacuum annunciator—if it has not been disconnected as recommended by Piper Service Bulletin No 947, does not illuminate until 4.2" Hg below that necessary for attitude indicator function. The same bulletin recommends a placard warning the low vacuum light is inoperative and advises kits to correct the problem will be available soon. Many operators have opted to install the placard but not disconnect the vacuum indicator which, when lighted, properly indicates a low vacuum condition. Lack of the annunciator doesn't confirm that vacuum pressure is sufficient.

The King 150 autopilot does not have airspeed input, nor does it control engine power or aircraft configuration. The pilot must adjust power as needed to satisfy desired aircraft performance. **The autopilot cannot sense overspeed or approaching stall.** At best, the autopilot will disconnect after a stall has progressed to an unacceptable pitch attitude or rate of roll.

The King 150 autopilot is not altitude or airspeed compensated. It responds with the same control force regardless of air density or velocity. Thus the autopilot may function well at one altitude and not be as stable at another. It is completely unaware of absolute (agl) altitude and will not protect the aircraft from impacting the terrain.

The autopilot cannot be used to land the aircraft. It has no ability to command a round out, or to correct for crosswind with a slip. Except for test purposes, it should not be engaged when on the ground, and should not be used for takeoff. It should never be engaged below 200 feet. The maximum airspeed with the autopilot engaged is 185 KIAS, and the maximum fuel imbalance is 10 gallons.

The autopilot must be watched carefully. It is simply a tool and cannot substitute for a human pilot. Many Malibu and Mirage pilots have documented unexplained excursions while the autopilot is engaged. Occasionally an altitude or radio course will not be captured. The autopilot can be disengaged inadvertently. For example, a long sleeve shirt cuff brushing against the trim switch may disconnect the autopilot.

Trim

The autopilot has only pitch autotrim. Rudder trim remains under the manual control of the pilot. The pilot is merely tightening or loosening a spring to counter the force against the rudder. Aileron trim is by an aluminum tab on the right aileron, adjustable only on the ground.

When the autopilot is not engaged, the manual electric trim is activated by the yoke mounted split switch. The pilot's electric trim switch has precedence over the copilot's control. When the autopilot is engaged, activating the trim switch disconnects the autopilot, which defaults to Flight Director status.

Vertical Speed Mode

When the inner knob is pulled out to set vertical speed, the outside knob changes vertical speed in 1,000-foot increments. This can be confusing when 600 fpm UP changes to 400 fpm DOWN with one click of the large knob.

If vertical speed is engaged without the setting knob in the out position, the vertical speed captured will be that commanded by the command bars or the current vertical speed of the aircraft, which may not necessarily be what you want.

Be particularly careful using the CWS while in VS mode. If for example during a climb, ATC requests you suddenly descend to an altitude you already passed, you properly depress the CWS switch and lower the nose until the new target altitude is reached. When you make such a rapid change, check the command bars before releasing the CWS. If the CWS is released immediately, the altitude preselect will interpret this as a resetting of the VS to the new rapid descent.

However, if the CWS button is held long enough to allow the airplane to stabilize at the new altitude before release, the airplane will remain at that level. Allowing the airplane to stabilize straight and level while holding the CWS zeros the vertical speed preselect.

There are three ways to change vertical speed when Vertical Speed Mode is already engaged.

1. Dial it in directly on the preselect after pulling the inner knob out.

2. Use control wheel steering (CWS). Depress it, adjust the attitude so the aircraft assumes the vertical speed desired, and then release the CWS switch. The vertical speed is momentarily indicated on the KAS 297B.

3. Use the rocker switch (up or down) to increase or decrease the vertical rate. The vertical speed is momentarily displayed.

How do you know when vertical speed is correctly set ? If in Vertical Speed Mode—the <VS> annunciator lighted on the preselect—depress the CWS switch. The current vertical speed will be annunciated as long as the CWS is held. If pitch is changed, the new vertical speed will be captured when the CWS switch is released. The rocker switch on the control panel, if briefly activated, will display the vertical speed for about two seconds.

Yaw Damper (or yaw dampener)

Control of the "third axis" is by the optional yaw damper. Yaw is particularly disturbing to passengers who sit at a distance behind the vertical axis. It is less disturbing to the pilot and crew who sit near or forward of the axis. The amount of yaw present at the instrument panel is indicated by the ball in the race. The rather simple Malibu/Mirage damper is properly activated after the airplane is established in straight flight (including climb or descent) in trim with a centered ball. It should not be activated while in turns or uncoordinated flight.

The damper does not sense slip or skid. If the aircraft doesn't have a centered ball, the yaw damper will maintain the slip or skid present when engaged. The yaw damper must be reengaged if the regime of flight changes—from climb or descent to straight and level, and vice versa. If the damper is not disengaged and reengaged, it will maintain the same degree of rudder control fighting the pilot's attempt to manually change rudder trim. Unfortunately, the yaw damper is automatically engaged when the autopilot is directly engaged and will maintain the established yaw.

If autopilot mode is entered from flight director mode, the yaw damper is NOT automatically engaged. The rudder can be manually trimmed before the yaw damper is engaged.

The yaw damper must be disconnected before an approach to land, or the damper will fight attempts to cross control necessary for a crosswind. Unlike the other two autopilot axis—roll and pitch—the yaw damper can be engaged alone and used while flying the airplane manually.

In-Flight Autopilot Exercises

The following exercises should be carried out in strictly VFR conditions, at a safe altitude, and with a check pilot who is familiar with the KFC 150.

1. Try each of six methods to turn off the autopilot.

   1) Trim Switch, 2) FD Button, 3) AP ENG Button, 4) Red Yoke Disconnect Button, 5) Radio Master, 6) Circuit Breaker

2. While in Attitude Hold, vary pitch using two methods:

   1) CWS, 2) Rocker Switch

3. Vary altitude while in Altitude Hold using two methods:

   1) CWS, 2) Rocker Switch

4. While in Altitude Hold, disengage for turbulence, and configure aircraft for V_A.

5. Vary vertical speed while in VS mode using three methods:

   1) Knob on Vertical Speed Module, 2) CWS, 3) Rocker Switch

6. While in Vertical Speed Mode, disengage for turbulence and configure aircraft for V_A.

7. Recovery from miss trim.

   Override autopilot with pitch until autotrim significantly displaces elevator trim. Disconnect the autopilot, and recover. This will require strong arm correction of pitch, and manual retrimming if the manual electric trim has been disconnected.

8. Recovery from overcontrol of pitch.

   Override autopilot with pitch until autotrim significantly displaces elevator trim. Release the control wheel and watch the autopilot recover. Don't allow the aircraft to stall or overspeed. Be prepared to disconnect the autopilot and correct trim manually.

9. Altimeter Setting Change.

   With the autopilot in vertical speed mode (up or down), rapidly change the altimeter setting at least 1 inch. To prevent significant porpoising, vertical speed must be temporarily disconnected. (Unless modification #3 has been installed, in which case altimeter setting should not affect the vertical speed.) Hold the CWS depressed while changing the setting. Alternatively remain coupled to the autopilot, but prevent the excursions by disengaging VS.

10. Sample Set-up for a Nonprecision Approach: Intercept and Track NAV, APP, or BC

Prior to FAF:

ALT Off

Set Alt Preselect to MDA

Set Vertical Speed for Go Around (Up 1,000 ft/min)

Leave Knob Out

Set Heading Bug to Go Around Heading

At FAF: Gear Down, CWS Pitch Down to Desired Airspeed

At MDA: Capture of Preselected Altitude, Add Power

At MAP:

Engage VS (Up 1,000 ft/min already set in KAS 297B)

Pitch to Bars, Add Power, Turn to Heading.

11. Sample Set-up for a Precision Approach: Intercept and Track LOC

Prior to FAF:

Engage GS

ALT Off

Set Alt Preselect to DH

Set Vertical Speed for Go Around (Up 1,000 ft/min)

Leave Knob Out

Set Heading Bug to Go Around Heading

At FAF: Gear Down, CWS Pitch Down to Desired Airspeed

At DH:

Engage VS (Up 1,000 ft/min already set in KAS 297B)

Pitch to Bars

Add Power, Turn to Heading.

12. Intercept and fly a Localizer Back Course (or fly outbound on an ILS course).

    The OBS must be set to Inbound (LOC) Course, autopilot should be engaged in BC Mode.

Ditching

Modified from the original supplied courtesy John Mariani, CFI, A. Excerpted in part from the Airman's Information Manual *(AIM).*

PA-46 aircraft have been involved in three known water landings. Successful ditchings depend on three key factors: sea conditions and wind velocity and direction, aircraft type, and pilot skill and technique. Wind direction and velocity can be estimated by observing wind streaks on the water and the sea state, respectively. As wind velocity increases, wind streaks become more prominent, heights of waves increases, and white caps are more visible.

Planning

1. For extended flight overwater, file a flight plan and stay in radio contact with ATC.
2. Brief passengers on use of survival gear (life jackets and raft), operation of doors, seating for ditching, and assignment of tasks. Life jackets should be readily accessible.
3. If no qualified copilot is aboard, the PIC should wear a life jacket for overwater portions of flight.
4. Use the highest enroute altitude practical.

Ditching

1. At power failure, if attempts to restart are unsuccessful, establish best glide (90 knots, prop control full aft) if land or a ship can be reached from present position. If no land or ship is within reach, establish minimum sink (80 knots, prop control fully aft) to maximize time before ditching.
2. Set transponder to 7700, activate ELT, and alert ATC of best estimate of aircraft position.
3. All occupants should don life jackets, but not inflate them. Remove shoes, neckties, dentures, and glasses unless required for flying duties.
4. At altitude, determine configuration of swells (not local waves) and decide direction of ditching. Always ditch parallel to swells and into the wind as much as possible. It is best to land along back or crest of swells, never ditch against swells.
5. Secure all loose objects by placing them in rear baggage compartment with baggage net secured. Place raft and survival kit in accessible position—on one of center seats, secured with safety belt.
6. At 1,000 feet above the sea, approximately one minute before touchdown:
    a. Resume best glide speed, 90 knots, for better maneuvering.
    b. Remove emergency door and throw overboard.
    c. Leave flaps and gear in up position throughout ditching.
    d. Turn off master switch and fuel selector.
    e. Pilot and copilot unplug and remove headsets.
    f. Each occupant should be seated with lap and shoulder harness worn tightly. Use cushioning material for head.
7. Touchdown:
    a. Make initial touchdown parallel to swells with 5- to 8-degree nose up attitude.
    b. Height may be difficult to judge over water, therefore do not plan a flare. Do not stall the airplane, but touch down as slow as possible.

Note: With calm wind and smooth surface conditions, it is easy to misjudge altitude above the water by 50 feet or more. If possible, throw out a seat cushion for better surface reference. Maintain the minimum sink rate possible at touchdown. At night, make an instrument landing, if possible, and maintain a vertical speed of 100 feet per minute or less at touchdown.

c. Maintain wings level with water. Do not compensate for crosswind.

d. After initial touchdown, which is often a skip, apply maximum up elevator while maintaining wings parallel to water; second impact will probably be more severe than first due to lower elevator effectiveness and nose beginning to dig in.

8. After touchdown, aircraft will come to rest in nose down attitude. Assume 60 seconds of flotation.

   a. Unfasten seat belts.

   b. Evacuate airplane in orderly, but rapid, manner through most convenient exit. If water level is above hinge of main lower door, open only main upper door.

   c. Occupant in charge of raft will throw raft outside of airplane and inflate while holding on to raft lanyard.

   d. When outside cabin, inflate life jackets and get into raft.

   e. Survival at Sea:

      (1) Immediate action: Stay clear of the aircraft and out of fuel-saturated water.

      (2) Flotation device: Salvage floating equipment:

         (a) Stow and secure all items in raft.

         (b) Bail water out of raft.

         (c) Take precautions not to snag raft with shoes or sharp objects.

      (3) Cold climate:

         (a) Rig a windbreak, spray shield, and canopy for protection from chilling winds.

         (b) Exercise regularly.

      (4) Warm climate:

         (a) Rig a sunshade.

         (b) Keep skin covered.

         (c) Use sunscreen to protect skin and lips from sunburn.

      (5) Signaling Equipment: Prepare signaling devices for instant use.

      Note: *Keep compasses, watches, matches, and lighters dry. Place them in waterproof containers.*

9. Additional information about ditching and survival at sea can be found in the *Airman's Information Manual* and *AOPA's Aviation USA*. The Air Safety Foundation tried to contact the pilots of the Malibu/Mirage aircraft that ditched. This was done in an attempt to obtain information such as: How was the aircraft loaded (passengers, fuel)? What were the wind and sea conditions? Did the aircraft land into the wind, parallel to the swells? How long did the aircraft remain afloat?, etc. This was done in an effort to compile information that could have been passed to other pilots to improve their chances of survival in the unlikely event that they would someday have to ditch. Unfortunately, none of the three pilots involved could be located.

Ditching

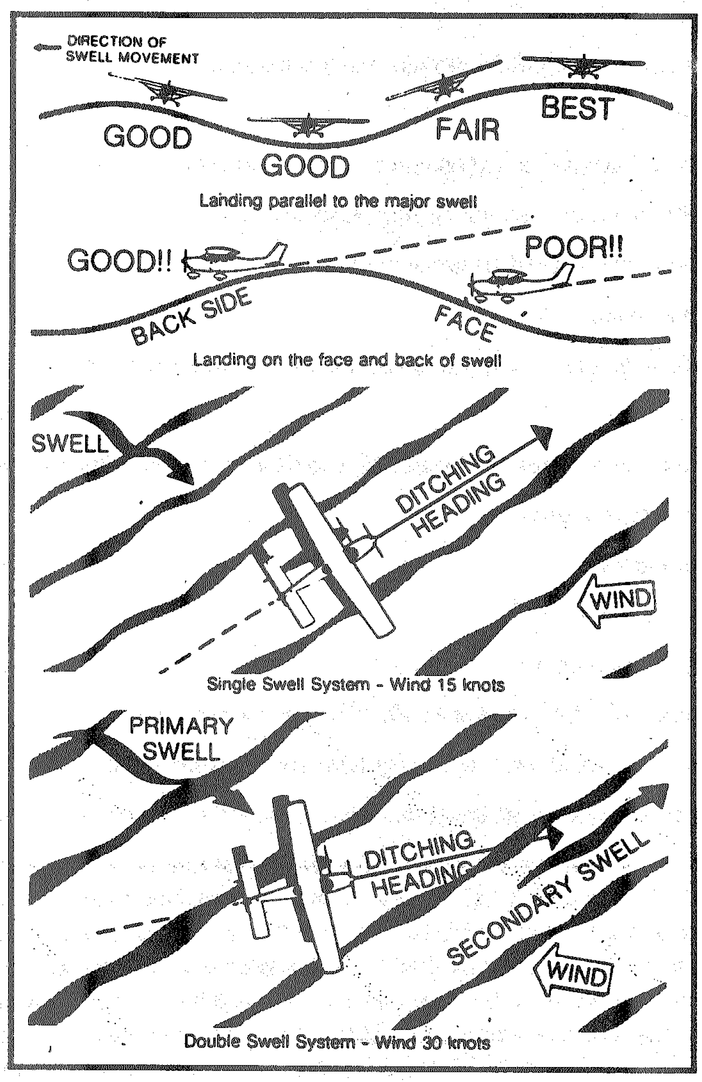
Wind speed:

Calm seas with no waves .... 0 to 10 knots
Scattered white caps .... 10 to 20 knots
Many white caps .... 20 to 30 knots
Streaks of foam .... 30 to 40 knots
Spray from the wave crest .... 40 to more than 50 knots

Note: If 25 knots or greater, choose a ditching heading that quarters into both the wind and a major swell (see the accompanying illustration).

Best ditching configuration:

1. Gear up.
2. Full flaps (high-wing aircraft).



Part 4

A Series of Piper Malibu/Mirage Model 46

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Reprinted From: The *AOPA Pilot* Magazine, February 1984

The Malibu Makes It

Flying the first of the future Pipers

By Edward G. Tripp

"Is that the new Beech?" "No, it's the new Piper." "It doesn't look like a Piper." Within minutes of the time we parked at the fueling area in San Jose, California, at least six people made similar remarks. All the rest of the pilots who thronged to the new Malibu just admired, poked, and asked questions such as, "What'll she do?"

N4319M is the fifth production Malibu. It already had been delivered to a retail customer, leased back to Piper and flown for 30 hours when *Pilot* creative director Art Davis and I flew to San Jose to make our first flight in Piper's stunning new single. What was supposed to have been a week with the PA-46-310P had to be compressed into one day due to aircraft scheduling problems and the very understandable desire of the purchaser to use his new machine.

All of us who had seen the prototype and read the specifications were impressed and anxious to see if the Malibu lived up to its very ambitious advance billing. The final word from the factory was that performance had been improved over the original claims. For instance, 75 percent cruise at 25,000 feet has increased from 208 to 215 knots. What Piper officials are not happy to talk about is the failure to obtain known icing certification, something they had promised would be accomplished by the time retail deliveries commenced. (The first delivery was supposed to have been made in August, 1983; it did not occur until November.) The company announced during the Paris Air Show last year that all work on obtaining the certification was complete except for flights in natural icing conditions.

This is not necessarily a reflection on the characteristics of the aircraft. There is considerable speculation in the industry that the Federal Aviation Administration is changing its approach to icing approval, and that it may decide not to certificate aircraft for known icing flight in the future. One source speculated that the FAA merely may note that an aircraft is equipped with sufficient anti-ice and/or deice equipment. Several attempts have been made to verify the rumors, but we have yet to get confirmation or denial. The Malibu is the second Piper single slated to be certificated for known icing that has not been approved. More than two years ago Piper announced plans to obtain known icing certification for the Saratoga, but that has yet to occur. Another significant difference between original and final specifications is weight. The goal was for an empty weight of 2,275 pounds and a maximum ramp weight of 3,867 pounds. These have increased to 2,606 and 4,116 pounds, respectively. Useful load is about 80 pounds below design goal.

The basic weight of N4319M is 2,772 pounds, which includes 165 pounds of optional equipment, including a 64-pound known icing package (all of which was disconnected), Sperry WeatherScout I color radar (17.4 pounds), air conditioning (59.9 pounds), and a Scott canister emergency oxygen system (8.5 pounds) that is based on one designed for McDonnell Douglas' DC-10. Payload with full fuel is 624 pounds, equal to that of several pressurized twin-engine aircraft of similiar performance. N4319M is a representative Malibu as equipped.

The many people who comment that the Malibu does not look like a Piper—at least not a Piper single—are correct. Rather than adapt an existing design to a new mission—the way the basic PA-28 Cherokee grew into retractables and twins, got a new wing, and was stretched to six- and seven-place singles and twins—the company started from scratch with performance and occupant comfort goals. These included on-purpose operation at high altitude with attendant environmental, range, and other performance considerations. Piper teamed with Teledyne Continental Motors to develop a piston engine that would work in the adverse conditions of high, thin air (see "Power for the Malibu: Run Lean, Run High," p. 4-7). When the powerplant originally was announced, it was to have an initial time between overhauls (TBO) of 1,600 hours; that has been changed to 2,000 hours.

The end product is a large, handsome, and truly untraditional Piper single. While the principal structure is conventional aluminum alloy, extensive use is made of flush riveting, and skins are butted end-to-end rather than lapped, to minimize aerodynamic drag. In this respect, it is cousin to the Aerostar (and shares the same production facility). Bonding has replaced rivets in much of the internal structure. According to the company, this provides a two-to-one advantage over rivets in terms of strength-to-weight, enables design shape to be held on the production line more closely, reduces vibration, improves fatigue characteristics, and provides a smoother surface. It also results in manufacturing efficiencies. Computer-aided design has been applied in the development and refinement of the Malibu, and computer-aided manufacturing is employed on the production line.

The high aspect-ratio wings span 43 feet. Each contains a 61-gallon (60 usable) integral fuel cell. Each wing tank feeds into a collector sump; a two-stage electric boost pump is submerged in the sump that is activated when the pilot selects either left or right tank. Each wing-tank system also has an independent, non-icing vent system.

The ailerons and flaps are fairly wide span. The hydraulically controlled, mechanically actuated flaps extend both aft and down and help make the spread between stall and top speed at sea level 124 knots (59 and 183 knots, respectively, according to the most recent performance specifications; top speed at 23,000 feet is 234 knots). The ailerons and one-piece elevator are mass balanced. A single trim anti-servo tab is mounted in the center of the elevator. All primary flight controls are cable controlled; the rudder and ailerons are interconnected by a spring system.

The landing gear is actuated by an electrically driven, hydraulically actuated system. The nose gear rotates 90 degrees to lie flat in the nosewheel bay when retracted. The hydraulic uplocks will keep the gear retracted in the event of hydraulic system failure so long as the gear selector is up. The emergency extension system is free-fall; downlocks are mechanical. The gear and flap systems share the primary hydraulic system. A separate hydraulic system actuates the brakes.

The engine compartment is tight, to put it mildly. A large nose baggage compartment separates the pressure vessel from the powerplant and helps isolate the cabin from noise and vibration. It also permits more loading flexibility to maintain weight and balance within limits.

Quite a few pilots have reacted skeptically to Piper's claim that the Malibu is a cabin-class airplane. But once you step through the clamshell door you probably will agree with its claim. The door has automatically deploying and retracting steps on the lower half; both halves and their supports are beefy. The locking mechanism is one large handle, and there are sight gauges to ensure all the locking pins are engaged.

The cabin is light and airy. Club seating is standard. Leg room is quite good, and all the seats recline and are equipped with cup holders, reading lights, and ventilation outlets. The fifth and sixth seats can be equipped with inertia reel harnesses (they should be standard), which are standard equipment for the crew seats. A 20-cubic-foot baggage compartment is located behind the last row of seats, within the pressure vessel. There are stowage bins below the third and fourth seats. Cabin options include leather seats, a folding writing table, refreshment cabinets, and a Wulfsberg Flitefone.

Access to the cockpit is fairly easy, and it is wide, comfortable, and well organized. Even with the optional sets of basic copilot and radar flight instruments installed, there is a lot of room left over on the panel. Several built-in features add to pilot comfort, such as large map pockets in front of the arm rests on either cockpit side wall and individually controlled heated air outlets aimed at the crew's feet. Seats adjust fore and aft and recline. Vertically adjusting seats are an option, part of the so-called Executive Group ($2,130 and 17.4 pounds) that is not really an option. It includes an ELT as well as an external power source, true airspeed indicator, locking fuel caps, and a polished spinner.

Organization and location of systems in the cockpit are good. The electrical system, which includes an emergency bus, has resettable circuit breakers throughout rather than the "push to reset when it pops only" type still found in so many aircraft. The biggest advantage is that systems can be isolated in the event of faults or electrical fires. Large rocker switches operate most systems, and they are grouped logically by function. Primary flight and navigation instruments are arranged in the standard pattern in front of the pilot, with engine gauges to the right and principal environmental controls to the left. A panel of 12 annunciator lights surmount the engine gauges. The power quadrant and trim controls are on a central console below the radio stack. The panel is finished in a businesslike gray paint; the absence of simulated wood grain plastic trim is welcome.

It is a utilitarian cockpit; easy to work in, easy to learn, and comfortable for long flights at altitude. The only feature I found to fault during our time with the aircraft is that the main spar carry-through intrudes on your backside when the seat is fully aft, fitting between the seat back and bottom cushion. Elbow and shoulder room is as good as that in many larger aircraft.

All in all, during our few hours in the Malibu at temperatures ranging from plus 20 degrees C to minus 26 degrees C, the cockpit and cabin were comfortable. Pressurization air is supplied by engine bleed air and is passed over a heat exchanger that can be fed by either ambient air or heated air from an exhaust shroud.

Davis and I flew with Joseph Ponte, Jr., Piper's manager of press relations, who had been through the factory school and had flown this and other Malibus for several hours. While a few hours in an airplane, particularly when compressed into a single day, with no time for reflection, variations in atmospheric conditions, and additional checking, does not constitute an evaluation, we sampled as great a variety of missions and situations as possible.

Preflight is simple and conventional. However, there are some cautions to be observed on refueling. The aircraft should be wings level to ensure that a balanced fuel load is maintained and to ensure that the system is filled to capacity. The Malibu probably is an aircraft for which special attention should be paid to temperature variations to preclude stress on the tanks and wings or, at the very least, expansion and loss of fuel through the vents. There always is mild positive pressure in the tanks, so care should be taken when opening the filler caps, particularly in high temperatures. There are only three fuel drains: one for each tank and a fuel filter sump drain low on the right side of the cowl.

Close attention should be paid to oil level, since the shallow sump has a maximum capacity of 8 quarts; Continental recommends it be full for long flights.

Cockpit checks and prestart to takeoff procedures are not complicated for an aircraft of this category and capability, but the check lists should be followed methodically and meticulously. Starting procedures are straightforward. What struck me on the first start were the low noise level and relative absence of vibration.

Taxiing and ground handling were pleasant surprises. I had anticipated ponderous movement with the heavy engine slung way out front, poor visibility over the nose, high pedal pressures, and lots of concern with the long wings. Only the latter proved true, and aside from the care needed to ensure clearance, ground handling is easy.

We flew the Malibu for just less than six hours that day. Operations included climb to and cruise at maximum operating altitude, cruise at middle and low altitude, emergency descents, a variety of approaches and landings, airwork, balked landings in a variety of configurations, and missed approaches.

Weight at initial takeoff was just less than 4,000 pounds. Our first task was to climb as quickly as ATC would permit to 25,000 feet. We rotated at 77 knots, accelerated to best-rate-of-climb speed of 110 knots while the gear was coming up, then settled on a cruise climb of 130. The assumption about vision over the nose was proven wrong more definitely: Visibility is good.

We did not get an unrestricted climb and were forced to level at intermediate altitudes twice. However, we averaged just less than 1,000 fpm to FL250. Passing through FL240, with indicated speed down to 105 knots with power set at 2,400 rpm and 32.2 inches of manifold pressure, the rate of climb was still 800 fpm. Cylinder head and oil temperatures were well in the green all the way up; average air temperatures were 10 degrees above standard.

We headed east toward Reno, Nevada, on a round robin that would terminate at Sacramento, California, to sample cruise performance and handling at altitude. We had hoped to find turbulence, but the best we could encounter was mild, continuous chop. I alternately hand flew and employed the flight control system, a King KFC 150 (King's KAP 150 autopilot is standard). Even maneuvers in the chop at altitude were good and solid.

Different cruise power settings, from 75 to 55 percent, were just about at book figures: 215 down to 186 knots. So was fuel burn. Above critical altitude (about 23,000 feet), leaning takes great care since the sloped controller for the turbocharger begins to act just like a fixed wastegate. Adjustment to any engine parameter—particularly mixture or manifold pressure—changes another, and the leaning process is a series of adjustments to throttle and mixture control. The engine is designed to be run at power settings of 75 percent and lower, with the mixture leaned to 50 degrees on the lean side of peak turbine inlet temperature (TIT). Fortunately for nervous nellies like me, the TIT gauge is large; small incremental changes are easy to make—after a bit of practice.

Indicated cabin altitude at FL250 was maintained at a comfortable 8,600 feet. Airflow for ventilation was good, temperature control easy; conversation between the cockpit and the back of the cabin was easy, too. And, during one leg at 65 percent power, true airspeed at 200 knots, the DME readout was touching 300 knots. ATC alternately was calling us a Cheyenne and asking what a Malibu was. It was great fun. Fuel burn at 55 percent power is 12 gph. With the wind at your back and more than a seven-hour endurance, you could cover a lot of country nonstop. In the right conditions, coast-to-coast flights with standard fuel are possible.

Westbound, we received clearance for an emergency descent to 12,000 feet. I extended the Malibu's landing gear, reduced manifold pressure to 20 inches (which will hold pressurization). In this configuration, you can go right up to 200 knots indicated in smooth air. I did not go above 185 knots, but the aircraft's vertical speed indicator was pegged at 4,000 fpm. At 170 knots, our rate of descent was 3,500 fpm. A brief 75-percent cruise check at 12,000 feet produced a true airspeed of 186 knots, quite good in the denser air.

For quite a while we orbited east of Sacramento doing stall series, steep turns, simulated missed approaches and slow flight in all configurations. The Malibu is solid and responsive throughout, down to minimum flying speed, although pitch sensitivity is a bit more pronounced at very slow speeds. There was a mild buffet preceding the stalls; in aggravated stalls and improper input, the break and departure were more pronounced but recovery was quick and straightforward.

During one simulated balked landing with gear and full flaps, I applied climb power without cleaning the airplane up; the Malibu's indicated rate of climb was still 700 fpm.

I made a few approaches at various airspeeds and settled on 120 as the most comfortable speed right down to final. My first impression is that it is a solid, stable instrument platform. Behavior in landing is unremarkable; that is to say, good.

During the photo mission, a type of flight where the pilot's attention is directed outside of the airplane, the Malibu again displayed its easy flying qualities.

Flying the Malibu is a pleasure; it makes few demands. The demands all should be satisfied before you fly, starting with specifying the optional extras. At base price, the airplane meets all requirements for basic IFR flight with the single exception of an ELT, and it includes a few things, such as an autopilot, that are not mandatory, yet are highly recommended. Anyone considering an aircraft of the Malibu's capabilities should recognize the hostile environment in which it is designed to operate.

Some of the options should be considered necessities. The 60-amp alternator is not sufficient to handle all the electrical loads in all types of flight, and there should be a dual system to provide back up. The same goes for the single vacuum system.

Icing encounters at altitude are prevalent in the summer and in warm climates. Even without known icing approval, the package should be installed. It is expensive ($20,160), but important. And, it includes dual alternator and vacuum systems.

Some method of weather avoidance should be included, also. Piper offers both the already mentioned Sperry radar and 3M's WX10 Stormscope.

One piece of equipment I could not find on the option list that should be standard on any aircraft that is built to fly at high altitude is a counter drum pointer altimeter. It is just too easy to misread the old-fashion double pointer altimeters, particularly if the pilot is distracted during climb or descent.

Corrosion protection and stainless control cables ($1,495 and $230) should be included.

The other advance work that should be undertaken by pilots moving up to any high-performance, high-altitude aircraft is pilot preparation. As easy as the Malibu is to fly, it is a systems airplane. Piper's school is up and running, and it provides the best way to learn the systems and related operational considerations and is the proper way to get checked-out.

For anyone who has not had it, the physiological training—including life in the altitude chamber—offered through the Chief of Physiological Training, AAC-143, FAA Aeronautical Center, Post Office Box 25082, Oklahoma City, Oklahoma 73125, should be essential. So should the Jet Transition course offered by FlightSafety International or its equivalent. While the Piper school treats the subjects covered in these programs, it cannot be as thorough.

The Malibu is a significant development. The appeal of a pressurized single already has been proven by Cessna. As best we can tell from our brief exposure, the Malibu is a large improvement.

There are a few considerations that are open questions. If known icing certification is not obtained, the operational utility of the Malibu will be restricted significantly. Only time will tell how successful Teledyne Continental's new engine development is. And there is a surprising number of operators who dislike Teledyne Continental products because of expensive operational problems. In our one-day flight of the Malibu, I heard from four of them who would not consider buying the aircraft because of the engine selection. Good operational results undoubtedly will make converts.

Piper decided to certificate the Malibu with fixed cowl flaps. My preference is for movable ones for several reasons, principally better engine temperature control in extreme cold and heat. Properly designed, they should add a bit to cruise speeds.

One of the operational proofs that will be determined by owner operation as opposed to factory-controlled testing is operation in high temperature. This is an area I have found to be a shortcoming with the P210 (although a new version, scheduled for introduction in April, includes aftercooling, which should offer improved performance).

Maintainability is another quality that will have to be demonstrated in the real world. Some preventive maintenance program should be considered.

I would like to have had the chance to fly the Malibu in icing conditions, turbulence, high ambient temperatures, and in heavy precipitation (the current static discharge system may not be adequate). To tell the truth, I would just plain like to fly it more. A lot more.

The market already has responded favorably to the aircraft. One dealer told *Pilot* senior editor Mark Lacagnina that he could sell five more immediately, and that Piper should double the production rate. According to the company, production is completely sold through this year.

The Malibu is a definite advance and has the systems, climb, cruise speed, and descent performance to live in the high-altitude, long-distance world. You can bet it is the first of a new family of Piper aircraft.

Reprinted From: The *AOPA Pilot* Magazine, February 1984

Power for the Malibu: Run Lean, Run High

By Mark M. Lacagnina

TS10-520 is a familiar engine designation. It identifies a series of turbosupercharged, fuel-injected, opposed, 520-cubic-inch displacement engines produced by Teledyne Continental Motors. In various forms, Teledyne's TS10-520 engine powers a number of high-performance singles and light twins.

The engine in Piper Aircraft's new Malibu bears the same basic identification; but according to engineers at both Piper and Continental, the Malibu's engine is significantly different in the way it was designed and in the way it operates.

It is not uncommon for aircraft manufacturers to select a particular engine for a new or modified airframe. However, when Piper began designing the Malibu, it was not satisfied with existing products. So, the company furnished the expected size and performance specifications and asked the engine builders to propose designs that would meet the basic specifications.

Continental won the contract with its proposal for a brand-new 520-series engine, the TS10-520-BE. Continental officials are enthusiastic about the manner in which the project was conducted, and they are proud of the engine they came up with. "We were given enough latitude to build an engine to meet the requirements of the airplane," a Continental spokesman said. "It was the kind of design freedom that we do not see often." The company was so pleased with the results that it recommended a 2,000-hour time between major overhauls (TBO) for the new engine.

The Malibu's engine produces 310 horsepower at 2,600 rpm and 38 inches of manifold pressure. It includes a standard TSIO-520 counterweighted crankshaft and crankcase with heavier cylinders from Continental's geared engines, which produce 435 horsepower in some installations.

Total dry weight of the engine is 565.5 pounds. Bore (the diameter of each of the six cylinders) is 5.25 inches; stroke (piston travel within the cylinder) is four inches; compression ratio is 7.5:1.

Continental engineer Bob Minnis, who directed the company's design efforts for the engine, said its most important features are the aftercoolers (intercoolers), tuned induction system, dual-stage fuel pump, and oil sump.

The engine has two Garrett AiResearch turbosuperchargers, each with an aftercooler. An aftercooler basically is a radiator. As air is compressed by a turbocharger compressor, it becomes very hot. When the compressor discharge air is passed through the core of an aftercooler before entering the intake manifold, some of the heat is transferred to the aftercooler's cooling fins and is carried away by ram airflow.

Continental routinely tests its engines under conditions that will produce the hottest induction air. Some compressors in engines rated at or near 300 hp discharge air at a scalding 300 degrees F. However, the company said that, during tests of the Malibu's engine under the most severe conditions, the maximum induction air temperature reached was 130 degrees F.

In addition to aftercoolers, the turbosupercharging system includes a sloped pressure controller, an overpressure relief valve, a variable wastegate assembly, and sonic venturis. The sloped pressure controller is a fairly new system developed by Garrett. It incorporates a diaphragm, which adjusts intake pressure to compressor discharge pressure. During part throttle operation, deck pressure (pressure between the compressors and the intake manifold) is lower, resulting in cooler and more efficient engine operation. The sonic venturis, located on the outflow sides of the aftercoolers, channel air into the cabin pressurization system.

According to Continental, much of its design effort focused on tuning the induction system to provide an even distribution of air and fuel to each of the six cylinders for uniform combustion efficiencies.

Many turbosupercharged engines experienced fuel-flow fluctuations at high altitude due to negative pressures produced at their fuel pump inlets. To preclude this problem, Continental designed a two-stage fuel pump. The first-stage pump maintains a low, constant pressure on the second-stage pump, ensuring positive fuel flow. There is an electric fuel pump to back up the two-stage, engine-driven pump.

As installed in the Malibu, the TSIO-520-BE engine is tightly cowled. Continental said extensive effort was devoted to the design of a shallow oil sump for the engine. The wet sump holds only 8 quarts of oil, as compared with 10 to 12 quarts in other 520-series engines. However, Continental said almost all of the oil in the new sump is usable. The company noted that up to 3 quarts of oil are unusable in the deeper sumps of other high-performance engines.

The Malibu's engine is designed to be run at 50 degrees lean of peak turbine inlet temperature (TIT) when the airplane is cruising at 80-percent power or less. (Leaning the fuel/air mixture is not approved during climb.) For some pilots used to flying other turbosupercharged airplanes, this procedure may appear questionable. However, a Malibu pilot who shies from following the approved leaning procedure may be doing his engine harm. The procedure is approved only when running at 80-percent power and below. But, setting the prescribed manifold pressure and rpm for 80-percent power and leaning slightly rich of peak will result in more than 80-percent power, thus causing internal temperatures to rise beyond the engine's tolerances.

Operating lean of peak TIT, however, requires some faith in the engine instruments. There are two temperature probes, one in each turbosupercharger turbine inlet. Readings from these probes are averaged and sent to the panel-mounted TIT gauge. Since there is room for error in the temperature-sensing system, it should be checked and calibrated regularly. One engineer recommended that the system be checked every 100 hours.

According to Continental, one of the most potentially harmful consequences of running lean of peak TIT is exhaust system corrosion because of extra heat and oxygen. To combat this potential problem, Continental fabricates portions of the exhaust systems with Inconel, an expensive chromium-iron alloy that can withstand higher temperatures and rejects corrosion.

When operated according to approved procedures, the engine has a specific fuel consumption of 0.395 pounds of fuel per horsepower per hour. The specific fuel consumption of similar engines typically is 0.42 pounds of fuel per horsepower per hour.

A few other items are worthy of mention. The engine has pressurized Slick Electro 6220 magnetos to ensure proper ignition at high altitude. In addition, the upper ring land in each piston has a steel insert that prevents the ring from fluttering at low power settings and during steep descents. Continental also has improved the heat treatment of exhaust and intake valves. According to the company, the new process provides harder and slightly stronger valves.

Continental said the TS10-520-BE engine is capable of producing much more than 310 horsepower and of operating much higher than the Malibu's 25,000-foot maximum certificated operating altitude. (Piper chose not to certify the Malibu for operations at higher altitudes since the regulations require more extensive—and expensive—structures and systems, such as double-pane windows.)

One Continental spokesman noted that the TS10-520-BE actually should be loafing in the Malibu. Another spokesman said the engine is the first to get a recommended 2,000-hour TBO "right off the bat."

Piper Malibu

Vero's Hero, One Year Old

By Thomas A. Horne

The Piper Malibu, the most significant new single-engine airplane design to hit the market, continues its sales success. Since the airplane's introduction in the fall of 1983, Malibus have been leaving Piper's Vero Beach, Florida, factory at a fairly steady rate of 10 per month. It appears that the market for pressurized single-engine airplanes is alive and well.

A large part of the Malibu's success can be attributed to its advanced design methodology and its new engine technology (see "The Malibu Makes It," p. 4-2).

Piper's use of computer-assisted design/computer-assisted manufacture (CAD/CAM) has been beneficial also. Computers nearly have done away with the old-fashioned drawing-board and T-square approach to industrial design and, with it, the costly expenditure of many man-hours. Parts fit better, tolerances are narrowed, and reliability is enhanced through the use of computer modeling.

The Malibu's extensive use of metal bonding provides high strength with less weight and helps the airplane's appearance, too. There are few rivets, and the airplane's lines are smoother.

The Malibu's engine—a Teledyne Continental TS10-520-BE—has been specifically designed for low fuel consumption during high-power, high-altitude operations.

Its intercoolers act as radiators, cooling the hot, compressed air that the turbochargers send through the intake manifold. When air leaves the turbochargers' compressors, its temperature can reach 375°F. The intercoolers lower that temperature to approximately 175°F. This results in better cooling and a reduction of the heat-related wear and tear on the engine's internal components.

The Malibu in cruise must operate at a mixture setting 50 degrees lean of peak turbine inlet temperature (TIT—a measurement of the exhaust temperature as it enters the turbochargers' turbine housings). This is a limitation. Run the engine as most would be tempted—at 50 degrees rich of peak—and you will subject the engine to damaging high temperatures and internal pressures.

The lean-of-peak procedure is designed for maximum power and fuel efficiency with minimal exhaust temperatures. At cruise settings of 75-percent power or less, enriching the mixture above the recommended value will result not just in higher fuel flows, but in a detrimental boost in power. For example, at the Malibu's normal, 75-percent power setting, a too-rich condition can boost the engine to 80-percent power and beyond.

There are other features designed especially for high altitude operations. A two-stage, engine-driven fuel pump ensures that there is sufficient fuel pressure to prevent fuel flow fluctuations at high altitudes, a common problem in some other piston singles and twins. Pressurized magnetos prevent high-altitude arcing and misfiring.

Continental seems content with this very specialized variant of its 520-series engine. In spite of the new technology and the non-standard leaning procedure, the company recommended a 2,000-hour time between overhaul (TBO) of the engine from the outset of the Malibu program.

New certification requirements brought about some significant safety improvements. Those parts of the exhaust system located near flammable fluids have been shielded with aluminum guards. A battery-feeder circuit breaker can be pulled to prevent the alternators from feeding electricity to a short-circuited battery. A new lightning protection circuit (with its own circuit breaker) incorporates a varistor that only conducts electricity at very high voltages. Should a lightning strike send a voltage spike through the airplane, the lightning-protection circuit instantly grounds the main electrical bus to the airframe, sparing the electrical system from major damage.

Lightning protection also is provided for the fuel system and the nose bowl. The fuel caps and drains have been designed to eliminate the chance of arcing. The nose bowl is made of Thorstran, a lightweight composite embedded with a conductive, woven metal mesh. Wing-tip caps, traditionally made of non-conductive fiberglass, have been replaced in the Malibu with aluminum. (For more information on lightning protection, see "Skyvolts," August 1983, *Pilot*, p. 70.)

Another safety feature is the Malibu's emergency bus. Should the alternator(s) fail, the pilot can engage a battery-powered emergency bus that drives much of the essential electrical equipment needed to safely complete a flight, even in instrument meteorological conditions.

The ice-protection system has some unique aspects, too. The deice boot inflation cycle is divided into three six-second segments. This is not unusual, but the wing-boot inflation method is. The wing boots inflate in two stages: First the lower halves of the boots inflate, then the upper. Piper tried 12 different design combinations before finding one that could remove all ice accretions from the leading edges.

The fuel vents have passive anti-icing. The vents are recessed in the underside of the outboard wing panels. Supercooled droplets flow past the recessed areas without adhering.

The cost of the deicing option is $19,880, and it includes dual pneumatic pumps and dual alternators. Thus equipped, the Malibu is approved for flight in known icing conditions

With all the Malibu's innovations, one might expect a good share of problems as the new airplanes pass through the shakedown phase. There have been a few. Twelve service bulletins have been issued on the Malibu. Piper considers compliance with service bulletins mandatory.

One service bulletin, number 781, requires that the rudder cable be checked for misrouting over a cable guard. In one case, a misrouting caused a rudder cable to fail. Another bulletin, number 786, gives mechanics instructions on how to prevent the toe brake cylinders from sticking after brake release.

A report of a nose-gear steering/rotator horn failure gave rise to bulletin number 793, which contains instructions for reworking the part. The Malibu's nosewheel rotates 90 degrees as it extends and retracts. In one incident, the nosewheel remained in the 90-degree position during an approach and landing.

Perhaps the most serious and burdensome service bulletin is number 803. Some Malibu deice systems have had their pressure control valves seize. When this happens, the deice boots will not inflate. The service bulletin requires the disassembly, cleaning, and adjustment of the valve every 25 hours. Carbon dust from the pneumatic pumps combines with a waxy residue from the lining of the pneumatic hoses to foul these valves, according to Piper.

Another substantial service bulletin is number 796, which requires replacement of certain lower and upper spar-cap wing rivets. This should have been performed within 100 operating hours of the bulletin's issue date, which was August 20, 1984.

Other bulletins deal with inadvertent illumination of the oxygen-system annunciator light (number 791), electric fuel pump circuit modifications (number 794), and a modification of the landing gear control to prevent inadvertent gear retraction (number 799).

Of the Malibu's eight service letters (compliance not considered mandatory by Piper), several indicate potential problems worthy of mention: passenger seat pan cracking (number 976); shearing door step linkage rods (number 973); failures and cracking of engine baffles (number 971); and poor fits of lower halves of cabin doors (number 967).

The Malibu's 17 service difficulty reports show two vague patterns. One concerns defective electrical parts—avionics power cables, shorted battery-connector diodes, and stuck starter contacts. The other concerns cracking engine components. Cracks have been found in an oil cooler mount flange, two intercooler mounting flanges, and in turbocharger inlets and transition tubes. One report warns of a problem familiar to many owners of earlier Malibus: The magneto switch guards can contact the starter switch during a magneto check. Newer Malibus have magneto guards hinged at the bottom, which lessens the chance of inadvertently bumping the starter switch. There is only one airworthiness directive on the Malibu, and it antedates the airplane. It deals with the Hartzell propeller, and requires its overhaul at 1,500-hour or five-year intervals.

Owners, by and large, are not complaining. The airplane has too many virtues to dwell on shortcomings. Malibu owners say that the airplane lives up to its advertising claims and that it serves well as an upscale alternative to higher-cost piston twins and turboprops.

The performance is superb. At the nominal cruise altitude of 25,000 feet, the Malibu at 75-percent power turns in 215 KTAS (210 KTAS if deice boots are installed). Fuel burn is approximately 16 gph and range is just over 1,325 nm. At lower power settings, range and endurance push human limits. At 55-percent power and 25,000 feet, for example, range is 1,550 nm and endurance is eight hours. A relief tube is a $345 option.

Control feel is quite light and responsive, considering the Malibu's long wingspan and high aspect ratio. Control harmony is well balanced. The wing's efficiency is apparent immediately in several basic procedures. In slow flight, pilots will see that very little power is needed to maintain level flight. Hold the manifold pressure at 15 inches, and the airplane will continue to cruise at approximately 100 knots. During the roundout and landing flare, the airplane can float excessively if normal approach airspeeds are used. The short-field landing procedure involves mushing in at idle power with full flaps, holding 77 KIAS on a steep approach profile.

The stall is very mild. Stall strips ensure that the center sections of the wing stall first. There is no washout in the Malibu's wings, and pitch stability is augmented by an elevator downspring. At airspeeds below trim speed, the spring exerts a nose down force. If the pilot wants to fly at lower and lower airspeeds, he must pull harder and harder on the control column as he fights the downspring.

Without the downspring, the Malibu's pitch control would be too light and responsive near the stall in order to meet the FAA's certification standards. The downspring makes certain that the nose trends downward before the stall. To the pilot, behavior near the stall resembles that of any other single-engine airplane.

A rudder-aileron interconnect is installed to enhance roll stability. The Malibu has a relatively small amount of dihedral (4.5 degrees) and no differential aileron travel. To meet certification guidelines, an interconnect was needed to provide coordinated roll responses with yaw inputs. The interconnect is noticeable during the takeoff run and landing roll. Nosewheel steering is extremely sensitive, particularly if holding aileron into a crosswind.

Less conventional is the leaning procedure. With a little practice, though, it becomes easy to set power. The recommended procedure for 75-percent power is to make an initial setting of 31 inches of manifold pressure, 21-gph fuel flow, and 2,400 rpm. After waiting a few seconds to let things settle down, slowly begin leaning until the TIT gauge reaches peak temperature. Continue leaning until you have a 50-degree temperature drop. This works out to a fuel flow of approximately 16 gph. Maximum allowable continuous TIT is 1,750°F. If there is engine roughness at this setting, reduce throttle slightly—do not enrich the mixture.

Above critical altitude (the altitude at which the turbocharging system's wastegate is closed—approximately 23,000 feet), setting the mixture takes finesse. As the mixture is leaned, manifold pressure will rise. The pilot must jockey the throttle and mixture until the proper setting is established.

The airplane has been designed principally to operate at 75-percent power. This is the setting that provides the best specific fuel consumption, the best engine cooling, and the best cabin heating. For short flights at lower altitudes, Piper recommends a setting of 25 to 28 inches of manifold pressure, 19 gph, and 2,300 rpm.

The Malibu's cockpit is well designed and as spacious as that of many cabin-class twins. Storage pockets for charts, approach plates, or check lists are installed in the sidewalls. The seats are comfortable, visibility is good, and noise levels are low, partly because of the pressurized cabin and partly because of the insulation provided by the nose baggage compartment. The instruments and switches are well-arranged, with the exception of the auxiliary fuel-pump switch. It is hidden from view, directly below the pilot's control column.

The landing gear and flap controls are buried deep in their detents. It takes a healthy yank to unseat them, and it is possible to nudge the throttle when operating the gear lever.

A complete King avionics package is standard. This includes a King KAP 150 flight control system with longitudinal electric trim and compass slaving for the horizontal situation indicator. A full range of optional avionics, including Sperry WeatherScout I color radar, a 3M Stormscope, Texas Instruments' TI9100 Loran C, and a Wulfsburg Flitefone V is available.

The passengers are not neglected, either. The dimensions are those of a cabin-class twin. There is very little cabin taper, so passengers have more room. With the optional writing table and refreshment and storage cabinets, the ambience is businesslike—it gives the illusion of a much larger airplane.

At a base price of $300,000, though, one would expect something more than a run-of-the-mill airplane. A more realistic sales price, one reflecting the operational realities of an airplane of this class, would be in the neighborhood of $380,000. The Malibu's competition—the pressurized Cessna P210—sells for approximately $50,000 less when comparably equipped. Still, with more than 120 total sales of the airplane, the Malibu seems to have secured a strong niche in the pressurized single marketplace.

The reason? The Malibu's technical innovation, styling, and ergonomics come together in a revolutionary new package. The airplane captures the imagination of those who have been numbly watching a steady annual stream of reconstituted 40-year-old designs. The buyer's conscience is changing, too. If he is to pay $300,000 for a single-engine airplane, he had better get his money's worth—in both performance and image.

Here, perhaps, we draw a lesson from automotive history. If we can learn anything from Detroit's inability to compete with imports from Europe and Japan, it is that sophisticated consumers no longer will accept sluggish engineering. Cosmetic alterations no longer play such a large part in a purchaser's decision. Technology—and a vision of the future—does.

Malibu Mirage

Going the Original Malibu One Better

By Thomas A. Horne

Once a new aircraft has been introduced, it's usually only a matter of time before its manufacturer makes certain improvements to the basic design. The most predicatable of these alterations is an increase in engine power, followed by enhancements to the standard equipment package. For example, when Piper brought out the first Comanche in 1958, it came with a 180-horsepower engine. By 1972, when this product line reached its end, a single-engine Comanche with a 400-hp engine was available, and so was a twin-engine version—the Twin Comanche.

Now, Piper's latest single-engine design, the six-seat, turbocharged, pressurized Malibu, has received its first boost of extra power.

The Malibu Mirage is equipped with a 350-hp Lycoming engine, which is the biggest single change to the original design. Earlier Malibus came with 310-hp Continental engines; this airplane will no longer be manufactured.

Like its Continental predecessor, the new Lycoming engine has dual turbochargers and intercoolers and provides compressor air for pressurizing the cabin. It's the same basic engine that has seen long service powering Piper's Navajo and Chieftain line of twins.

But the Mirage's engine has some important extras, apart from the additional 40 hp. Dual 70-amp alternators are part of the standard equipment package, as are dual continuously-driven vacuum pumps. The extra power and redundancy of the Mirage's electrical systems give an assurance that adequate electrical power will be available in the event an alternator fails. The Mirage, when equipped with the optional $22,190 package of deicing components, is certified for flight into icing conditions. The Malibu Mirage's base price is $349,000.

A word about the Mirage's windshield anti-ice is in order. There are several electrically powered methods of preventing ice formations on windshields. One is to mount a heated plate on the windshield's exterior. Another is to bond heating filaments to the windshield itself. The latter method is better because it clears a larger, less obstructed viewing area. The original Malibu uses a plate; the Malibu Mirage uses the heated windshield.

The Mirage interior has also been overhauled. The seats are larger, and the pilots' seats are especially comfortable thanks to sheepskin covers, another standard feature. For an extra $485, leather seats can be ordered. Some aisle room is sacrificed with the new seats, but anyone would agree that the added comfort more than makes up for this.

Any number of avionics options may be ordered. The standard package is a full IFR complement of Bendix/King, complete with a slaved compass and a KAP 150 autopilot. An international package is available, with dual ADFs or a slaved ADF installation. An electronic horizontal situation indicator (EHSI) is also available—the Bendix/King EHI40—for those wanting the advantages of a multicolor cathode-ray tube display. Various loran receivers (and the Argus 5000 Moving Map Display) are available, as is a 3M Stormscope, Sperry WeatherScout I color radar, and a Wulfsberg Flitefone VI. An independently powered stand-by attitude gyro is among numerous other avionics and interior and exterior options.

The real pleasure is in flying the Mirage. Ground handling is conventional in all respects, with nose-wheel steering requiring very little in the way of pedal pressure. Normal takeoffs are made without flaps, and rotation is initiated at a relatively high 78 knots. Initially, a fair amount of back pressure is required to raise the nose to the climb attitude.

For optimum engine cooling and visibility, 125 knots and full throttle (not to exceed 42 inches of manifold pressure) are used for normal climbs. (V_X and V_Y are 81 and 110 knots, respectively.) For extended climbs, the first power reduction is to 35 inches of manifold pressure and 2,500 rpm. Fuel flow in the climb is approximately 37 gph. A glance at the six-point cylinder head temperature gauge—another new standard feature—showed that temperatures remained well in the green, all the way up to our cruising altitude of Flight Level 230. Time to climb was just over 21 minutes.

For a high-speed cruise setting, power was set to 32 inches of manifold pressure, with propeller rpm left at 2,500. The leaning procedure calls for pulling the mixture back to peak turbine inlet temperature (TIT), as long as the redline of 1,750 degrees is not exceeded. Our peak TIT turned out to be 1,700 degrees, as shown on the panel's prominently placed TIT gauge. Cylinder head temperatures settled at 400 degrees, well below the 500-degree redline. The fuel flow was just a hair above 20 gph. Our true airspeed was 215 knots. At the Mirage's ceiling of 25,000 feet, true airspeed is 225 knots. This represents a 10-knot increase over the earlier Malibu's high-speed cruise figures.

Along with us for the flight was Mike Fizer, our associate art director. While I flew with Piper's director of personal aircraft services, Bob Scott, Fizer took photographs and played the role of corporate chief in the aft cabin. He seemed comfortable in the large, bench-style "boss's seat" and amused himself by checking out the refreshment center and other amenities. The 5.5-psi pressurization system kept the cabin at a comfortable 7,000 feet. At the airplane's service ceiling of 25,000 feet, the cabin would be at 8,000 feet.

In the event of a rapid decompression, crew and passengers can activate any of three chemical oxygen generators. These will provide all of the airplane's occupants with 15 minutes of oxygen—enough for a descent to a safe altitude.

At normal cruise power, the Malibu Mirage's range (with IFR fuel reserves) is 1,056 nautical miles. At a long-range cruise power setting, range increases to 1,450 nm.

For the rapid descents that are frequently required when leaving the flight levels, Piper recommends several methods of increasing the Mirage's descent rate. At 165 knots, the landing gear and first increment of flaps may be extended. Set the power at 22 inches of manifold pressure and 2,500 rpm, and the Mirage will descend at a brisk 3,500 fpm. Less spectacular descents can be made by leaving the gear and flaps retracted.

Landings are conventional in most respects. VFR procedure is to extend the landing gear, use 90 knots on downwind, then reduce the airspeed to 77 on final, using full flaps. There is very little change in pitch forces with gear or flap extension. The only peculiarity is one shared with the original Malibu. The airplane's 43-foot wingspan gives a good deal of lift in ground effect, and if the airplane is flown too fast, there is a pronounced tendency to float.

While the Malibu Mirage is easy to fly, it is a complex and very capable airplane. Those wanting to take full advantage of the airplane should have an instrument rating and be familiar with high-altitude flying and meteorology.

To accommodate nonpilot customers wanting a Mirage, Piper has announced a new flight training program. This intensive 17-week course begins with a week-long introduction to the basics at Piper's Executive Flite Center in Vero Beach. During this time, students will receive dual instruction in a Piper Cadet, pass the private pilot written examination, and reach the solo phase of flight instruction.

In each of the following four months, students spend one week at Vero Beach and also receive training from their own Piper-assigned instructors at their home airports. After nine weeks, students will have received their private pilot certificates. At the end of the training period, students will have earned their instrument ratings, as well as have received training in the systems and procedures of their own Malibu Mirages. The program speaks well for Piper in that it seeks to standardize training and provide a level of personalized instruction that can only make a student's flying safer. It's an innovative idea, and one that will be interesting to watch develop in the months ahead. Those who have been following the Malibu product line since its inception in late 1982 are bound to wonder why so many changes were made to the basic Malibu design. A balanced view is that the Mirage represents a refinement of the Malibu concept. According to a Piper spokesman, the Mirage is a direct response to customer feedback.

Whatever its etiology, customers have been intrigued by this new airplane. More than 90 individuals have ordered Malibu Mirages as of this writing, and so great is the demand that Piper has had difficulty in providing enough airplanes for demonstration rides.

Piper, under owner M. Stuart Millar's steady hand, continues to implement plans designed to stimulate general aviation. Today, it's the Malibu Mirage. Tomorrow, the turbine Malibu.

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Under a Cloud

A series of accidents raises serious questions about the Piper Malibu

By Mark R. Twombly

The flagship of piston singles and the pride of Piper Aircraft Corporation is facing its severest test. Seven Malibus have broken up in flight in the last two years, and we don't know why yet. Nothing is more frightening for a pilot to contemplate than an airplane that comes apart in the air for unexplained reasons. Families and friends of those who died in the accidents obviously are most affected. So are owners of the more than 500 Malibus Piper has delivered over the past seven years. Many have confidence in their airplane, yet an unusually restrictive airworthiness directive issued after the most recent breakup prevents them from flying except in VFR conditions. Finally, everyone in general aviation has a stake in seeing the issue resolved because it may determine the future of Piper Aircraft Corporation.

The most recent in-flight breakup was on March 17 in northern Florida. Four days later a frustrated FAA, which along with the NTSB has had an ongoing investigation of Malibu accidents, issued an Emergency AD that immediately prohibited pilots from flying the Malibu in instrument meteorological conditions. The airplane can be flown on an IFR flight plan as long as the pilot remains in VFR conditions. In other words, Malibu pilots still can cruise at and above Flight Level 180 as long as they are in VMC. Even so, the IMC restriction removes much of the Malibu's utility.

The AD also prohibits pilots from using the autopilot, control wheel steering button (which when held depressed interrupts the autopilot, freeing the pilot to adjust heading or altitude using the yoke), or vertical trim control to change altitude. The autopilot may still be used for level flight. The Bendix/King KAS 297 Altitude Preselect and Vertical Speed Select, if installed, must be physically removed from the aircraft and the electrical connections capped. In addition, pitot heat and alternate induction air must be used throughout the flight except for takeoff and landing.

The AD has caused a firestorm of protest among Malibu owners, and with good reason. The AD addresses symptoms of the accidents rather than the causes. So far, no solution has emerged from the investigation of the accidents—only the AD—and that is what has people upset. In a letter to NTSB Chairman James L. Kolstad and FAA Administrator James B. Busey, AOPA President Phil Boyer noted that it has been nearly two years since the first breakup, "and our government appears no closer today than it was two years ago to solving the mystery, making appropriate recommendations, and returning the Malibu fleet to adequate levels of service." AOPA has been acting as an information conduit to Malibu owners, passing on whatever is learned from the investigating parties.

Boyer called on the FAA and NTSB to release all information used by the FAA to justify the Emergency AD, and to make public all the facts of the in-flight breakup investigation. Boyer also asked Busey and Kolstad to set a date for either reaching a conclusion on the cause of the accidents, or easing or lifting the AD.

There are some common factors in the five accidents. The airplanes apparently were in IMC, although that is not certain. One of the key ingredients in the accident investigations is detailed weather data, but so far the NTSB has been unable to get the information.

Pilots were climbing, descending, or had just leveled off at an assigned altitude when large altitude deviations began, followed by high-speed descents and airframe failures. Each of the aircraft was equipped with a King KAP/KFC 150 flight control system. It is the only autopilot system certified in the Malibu. The KAS 297 allows the pilot to program a climb or descent rate for the autopilot to fly and a target altitude for leveling off.

Piper and Bendix/King have been participating in the investigation. Both companies have conducted extensive reviews of the design, certification, manufacture, and service history of their respective products, and no smoking guns have been uncovered.

An FAA review of the supplemental type certificate for the KFC 150 as it is installed in the Malibu concluded in February. According to King, the review confirmed that the autopilot performs as certified. The FAA noted that "the autopilot design does not indicate any shortcomings that would contribute to a hazardous flight condition," King said. Moisture contamination of the pitch and yaw servos in the tailcone has been a problem—King made a kit available in 1990 to shield the servos—but so far that has not been implicated in the accidents. King said that of the accident airplanes examined to date, the flight control servos showed no evidence of water damage, corrosion, or deterioration; the automatic pitch trim switch springs were intact and unbroken; and the clutch tensions checked within tolerances.

Piper says it devoted more than a year to its review, covering everything from the basic design to the pilot's operating handbook. Flight tests and failure load analyses confirmed that all control surfaces and structures exceed certification requirements for load limits.

"We've spent more than 10,000 hours searching for a needle in a haystack," noted Raymond L. Dickey, Piper's vice president of product engineering. "We didn't find the needle, and we don't think there's one in there."

Piper is recommending that Malibu pilots be required to take formal proficiency training. "We believe there must be demonstrated competency to fly an aircraft like the Malibu," said Piper's owner, M. Stuart Millar. Piper will design an expanded training curriculum—Millar called it a "Piper type certificate"—based on what is currently being taught at the factory school. It will be offered to training schools and firms.

The AD was issued a few days after Socata, the light-airplane manufacturing division of France's Aerospatiale, terminated negotiations to buy Piper. Socata apparently pulled out because of concern over the potential outcome of all product liability claims pending against Piper.

Socata was seen as Piper's best hope for survival. The company has been operating on a shoestring for months, building only the occasional Malibu and Cheyenne. Employment is down to a skeleton crew of just over 300. Millar has said it will take a major outside investment to put the company back on its feet. Several other parties are interested in the company, but according to Millar it could mean moving everything, including manufacturing, to a foreign country.

The Malibu's troubles will make it more difficult for Piper to find a willing investor. Meanwhile, Malibu owners—all Piper owners, for that matter—are concerned about continued technical and parts support from the factory.

When Piper debuted the Malibu at a splashy dealer conference in 1982, the airplane was immediately heralded as the classiest single available then and probably for years to come. Indeed it has been. The Malibu has a stature and image of class unmatched by any other piston single. The tall gear, extended nose, and long wing contribute to its aesthetic appeal, but it is the wide, six-place pressurized cabin and airstair door that really set the airplane apart.

The Malibu eclipsed the Cessna P210N, the only other pressurized piston single produced in volume, in appearance and performance. The all-new design, Piper's first in years, had a clear advantage over the P210N in cabin space and comfort. The 5.5-psi pressurization differential yields an 8,000-foot cabin altitude at the airplane's 25,000-foot maximum operating altitude. The P210N's 3.35-psi differential translates to a 12,100-foot cabin at 23,000 feet.

A clean airframe (metal bonding is used extensively to mate skins to structure) and high-aspect-ratio wing contribute to the Malibu's efficient high-altitude performance. The PA-46-310P Malibu, powered by a turbocharged and intercooled 310-hp Continental TS10-520-BE engine, cruises at about 215 knots on 16 gallons per hour at 25,000 feet. The 350-hp Lycoming TIO-540-AE2A-powered PA-46-350P Mirage is capable of 225 knots, although at a higher fuel flow.

Where the P210N edges the Malibu is in handling qualities in turbulence and in the clouds. The Malibu's long wing is an advantage in climb and cruise, but it does not take the bumps as well as the P210N's shorter-span, wider-chord wing. The Malibu has lighter pitch forces than the P210N ("truck-like" is often used to describe the Cessna's handling) and also is less stable in yaw. Light control feel is a delightful characteristic when hand-flying in visual conditions, but less desirable in turbulent air or when the view out the windows is of the inside of clouds. The P210N has not been immune to airframe failures, especially early in the program when it was beset by vacuum system troubles and in thunderstorms. It was also once the subject of an AD restricting operation in IMC, but with modifications the airplane could be immediately returned to full service.

Teething problems beset the Malibu soon after it entered service. Owners received a ream of service letters, bulletins, and ADs. The most serious problems concerned the Continental engine, in particular, fretting of the crankcase at the main bearing support and shifting of the bearings. Piper's relationship with Continental became increasingly strained as the two companies sparred over engine problems. At one point Millar took the extraordinary step of contacting Malibu owners to ask them to stop flying their airplanes until a problem was corrected. To atone for the inconvenience, Millar bought first-class airline tickets for Malibu owners who had to make business trips.

In 1989, Piper switched to a Lycoming engine for the Malibu and in the process adopted the name Mirage. Dual 70-amp alternators and dual continuously driven vacuum pumps were included as standard equipment on the Mirage. The interior also received a facelift. Even at $359,000 for the basic airplane (the price for a new Mirage equipped with color radar and electronic flight instruments topped $550,000), orders flowed in and the backlog grew.

The first airframe failure was in May 1989 near Bristol, Indiana. The pilot had been cleared to descend to 12,000 feet and to deviate around "a big cell," according to the NTSB, when the airplane entered an area of level two and three thunderstorms. The airplane broke apart soon after, scattering debris over a 4-mile area. Three people died.

In February 1990, a Mirage broke up in flight near Bakersfield, California. The airplane experienced an uncontrolled descent from 9,000 feet and came apart at 7,800 feet. Two were killed.

The third accident took place in May 1990 near Naylor, Missouri. Frank Adams, a former top executive of AlliedSignal Aerospace, parent of Bendix/King, and his wife were killed after their Malibu broke apart. According to the NTSB, Adams had changed to a cruising altitude of Flight Level 210 and had reported moderate turbulence. At the time, thunderstorm activity was reported 20 miles southwest.

A month later one person died when a Malibu broke up near Lakeville, Michigan. The pilot had been cleared to climb to 15,000 feet just prior to the breakup.

In March of this year, a family of four was killed near Bronson, Florida. The airframe failure occurred late at night shortly after the pilot, who had departed St. Petersburg, Florida, for Massachusetts, had been cleared to climb to higher altitude. Another Malibu owner who had planned to fly north from Florida that night cancelled his trip after receiving a briefing that noted severe storms in northern Florida.

The other two in-flight breakups occurred outside the United States, one in Mexico and one in Japan. Reports indicate that each involved a VFR-rated pilot taking off into instrument conditions. In the Mexican accident, witnesses said the airplane entered a thunderstorm, then came out the bottom in pieces.

The NTSB may never pinpoint the cause of every Malibu breakup accident, but it seems obvious that some involved weather that either the pilot or the airplane could not handle. That is not unique to the Malibu, and the fix is the same as for any airplane: a trained and proficient pilot who flies within his and the airplane's limits. The Malibu is no more difficult to fly than other high performance singles, and its systems are not overly complicated. But given the big-airplane cabin and cockpit, a preference for cruising in the flight levels, and the sophisticated avionics many owners opt for, it may be that pilots are lulled into believing the airplane is capable of more than it is, and are treading in places where they should not.

On Course:

Of Malibus and Mirages

By Richard L. Collins

When we went to Vero Beach, Florida, in late November 1982 for a Piper Aircraft Corporation conference, we all thought there would be excitement. There was, and the star of the show was the new Malibu. Introduced in Hollywood-extravaganza style, the Malibu emerged from a dry ice-generated fog to the strains of "Chariots of Fire." More than one observer opined that this was the beginning of a new era in general aviation. The bad times in manufacturing were behind, and the Malibu would lead an upward and onward charge.

A lot of things happened to Piper and to the PA-46 Malibu design. Not many were positive. Where I turn introspective about the design is in examining the problems and the accidents that the airplane had. They became so numerous that the airplane was grounded at one point, and restrictions on its use in IFR conditions, prompted by a spate of loss-of-control accidents, have just been lifted to allow Malibu and the Lycoming-powered Mirage pilots to enjoy the full capability of the airplanes.

One reason that I have been especially interested is that I had a Cessna P210, the first viable pressurized single, while the Malibu was being developed. I went to Vero Beach a lot, and Piper engineers spent a lot of time looking at my airplane. I sort of knew why they were looking, and my admonition to them was to not copy the mistakes. The P210 was never grounded early in its life, but IFR operation without modifications was prohibited at one point; there were numerous restrictions on engine operation caused by engine failures and other malfunctions; and many things were changed before the airplane became both viable and reliable. (We all turn into poets at some point.) I've kept all the mailgrams, airworthiness directives, and service letters, and the file is quite thick. Surely with all the history on the P210 to learn from, the Malibu could have been brought on line without a lot of problems.

Not so—and the question has to be whether the P210 mistakes were repeated or new ones were made.

Both airplanes had a lot of engine problems for, I think, the same reasons caused by different factors. Some P210s were lost with low time. Two, I think, crashed on ferry flights home from the factory, when detonation was experienced followed by engine failure. These could well have been related to instrumentation. To this day, if you set power in my airplane by the Cessna book, the climb is with the exhaust gas temperature lean of peak, and you'd never get the airplane out of the county. Early on, Cessna engineers checked the gauges a few times and said they were accurate, but they weren't. During a typical cruise-climb, I just put enough fuel through on hot days to keep the EGT at the 150 degrees rich of peak suggested by Cessna flight-test data. For colder weather, 75 rich of peak was said to be okay. This and judicious use of the cowl flaps has always been adequate to keep needles in the green, though not as far in the green as I would like on hot days.

Neither the Malibu nor the Mirage is fitted with cowl flaps. Both run very hot. While engineers will tell you that any temperature in the green is okay for the cylinder heads and the oil, it stands to reason that there is more wear at higher temperatures. The mistake that was repeated on the Malibu was the failure to realize that a pressurized airplane will spend most of the time at high altitude and, thus, high engine temperatures caused by heating the intake air as it is compressed to maintain manifold pressure. There was a lot of history with the turbocharged Continental in unpressurized Cessnas, but until the P210, they were seldom flown high on a routine basis. Routine high-altitude operation was the basis of most of the P210s' engine problems, and the same is likely true for the Malibu, which should really have cowl flaps.

Mistakes that were not repeated related to systems. The P210's fuel, turbocharging, exhaust, vacuum, and electrical systems all had substantial problems that had to be worked out. Most of this was also related to a high percentage of the airplane's time being spent at high altitude. The vacuum system, for example, had done okay in the turbocharged 210, but when the airplane was pressurized, it simply didn't work. The internal temperatures developed in the pump while it was producing the required vacuum at altitude were so high that failures occurred every 200 hours or so. The Malibu is not trouble-free in all areas, but it has done better.

From my experience with the Malibu, it has only one characteristic that could be related to control problems in turbulence. Because of the relatively low span loading of the airplane and the ratio of wingspan to airframe length, the ride in turbulence is busier than most light airplanes. That doesn't mean it is impossible to control when the ride gets wild, but it is more difficult to control.

The biggest repeated mistake or omission relates as much to the human element as to anything mechanical. This has been acknowledged by the FAA's rescinding of the AD with no changes in the airplane. After rigorous testing of the airplane and systems, especially the autopilot or flight control system, no smoking gun was found, so the FAA had no choice but to cancel the AD and try to save face with some banal recommendations. There was a dangerous suggestion in the AD, too, that I hope everyone charged to the FAA's lack of understanding of light airplanes. Flight in thunderstorms was prohibited by the AD, as if to suggest that it was okay to fly a P210, for example, in thunderstorms. Or that now that the AD has been lifted, it is okay to fly Malibus in thunderstorms. It is sometimes a challenge to save yourself from the FAA.

One of the recommendations requires caution, too. It is the suggestion to become proficient at recovery from unusual attitudes. The better course of action is to learn to keep the airplane out of unusual attitudes after the failure of anything in turbulence. The unusual attitude that leads to the most trouble is the spiral dive, and if you get very far into one of those, the likelihood of a successful recovery is slim indeed.

As usually happens, it winds up back with the pilot. Some suggested that a Malibu type rating be required to fly the airplane, but I think that misses the point. It is a more complex airplane than a Saratoga, for example, but it is not that much more complex. Certainly more than a day of good ground school on the systems would lapse into the obvious and boring for a pilot who had prepared by studying the pilot's operating handbook. The official suggestion that pilots become familiar with the autopilot only echoes what has been said before.

When all this is viewed in context, which is apparently something beyond the capability of the FAA, the problem becomes more obvious. Most all of the pressurized light airplanes have a relatively bad accident rate. In fact, some of them have an atrocious accident history. The FAA, instead of singling out the Malibu, should have given thought to the big picture. It is obviously the more complex environment—the weather environment that exists when you climb up into the flight levels—that has led to a lapse in risk management on the part of a lot of pilots. The aura surrounding the airplanes contributes heavily to this.

The pressurized piston airplanes have, at times, been praised because they fly higher, the implication being that they can get you above weather. One problem is that they can only get you above some of the weather—about belly-button level of a real thunderstorm—but they can get you above some weather that can be quite unpleasant to descend through. They can also get you into weather that is unpleasant to fly through.

Another problem is that they can make a pilot feel at least a little omnipotent. The airplanes kind of hum along with the radar running and the Stormscope or Strike Finder working, the autopilot flying, the loran leading the way, and the lights blinking, all of which suggests to the pilot that, yes, with this hummer, you can handle just about any weather. Believe me, there is some nasty turbulence in the 18,000- to 25,000-foot range that is well clear of thunderstorms. Troughs aloft and warm fronts are especially turbulent in this range. Jet-core-related turbulence dips down to and sometimes below these levels. Flying a pressurized piston (or turboprop) involves a lot more than popping up on top and humming along, and all that equipment that can make it seem so effortless at times is subject to failure. That may leave the pilot at FL250 with a 30-minute requirement for brilliance and the fanciest hand and footwork imaginable. A reader once scolded me for being so "professional" about flying. That is the only way to manage risk in any airplane and especially in a high-flying airplane.

The Malibu, too, came along at an unfortunate time in the history of our society. It was certainly not unique in having problems as a new design. That happens to general aviation and airline and military aircraft. But the Malibu came along as the American public was becoming convinced that anytime something untoward happens, it is somebody else's fault. I remember once when the P210 was having problems, someone with more political clout than knowledge of the airplane became involved in an incident. The airplane was almost grounded as a result, but cooler heads prevailed. Since that time, society's acceptance of the understanding of and accepting of risk has waned, and the Malibu had to bear the brunt of this. There is no question that the value of the airplanes suffered; hopefully now the air has been cleared, and Malibu pilots will benefit from knowledge of all the additional testing that was done on the design, learn what they need to know, and fly happily ever after.

Back From the Edge

The FAA looks for trouble

By Thomas A. Horne

A reputation is a fragile thing, especially when it comes to high technology. In the aviation world, there have been numerous cases where aircraft presumed to have been brilliant milestones turned out to be conspicuous disasters. For example, the de Havilland Comet, the world's first jet airliner, got rave reviews when it went into service in 1952. But by 1954, a series of fatal crashes ended its brief time in the spotlight; the problems were traced to cabin designs insufficiently strong to withstand repeated pressurization cycles.

Likewise, general aviation aircraft have had their share of reputation-damaging events. Over the years, various airplanes have experienced design-related safety problems. In most cases, suspicions about an airplane's design were raised by patterns of accidents taking place under similar conditions. In the case of the Mitsubishi MU-2 and Learjet, a series of fatal, unexplained plunges from altitude prompted Federal Aviation Administration reviews of these airplanes' compliance with certification standards. The airplanes passed this scrutiny with minimal fuss.

In the late 1970s and early 1980s, the safety of the Beechcraft V35 Bonanza became a major issue. The problem was a pattern of in-flight airframe failures. Many of these disintegrations occurred in instrument meteorological conditions and with non-instrument-rated pilots at the controls. There was considerable speculation that the V35's V-tail design was partially to blame. It was learned that under certain high G loadings, the tail structure could twist and bend to an unusually large degree. Once again, a certification review was ordered, and once again, it was determined that the airplane met the rules. Eventually, a method of strengthening the V-tail's tail spar assemblies was developed by Beech, then offered to owners free of charge.

That took care of the structural component of the situation. As for the human factors aspects, the picture was less clear. Was the Bonanza too slippery, too demanding for a low-time—or unproficient—pilot?

We'll probably never know the answer to that kind of question, but it came up again in 1989 and in a similar context. This time, the reputations of the Piper Malibu (PA-46-310) and Malibu Mirage (PA-46-350) aircraft were on the line. Between May 1989 and March 1991, there were seven fatal accidents, six of them involving Malibus, one of them a Mirage. They drew attention because all were in-flight breakups; most occurred at altitude, some involved flight in thunderstorms, and some involved relatively low-time pilots.

In March 1991, the FAA was moved to issue an airworthiness directive prohibiting Malibu and Mirage pilots from flying in instrument meteorological conditions. The following month, after howls of protest, it rescinded the AD, then published another. This unusual rule prohibits flight in or near thunderstorms, icing, and moderate to severe turbulence. The rule was unusual because it inferred that other airplanes may fly in these conditions without suffering harm, when in fact every pilot knows that severe weather can down even the strongest, most powerful airplanes carrying the most experienced crews.

Suspecting—as with the MU-2—that autopilot problems may have been responsible for the crashes, the FAA also prohibited the use of the PA-46's Bendix/King KFC 150 autopilot for altitude changes.

At the same time, the FAA ordered a special certification review (SCR) of the PA-46 series. It turned out to be one of the most thorough certification reviews ever conducted.

The review process consumed the better part of 1991 and involved the full cooperation of both Piper and Bendix/King. Finally, on December 5, 1991, the review was published. The aviation press dutifully reported the news: The Malibu and Mirage, as well as their autopilots, were in full compliance with certification rules.

Piper jumped for joy, saying, "This proves what we've been saying all along...that there is nothing wrong with the airplane." In a press release, Piper's then-owner, M. Stuart Millar, added a line that all could agree upon: "...but a focus is needed on pilot training and systems familiarity."

Bendix/King was more reserved. In its release, it said simply, "FAA personnel were also asked whether they had found any evidence linking the KFC 150 autopilot to any Malibu/Mirage accident, and their response was in the negative." This comment was obviously crafted with legal defense in mind. It's important to remember that the SCR was just that, a certification review—not an accident investigation. Rulings of these accidents' probable causes are the province of the National Transportation Safety Board, not the FAA. So the SCR does not blame. Instead, it identified various problems and made recommendations of them, in this case, for improving the airplane and its autopilot.

It's doubtful that many took the time to read the SCR report. It's 3 inches thick and has about a thousand pages. Still, it's interesting to take a look inside, especially at those sections dealing with the autopilot tests. Finish reading the text sections of the full report (don't bother reading the graphs or raw data unless you're an aeronautical engineer), and you'll come away with a greater respect for the airplane's strength, the researchers' professionalism, and, perhaps most important, the complexities of autopilots in general and those of the KFC 150 in particular.

Testing the airframe

Structural testing and review of the Malibu/Mirage airframe came from several sources. The FAA, Piper, and the NASA Langley facility validated the results of Piper's original calculations on the PA-46's aeroelasticity and flutter characteristics. The analysis proved that the wings would begin to flutter at about 600 KIAS, the horizontal tail at better than 1,000 KIAS. That's better than three times the airplane's V_{NE} of 198 KIAS and well into the supersonic realm.

Because the accident aircraft all showed an essentially simultaneous failure of the wings and horizontal tail, great attention was paid to both static and dynamic load testing. Piper did a static load test of the Malibu's tail and found that it failed at 239 percent of its 3.8-G limit load, or approximately 9 Gs. Other static tests were performed at loadings ranging from 3.8 to -2 Gs.

Then Piper performed flight tests, using one of its own test aircraft (N9135D—the one used in the original certification process). For each of the 75 tests, the airplane was loaded to the same weights as the accident aircraft and at their most rearward and most forward CGs at the times of the accidents. The aim here was not to load the test airplanes to their CG and gross-weight limits (that had already been done when the Malibu was first certified), but to duplicate the accident aircraft weights at the edges of the potential CG envelope for those weights (except for one accident aircraft, which was determined to have had a CG dangerously aft of the design envelope).

To document test results, pressure sensitive "Strip-a-tube" was applied the length of the horizontal tail's chord; this recorded pressure distribution over the tail. Strain gauges were installed to measure aerodynamic stresses electronically. Potentiometers, installed at the end of the elevator push rod, gave precise readings of control deflections. Finally, two video cameras were aimed at the tail surfaces—one in the cabin, aiming rearward, and one on the vertical fin, looking down.

What followed were a number of tests—far too many to cover in a magazine article. Among the most important, however, were those measuring stick force per G, in which control forces were measured at speeds between 130 and 200 KIAS, pulling anywhere from 1.2 to 3.05 Gs. These tests measured the amount of control force required to deviate from the airplane's trim speed and, as such, are important measures of an airplane's longitudinal stability: The farther you deviate from trim speed, the harder you must pull on the control yoke. The Malibu/Mirage not only passed these tests—each one, remember, at different weights and CGs and conducted at 10-knot intervals—with flying colors, it exceeded certification requirements. For example, Piper didn't have to perform stick force per G tests at speeds as high as 200 KIAS. But it did, even though this was some 40 knots higher than the letter of the law.

In addition, extra, out-of-trim stick force tests were conducted. Here, the pitch trim wheel is run for three seconds against trim speed. Then the controls are pushed and pulled for G measurements. These tests proved satisfactory, as well.

Another series of flight tests addressed the airplane's behavior at and below maneuvering speed. Called unchecked pullups, they entailed tests between 70 and 126 KIAS (Piper's calculated average maneuvering speed for the accident aircraft), once again, each at different weights and CGs. This test goes as follows: (1) Trim the airplane to the target speed; (2) haul back on the yoke very quickly; (3) keep pulling until full elevator deflection is reached; and (4) measure the time it takes for the airplane to stall. Once again, the airplane passed with ample margins. Incidentally, it took the airplane one second to stall when pulled up from 70 KIAS and four seconds (the regs set a three-second minimum for this test) to stall from 126 KIAS. In every case, the airplane stalled, as it was supposed to, before reaching the limit load of 3.8 Gs.

For Piper test pilot David W. Schwartz, the unchecked pullups were the hairiest of all in the SCR series. "We were uncertain about the airplane's reaction to an unchecked pullup from V_A at these weights and CGs. It hadn't been done before. So I didn't know if the airplane would enter a loop or do whatever," he said. "But it all worked out fine. Just a straight-ahead stall with no tricks."

Checked, or balked, maneuvers were also performed, at speeds ranging from 150 to 200 KIAS, at the different weights and CGs and at the standard 10-knot intervals. Checked maneuvers are those in which the test pilot suddenly pulls on the control yoke, then, just as suddenly, pushes on it. It's a maneuver designed not just to measure aerodynamic loads over the flight surfaces, but to simulate a panicky pilot trying desperately to keep his airplane within the design flight envelope and load limits—as might be the case in severe turbulence or convective activity.

This maneuver requires precise timing because the goal is to obtain precise positive and negative G measurements for displacements from each 10-knot increment of airspeed. Fleeting, thousandths-of-a-second-long motions of the yoke are needed. Piper's checked maneuvers yielded data at points ranging from -2.5 to 4.2 Gs. "That 4.2 Gs was unintentional," said Schwartz, "I pulled a little too hard, a little too fast on one test and went outside the envelope for just a little bit."

The videotape? Piper engineers kindly offered this author the chance to look at the footage. The pictures showed but the slightest, almost imperceptible, flexing of the horizontal stabilizer, and even then at only the highest G loads. Piper's chief engineer of aerodynamics, Mal Holcomb, when asked if the SCR tests brought any surprises, said, "The strength of the tail. We didn't realize it was so stiff."

Inside the autopilot

One third of the SCR team's 60 recommendations dealt with the Malibu/ Mirage's autopilot systems. But the autopilot recommendations seem to carry a greater sense of urgency than the rest. Maybe that's because the SCR team uncovered some autopilot tricks, traps, and unknowns that it—let alone most pilots—hadn't fully explored or understood before.

For those pilots with the patience and discipline to read it, the SCR report provides valuable insight into the world of autopilot malfunctions. As far as most pilots are concerned, this is a world that has never seen the light of day—not in any classroom, and certainly not in any manual or check list.

Here is a smattering of what the SCR team learned about the KFC 150 and its associated hardware:

Not all failures of the KFC 150 are detected by the system's monitor circuits, and not all failures are "soft" (return control to the pilot automatically). A failure of the autopilot computer's attitude-sensing capability, for example, is not annunciated. A preflight check of the autopilot system will show everything normal. Should an attitude-sensing signal be lost in flight, the flight envelope could be expected to be exceeded (60 degrees of bank) within five to eight seconds.

Failure of the KFC 150's KC 192 gyro sensor can cause runaways in both pitch and roll simultaneously. For example, after an attitude gyro sensing failure during an autopilot-controlled climb, the autopilot sensed a level flight condition—even though the pitch-up rate increased, and the airplane rolled first to the right, then the left. After eight seconds, the airplane had rolled 80 degrees to the left and 10 degrees nose down. It was noted that excessive roll rates would not disengage the autopilot in this failure mode.

In a descent from level flight at 160 KIAS, test pilots failed an attitude gyro sensor while simultaneously disengaging the vertical speed mode. Bank angle went from 45 degrees left to 30 degrees right, and pitch angle went to 20 degrees nose down. After 16 seconds, the airplane reached 200 KIAS.

After failing the vacuum system during an autopilot-controlled climb at 160 KIAS, the system commanded a continuation of the climb. But after three minutes, a 500-feet-per-minute descent rate began, and a yawing right turn developed. After 4.5 minutes, the airspeed was at 185 KIAS, and 2,000 feet had been lost.

During flight tests of simulated nose-up pitch trim runaways, it was determined that "manually stopping the trim wheel rotation could only be accomplished momentarily as the overpower force to counteract the electric trim was too high." This was a significant finding for two reasons.

One is that manually overpowering the electric pitch trim with the trim wheel is supposed to be a way of stopping a pitch trim runaway. Another reason is that, until recently, the Bendix/King manual specified such a check during each preflight. "Until recently corrected," the SCR report stated, "the normal procedure of the airplane flight manual supplement outlined a preflight test procedure for the manual electric trim system which was incorrect because it could not be accomplished as written. One step of the procedure asked the pilot to rotate the trim wheel manually against the engaged clutch [the left half of the manual electric pitch trim's split switch. The right half actuates the trim motor—Ed.] to check the pilot's trim overpower capability. This cannot be done in the PA-46-310P/350P airplanes because the pilot does not have enough mechanical advantage to manually rotate the trim wheel with the clutch engaged."

A subsequent revision eliminated this check, which was also unusual. This manual override capability must be demonstrated in other installations of the same system in other airplanes with similar servo clutch torque limit values. The SCR team "assumed that the reason for this variance was a result of the unique design for this airplane's pitch trim wheel linkage to the trim servo and trim tab controls." The autopilot supplements in Piper's airplane flight manual still contain this preflight check.

This raised a question. If pilots performed the preflight check, they would have noticed their inability to override the pitch trim servo clutch manually. In this case, the manual override failed the test, and use of the electric pitch trim would be prohibited. Did pilots do the check and ignore the findings? Or did they not perform checks at all?

In the Mirage, the pilot couldn't easily pull the pitch trim circuit breaker. That's because it is located on the copilot's side-wall panel, virtually out of the pilot's reach.

In spite of these and other quirks, the SCR team found the autopilot in full compliance. Other disconnect features worked, so the chances of a completely out-of-control pitch trim runaway were almost nil (there are seven means of disconnecting the autopilot).

Addition of a gyro sensor monitor feature was listed among the SCR's recommendations. So were requests for interlocking the stall warning sensor to the autopilot (so that the autopilot would automatically disconnect if the stall warning activates), installing sensors that would disconnect the autopilot if airspeed exceeded 185 KIAS (the maximum speed for autopilot use), and changing the certification rules so that a single autopilot malfunction cannot lead to multi-axis deviations in aircraft attitude.

The SCR emphasized that the rules for autopilot certification came about in the era when Transport-category airplanes with two-man crews were the only autopilot users. The assumption was that one of the pilots would always be monitoring the autopilot, on the lookout for malfunctions. Another assumption was that it would take a crew just three seconds to recognize and correct an autopilot problem. To this day, certification rules still carry the three-second-delay requirement before initiating a recovery from an autopilot malfunction. In that three seconds, the airplane must not enter an unsafe attitude or condition.

The report pointed out that in single-pilot operations—the kind typical of Malibu/Mirage flights—three seconds is too short a time to be representative. For this reason, many of the autopilot malfunctions reenacted for the SCR review were conducted with recovery delays greater than three seconds. Some delays were as long as 24 seconds, others just under five minutes. The report strongly suggested that the rules be changed to extend the recovery delay beyond the three-second limit. The moral: Continuously monitor any autopilot's performance at all times.

While a lot of attention is focused on pitch trim runaways, or so-called "hardovers," the SCR noted that subtle malfunctions may be much more difficult to recognize and take longer to recognize. Because of this, the maneuvers produced by subtle malfunctions may be more severe than those resulting from trim runaways.

But above all, the SCR's recommendations asked for more pilot education and better manuals and other product information. One Bendix/King official recounted a story that underscores the level of pilot misunderstandings. A Malibu pilot called Bendix/King, complaining that his autopilot would oscillate wildly in pitch during attempts to level off from descent. It turns out that the pilot initiated his descents with the autopilot's altitude hold feature engaged. The descent was accomplished by pushing on the control yoke. When the desired altitude was reached, the pilot released the yoke, expecting the autopilot to somehow capture the new altitude. Instead, of course, the autopilot commanded an immediate climb back to the originally programmed altitude. The pilot had been fighting the autopilot during his descents and inducing huge mistrims in the process. A proper autopilot descent requires the pilot to first disengage altitude hold, then use the autotrim switch to command a safe descent rate.

The SCR report also mentioned other, simple bits of autopilot knowledge (affecting all types, not just the KFC 150) that should be emphasized in the course of autopilot training—such as never putting any manual restraint on the normal operation of the autopilot; large pitch mistrims could occur. Pilots also should understand that it's possible to program an autopilot climb that's beyond the performance capabilities of the airplane; commanding the autopilot to climb the airplane at a rate higher than it's able to execute, for example, can result in a stall.

So where does this leave us? The airframe and autopilot passed the review. Though 60 recommendations were made, the FAA saw fit to propose only four airworthiness directives, all of them fairly benign in impact. Those affecting the airframe (strengthening the empennage with stronger rivets and inspection of elevator trim cable guide tubes) have, for the most part, already been addressed by owner compliance with previously issued Piper service bulletins (see "Pilot Briefing," April, 1992, *Pilot*).

One proposed AD affecting the autopilot asks that the low vacuum warning lights be placarded as inoperative and that vacuum gauge markings (a green arc showing the range of normal suction values) be added. During the SCR's tests, it was learned that the low vacuum light switches sometimes did not illuminate when system suction dropped below normal levels.

The other proposed autopilot AD would require a cover for the pitch servo unit. This was prompted by reports of circuit board corrosion, caused mainly by pressure washing. Apparently, water could pass by the servo unit and enter internal components of the autopilot. Again, most Malibus already had this fix completed, per a March 1990 Bendix/King service bulletin.

The NTSB's response took more of an educational tack and emphasized human factors. It urged that pilots better familiarize themselves with the capabilities and limitations of the Malibu/Mirage's autopilot, flight director, and altitude preselect components. It also asked for more training in unusual attitude recoveries and high-altitude operations. These are good ideas for pilots of any high-performance, autopilot-equipped airplane.

It's tempting to say that the Malibu's reputation has been saved by the SCR's findings. But if the certification team spoke the truth about the Malibu/Mirage, it also revealed some other truths. One of them is that many pilots stepping up to the Malibu/ Mirage's left seat apparently don't have sufficient respect for the kind of high-performance airplane that they've bought, nor the environment in which they fly.

Glossary of Terms and Abbreviations

A/C: Aircraft

AD: Airworthiness Directive

App: Approach

APU: Auxiliary Power Unit

ASR: Airport Surveillance Radar

ATC: Air Traffic Control

CHT: Cylinder Head Temperature

CG: Center of Gravity

Comp: Comparison

CRM: Cockpit Resource Management

Dest: Destroyed

DG: Directional Gyro

DH: Decision Height

DME: Distance Measuring Equipment

EFIS: Electronic Flight Information System

EGT: Exhaust Gas Temperature

Engine connecting rod: An internal engine part connecting the piston to the crankshaft.

Fatal Injury: An injury which results in death within 30 days of the accident.

FSS: Flight Service Station

Fuel Exhaustion: A condition with no fuel remaining in tanks.

Fuel Starvation: A condition with fuel in the tanks but not connected to the engine.

HI: Heading Indicator

HSI: Horizontal Situation Indicator

IFR: Instrument Flight Rules

ILS: Instrument Landing System

IMC: Instrument Meteorological Conditions

INST(S): Instrument(s)

LDG GR: Landing Gear

MAP: Missed Approach Point

MDA: Minimum Descent Altitude

Minor Injury: Any injury that does not qualify as serious or fatal.

NDB: Nondirectional Beacon

Non-Injury: No injuries were reported.

NTSB: National Transportation Safety Board

NWS: National Weather Service

Pax: Passengers

PIC: Pilot In Command

POH: Pilots Operating Handbook

Retract: Retractable Landing Gear

SDR: Service Difficulty Reports

SEF: Single-engine Fixed Gear

Serious Injury: A serious injury must meet one of the following guidelines:

1. Requires hospitalization for more than 48 hours, commencing within seven days from the date the injury was received;
2. Results in a fracture of any bone (except simple fractures of fingers, toes, or nose);
3. Involves lacerations which cause severe hemorrhages, nerve, muscle, or tendon damage;
4. Involves injury to any internal organ;
5. Involves second or third-degree burns, or any burns affecting more than five percent of body surface.

SER: Single-engine, Retractable Landing Gear

SERT: Single-engine, Retractable Landing Gear, Turbocharged

SID: Standard Instrument Departure

STAR: Standard Terminal Arrival Route

Subt: Substantial

SYS: System

TIT: Turbine Inlet Temperature

U: Unknown

UN: Unknown

UNK: Unknown

VAC: Vacuum

V_{RA}: Rough Air Speed

V_S: Stall Speed

V_{S1}: Stall Speed 'Clean', at max gross weight

V_{S0}: Stall Speed in Landing Configuration

VSI: Vertical Speed Indicator

VVI: Vertical Velocity Indicator

V_X: Best Angle of Climb Speed

V_Y: Best Rate of Climb Speed

V_{FE}: Maximum Flaps-extended Speed Virga

V_{LO}: Maximum Speed for Landing Gear Extension

V_A: Maneuvering Speed

V_{NE}: Never-exceed Speed

V_{NO}: Normal-operating Limit Speed

VFR: Visual Flight Rules

VMC: Visual Meteorological Conditions

VNAV: Vertical Navigation

VOR: Very High Frequency (VHF) Omnirange

Phase of Operation

The phase of the flight or operation is the particular phase of flight in which the first occurrence of circumstance occurred. These are the official NTSB definitions:

Standing: From the time the first person boards the aircraft for the purpose of flight until the aircraft taxies under its own power. Also, from the time the aircraft comes to its final deplaning location until all persons deplane. Includes preflight, starting engine, parked-engine operating, parked-engine not operating, and idling rotors.

Taxi: From the time the aircraft first taxies under its own power until power is applied for takeoff. Also, when the aircraft completes its landing ground run until it parks at the spot of engine shutoff. Includes rotorcraft aerial taxi. Includes taxi to takeoff and taxi from landing.

Takeoff: From the time the power is applied for takeoff up to and including the first airborne power reduction, or until reaching VFR traffic pattern altitude, whichever occurs first. Includes ground run, initial climb, and rejected takeoff.

Climb: From the time of initial power reduction (or reaching VFR traffic pattern altitude) until the aircraft levels off at its cruise altitude. Also includes enroute climbs.

Cruise: From the time of level-off at cruise altitude to the beginning of the descent.

Descent: From the beginning of the descent from cruise altitude to the IAF, FAF, outer marker, or VFR pattern entry, whichever occurs first. Also includes enroute descents, emergency descent, autorotative descent, and uncontrolled descent.

Approach: From the time the descent ends (either IAF, FAF, outer marker, or VFR pattern entry) until the aircraft reaches the MAP (IMC) or the runway threshold (VMC). Includes missed approach (IMC) and go-around (VMC).

Landing: From either the MAP (IMC) or the runway threshold (VMC) through touchdown or after touchdown off an airport, until the aircraft completes its ground run. Includes rotorcraft run-on, power-on, and autorotative landings. Also includes aborted landing where touchdown has occurred and landing is rejected.

Maneuvering: Includes the following: Aerobatics, low pass, buzzing, pullup, aerial application maneuver, turn to reverse direction (box-canyon-type maneuver), or engine failure after takeoff and pilot tries to return to runway.

Other: Examples are practice single-engine airwork, basic airwork, external load operations, etc.

Unknown: The phase of flight could not be determined.

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