Piper Cherokee and Arrow Safety Highlights

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Introduction

Reliability, sturdy construction, and gentle flight characteristics make the Piper Cherokee and Arrow favorites among aircraft owners and the flight training community.

There are currently close to 20,000 PA-28 aircraft on the FAA Registry. During the past eighteen years, there were an average of 147 PA-28 accidents per year, or approximately three per week. In this booklet, the AOPA Air Safety Foundation compares 2,120 PA-28 fixed gear accidents to 5,105 accidents of other light four-place single-engine aircraft during the years 1982-1999. Five hundred nineteen Arrow accidents are compared to 1,140 accidents of comparable aircraft for the same time frame.

In this booklet, the PA-28(F) (fixed gear) aircraft accidents are compared to accidents of the Beech Musketeer/ Sundowner, Cessna 172 Skyhawk, Cessna 182 Skylane, and the Gulfstream American AA-5 Traveler. Aircraft compared to the PA-28R (Arrow) are the Beech 24/Sierra, Cessna 172RG and 182RG, Rockwell 112/114, and the Mooney M20 series.

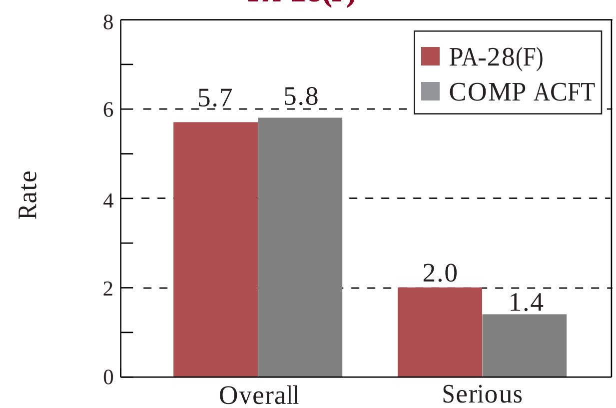
The following aircraft were included in the research for this booklet:

PA-28(F):	**PA-28R:**
PA-28-140	PA-28R-180
PA-28-150/160	PA-28R-200/201
PA-28-151	PA-28RT-201
PA-28-161	PA-28R-201T
PA-28-180	PA-28RT-201T
PA-28-181	
PA-28-235B-F	
PA-28-236	

FAA estimates the PA-28 fleet flew nearly 45 million hours during the years 1982-1999. The Arrow was involved in about seven accidents per 100,000 hours, most of which were minor. Fixed-gear Cherokees had slightly less with just six accidents per 100,000 hours. The comparable aircraft accident numbers do not differ much from those of the PA-28. (see Figure 1).

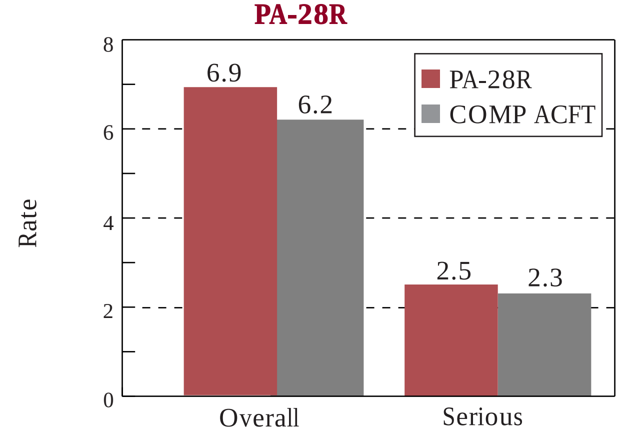
Figure 1. Accidents Per 100,000 Hours

PA-28(F)



PA-28(F)	2120	733
COMP ACFT	5105	1269

PA-28R



PA-28R	519	186
COMP ACFT	1140	419

Most PA-28 accidents resulted in little or no injury, but approximately one-third were classified as serious in accordance with NTSB Part 830 definitions. Serious accidents were typically a result of weather decision making and low-level maneuvering flight, while landings caused most of the minor accidents.

Approximately 35 percent of all fixed-gear Cherokee accidents were serious, compared to nearly 25 percent for the comparable aircraft. The Arrow was almost identical to its comparison aircraft group in this category, with about 36 percent of the accidents classified as serious. (see Figure 2).

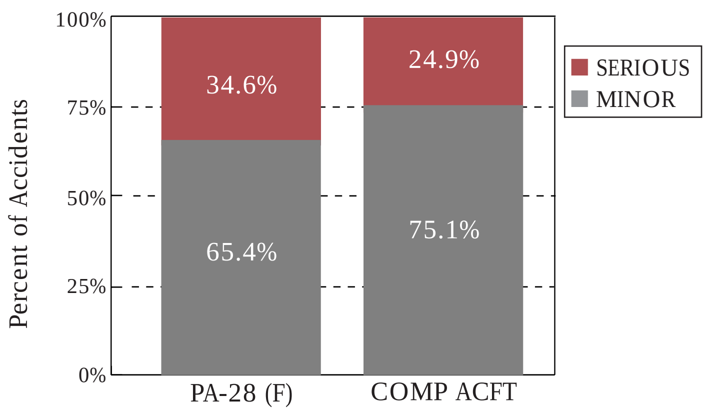
Low time in type equates to high accident involvement. More than 60 percent of all serious PA-28 and comparable aircraft accidents occurred during the first 100 hours of time in type. (see Figure 3).

Pilot-Related Accidents

Eighty-one percent of PA-28(F) and 72 percent of PA-28R total accidents were caused by the pilot, mostly as a result of poor judgment. Mechanical and maintenance causes were a distant second. (see Figure 4). With so many pilot-related accidents, primary emphasis should be placed on judgment training and proficiency, not on hardware. However, proper maintenance is essential and must not be neglected.

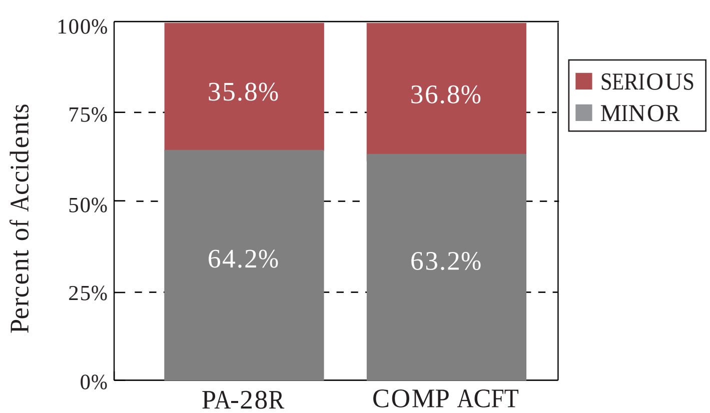
Landing problems were the leading cause of PA-28 pilot-related minor accidents. (see Figure 5). This is typically the result of lack of

Figure 2. Accident Summary PA-28(F)



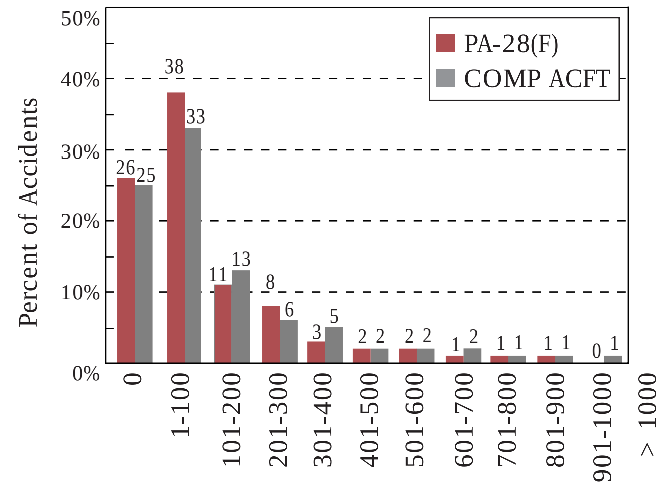
SERIOUS	733	1269
MINOR	1387	3836

PA-28R



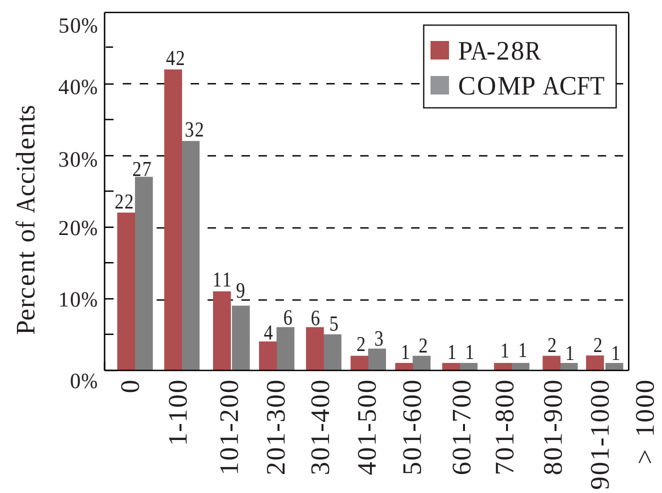
SERIOUS	186	419
MINOR	333	721

Figure 3. Pilot Time in Type Serious Accidents PA-28(F)



PA-28(F)	189	282	81	61	25	15	15	5	6	7	2	18
COMP ACFT	321	424	167	81	62	31	21	25	8	11	14	54

PA-28R



PA-28R	40	79	20	8	11	4	2	1	2	3	3	5
COMP ACFT	114	136	38	24	19	13	7	6	6	4	6	32

skill and proficiency. Serious pilot-related accidents were mostly a result of weather decision-making.

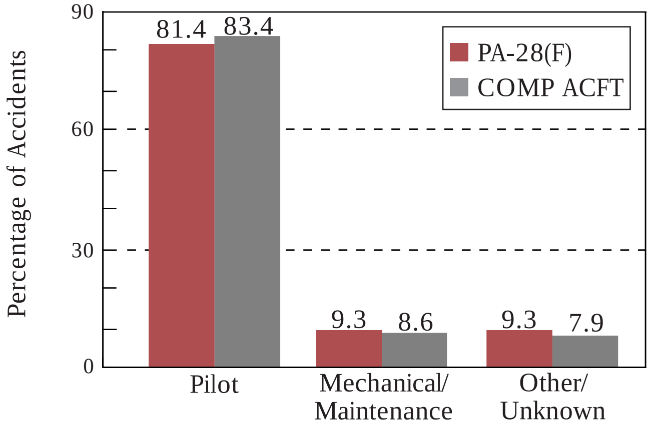
Preflight

ASF recommends arriving at the airport at least 30 minutes prior to departure. If the aircraft requires preheat or snow/ice removal, allow extra time. A proper preflight should include the following:

- ✓ A review of the airplane's airworthiness status, including a walk-around inspection as described in the *Pilot's Operating Handbook*.
- ✓ A review of the appropriate charts and publications for the flight. Be sure that your sectional chart, taxi diagrams, and approach charts are current. When checking the aircraft's paperwork, remember the acronym ARROW:

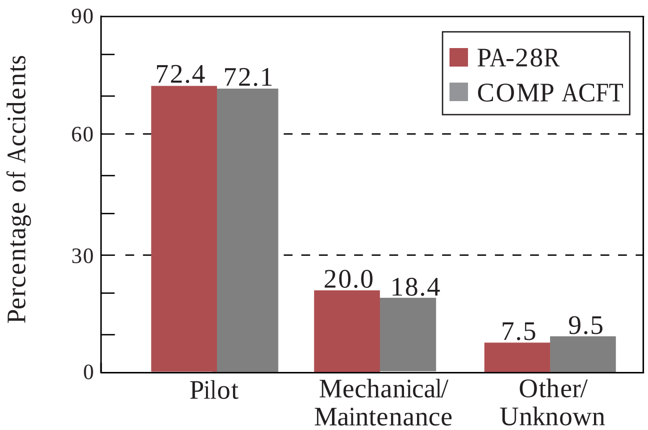
  Airworthiness certificate
  Registration certificate
  Radio station license - for international flights only
  Operating limitations - *Pilot's Operating Handbook*
  Weight and Balance records

Figure 4. **Major Cause**
PA-28(F)



PA-28(F)	1725	198	197
COMP ACFT	4260	440	405

PA-28R



PA-28R	376	104	39
COMP ACFT	822	210	108

- ✓ Calculation of weight and center of gravity (CG) limits.
- ✓ Calculation of takeoff and landing distances – ASF recommends adding 50 percent to the distance numbers. (See the Takeoff section on page 8 for details.)
- ✓ Calculation of fuel requirements – ASF recommends landing with at least one hour of fuel reserves on board. Add several gallons per hour to "book consumption numbers" until you have accumulated some experience with that *particular aircraft* to verify the fuel burn of that engine with your leaning techniques.
- ✓ A weather and notam briefing.

Although they seem obvious, if all pilots would follow these simple precautions the accident rate would be significantly reduced.

The 400-hour instrument-rated pilot departed in IMC conditions, knowing the propeller governor was inoperative. The engine quit 4 miles from the airport. The pilot declared an emergency and descended through the clouds. He went through some trees and landed in a pasture. The piston pin plugs had disintegrated and contaminated the oil system. Some of the metal caused the propeller governor drive shaft to separate. Oil was depleted until pressure was lost, and the engine seized.

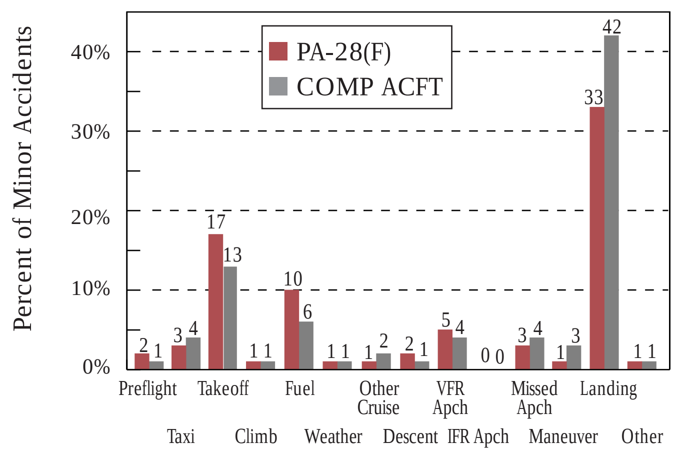
Weight and Balance

Weight and balance affects an airplane in all phases of flight. For example, heavier gross weights result in longer takeoff runs, shallower climbs, faster landing speeds, and longer landing rollouts. If the aircraft is out of balance, it may become uncontrollable immediately after takeoff.

The pilot is responsible for ensuring that the airplane is properly loaded. Having four seats, two fuel tanks, and a baggage compartment doesn't mean you can safely fill them all. This is especially true of the lower powered Cherokee series. Flight in the traffic pattern with a flight instructor, a couple of flight bags, and full tanks poses no problem. However, if your plans include a weekend getaway to the beach, with three passengers and their baggage, use extra care when figuring the weight and balance. You will likely have to limit passengers, baggage, fuel, or all three.

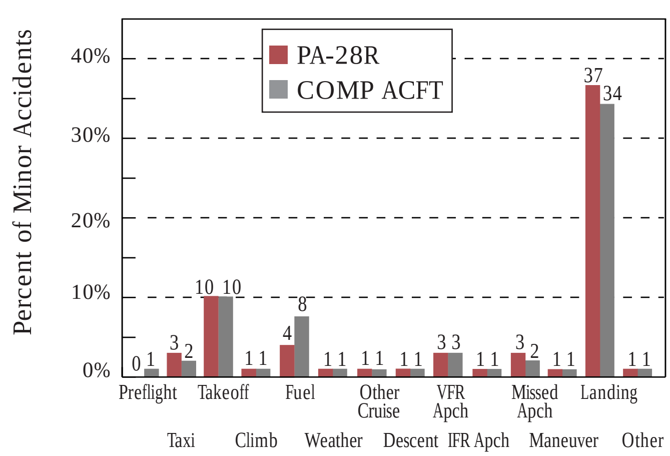
The 80-hour private pilot began his flight with the aircraft about 198 pounds over its maximum gross weight limit. The airplane was observed to lift off near the departure end of the runway, then continue in a nose-high attitude. Some witnesses observed the wings rocking or wobbling. Reportedly, it gained some altitude, then settled into an apartment building.

Figure 5. **Pilot Related Causes**
Minor Accidents PA-28(F)



PA-28(F)	23	38	232	14	143	18	19	25	65	5	38	20	460	11
COMP ACFT	38	166	495	20	242	34	63	46	165	15	163	100	1617	22

PA-28R



PA-28R	1	10	33	4	14	2	3	4	11	2	10	4	123	2
COMP ACFT	4	16	75	7	55	7	8	6	25	6	17	8	246	9

When computing weight and balance, consider the density altitude of the departure airport. It could mean the difference between clearing an obstacle on takeoff or colliding with it. During the past 18 years, PA-28 series aircraft were involved in 38 density altitude related accidents. Pilots who regularly fly in mountainous terrain are familiar with high-density altitudes, but what about flying on a hot summer day from a 1,000-foot msl airport? Compared to standard sea-level conditions, ninety degrees Fahrenheit at a 1,000-foot msl airport will result in a *50 percent* increase in takeoff distance and a nearly *30 percent* decrease in climb performance.

Weather

Faulty weather decision making accounted for the majority of serious PA-28 pilot-caused accidents. A weather briefing is recommended for most flights, especially when going beyond the traffic pattern. The actual weather may differ from the forecast. Monitor weather en route, and don't continue into bad weather. Before the flight, prepare an alternate course of action in case bad weather is encountered.

Pilots should certainly consider severe weather such as thunderstorms and ice, as well as performance-degrading situations such as heat and humidity, **but the most common causal factor in weather-related accidents is low ceiling and poor visibility.**

Anticipate and avoid hazardous weather conditions. However, if you do encounter such weather, use all available resources to aid in the quickest departure from the dangerous situation. The following resources are readily available:

✓ Eyes – They are your best source for weather avoidance. Fly at altitudes that will give you a good view of the weather. **React to what you see.** If it looks bad, it probably is. Avoid it!

✓ ATC – Use flight following when possible, to remain in contact with ATC. Use their assistance if necessary and listen to what other aircraft on the frequency are doing to avoid the weather.

✓ Autopilot – Relief of basic aircraft control allows pilots to manage the flight with much less fatigue. However, the autopilot cannot fly the aircraft in severe turbulence, or solve an icing problem. It should be used by VFR pilots during an inadvertent IMC encounter, but not to deliberately penetrate instrument conditions. Utilize the autopilot for a 180-degree turn to exit the weather quickly.

✓ FSS – Use Flight Watch and Flight Service to keep up on what the weather is doing. In most cases, listening on the frequency for a few minutes will provide you with a good picture. Give and get pireps.

Note: Visit www.aopa.org/asf for weather information products available from the Air Safety Foundation.

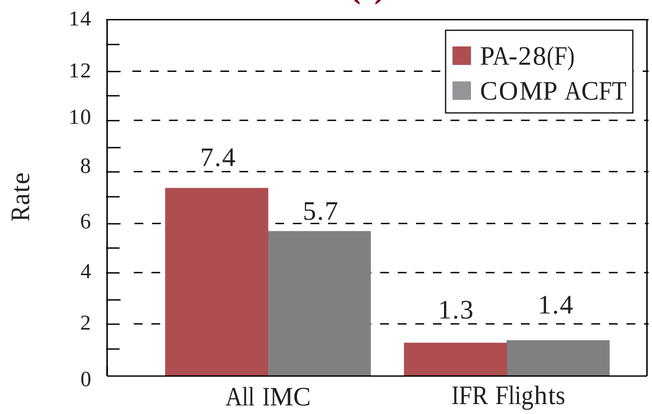
The 760-hour instrument-rated pilot encountered forecast thunderstorms en route and requested deviation around the weather. The pilot did not report further difficulty, but loss of control and an in-flight breakup of the aircraft occurred shortly thereafter. Weather and radar data indicate that the airplane broke up near the edge of a thunderstorm. Heavy rain and lightning were reported by local residents. The outboard end of the left wing and the stabilator had separated in flight. The left wing failed in positive overload.

Instrument Meteorological Conditions (IMC) Accidents:

The fixed-gear Cherokee had only slightly more accidents per 100,000 IMC hours than its comparison group, with 7.4 and 5.7, respectively. However, the Arrow had significantly more than its comparison aircraft, with 12.2 accidents per 100,000 IMC hours, compared to 7.1 for its comparison group. (see Figure 6).

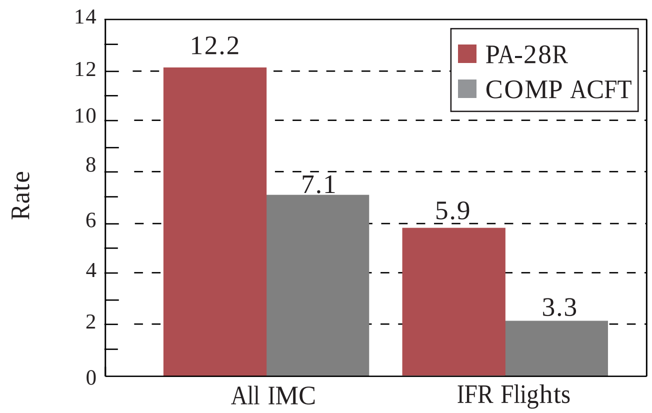
Figure 6. IMC Accidents Per 100,000 IMC Hours

PA-28(F)

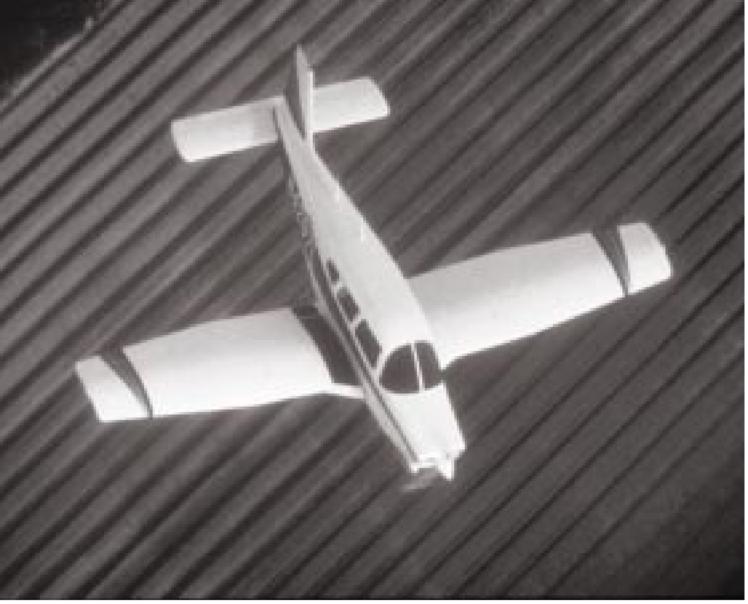


PA-28(F)	242	41
COMP ACFT	385	97

PA-28R



PA-28R	81	39
COMP ACFT	155	71



Although the PA-28R had more accidents per 100,000 IMC hours than the PA-28(F), it had fewer overall. The PA-28(F) had 242 IMC accidents, while the PA-28R only had 81. Arrows likely have a higher accident rate because they experience more challenging weather conditions typically found in cross-country flight, while fixed-gear Cherokees tend to be flown more locally.

Note: A disproportionate number of accidents occur at night and in IMC in mountainous terrain. ASF recommends a minimum 4,000-foot ceiling and 10 miles visibility when in the vicinity of mountains. Reporting stations are scarce, so weather may be lower between them. There is a higher risk involved with this type of flying.

Continued VFR into IMC remains a hot safety topic. Regardless of the type of aircraft you fly or the amount of experience you have, always be aware of your limitations. Fly into instrument conditions only when current and proficient. VFR into IMC accidents are fatal about 75 percent of the time. Practice partial panel flight so you are prepared to handle IMC if necessary. Backup power for gyro stabilized flight instruments is a good investment.

Compile a list of personal minimums, and stick to them. Remember that they will vary from pilot to pilot and, for each pilot, from day to day. FAA has developed a Personal Minimums Checklist, www.faa.gov/avr/news/checklst.pdf, which can be tailored to the individual pilot. The following weather guidelines, as recommended by the Air Safety Foundation, may be modified according to personal experience:

- ✓ Day/Night VFR – 2,000-foot ceiling/5 miles visibility (double in mountainous terrain)
- ✓ Day/Night IFR – 400/1 or lowest minimums plus 200/ ½

Prior to departure, the 230-hour private pilot received a weather briefing, which concluded with a severe weather warning. He decided to go anyway, and if the weather got too bad, he would return. About 16 minutes later, the pilot requested updated weather conditions. He was advised of a convective sigmet, severe weather watch, and active thunderstorms throughout the area. He was also advised VFR flight was not recommended. He continued despite the warnings. Twelve minutes later, the flight contacted Approach Control and requested immediate radar vectors to the nearest lighted airport. The target was eventually lost. The aircraft had descended into a marsh area in an extreme-nose-down attitude.

Icing:

PA-28 aircraft were not designed for flight in icing conditions. Structural ice destroys the flow of air over the aircraft, which increases drag and decreases lift. The airplane may stall at higher speeds and lower angles of attack than normal. Carburetor or induction icing could result in a complete loss of power. Use pireps and weather reports to avoid icing conditions, and coordinate with ATC for assistance. During the past 18 years, PA-28s were involved in 27 airframe and 22 carburetor/induction icing accidents.

Structural Icing Risk

	Cumulus Clouds	Stratiform Clouds	Rain and Drizzle
High	0° to -20° C 32° to -4° F	0° to -15° C 32° to 5° F	0° C and below 32° F and below
Medium	-20° to -40° C -4° to -40° F	-15° to -30° C 5° to -22° F	
Low	< than -40° C < than -40° F	< than -30° C < than -22° F	

Conditions that may be conducive to severe in-flight icing are high moisture content in clouds, relatively warm temperatures, and freezing rain. (see chart above).

Carburetor or induction ice is usually indicated by engine roughness and a drop in rpm or manifold pressure. This form of icing occurs when humidity is high and the temperature is between 14 degrees Fahrenheit and 77 degrees Fahrenheit. The engine is more susceptible during low power or closed throttle settings. At the first indication of carb or induction ice, apply full carburetor heat. Partial heat should not be used. The engine may run rougher as the ice melts and goes through the engine, but will smooth out again. Although the carburetor installation on PA-28s is less likely to ice than that on some other aircraft, when in doubt, use heat.

The Air Safety Foundation's Safety Advisor, *Aircraft Icing*, www.aopa.org/asf/publications/sa11.html, discusses both structural and carburetor icing, and how to fly safely when icing conditions are forecast.

Night

The night accident rate for IMC is higher than the rate for day IMC accidents. Weather minimums should be raised accordingly and pilots must be proficient with night flying techniques and procedures. For pilots with little or no recent night flight experience, ASF recommends dual night instruction. Specific subjects to be covered are as follows:

- ✓ Spatial disorientation – The horizon is less visible at night, and lights may create an artificial horizon. This is especially true in night IFR conditions.
- ✓ Operation of aircraft and runway lighting – Use available aircraft lighting to be more conspicuous, and understand the operation of runway lighting.
- ✓ Night vision and other physiological issues – Vision decreases with age, fatigue, and altitude.
- ✓ Obstruction clearance – Avoid short runways and small unfamiliar airports after dark. Choose runways with ILS or VASI.
- ✓ Weather – Clouds are much harder to see at night. Temperature and dew-point are closer. Fewer pireps are available.

Night accidents were higher for all PA-28 aircraft than for their comparison aircraft group, and the Arrow had many more night accidents per 100,000 night hours than the PA-28(F). (see Figure 7). That may be because the fixed-gear Cherokee is used as a trainer, and the Arrow is flown on more cross-country flights in diverse weather environments. Night currency doesn't equal night proficiency for

cross-country operations. ASF recommends a dual night cross-country to increase your night flying skills.

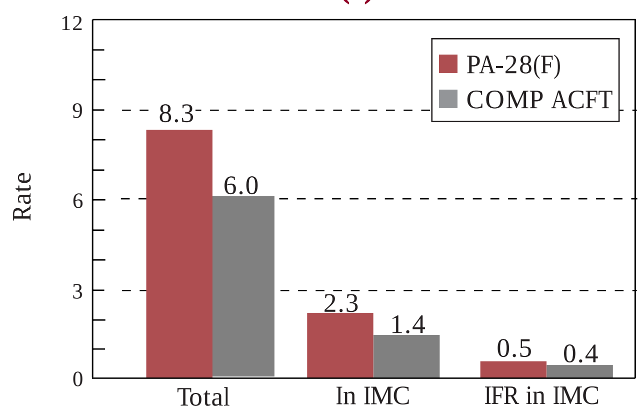
Note: Remember to turn the panel lights off for daytime flying. If you fly a retractable gear aircraft, turning the panel lights on causes the gear lights to dim, making them difficult to see in daylight. That could lead to unwanted excitement during the approach.

Mechanical

The PA-28 was designed for simplicity of manufacture, operation, and maintenance, and has few major Airworthiness Directives. Most mechanical-related accidents were due to powerplant or propeller problems. (see Figure 8).

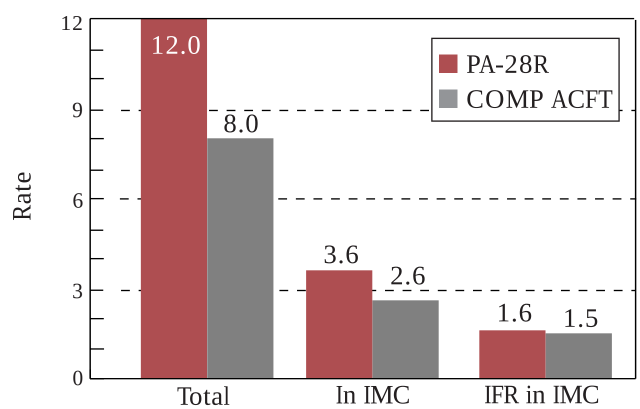
One mechanical issue for Arrow pilots is the automatic gear-extension system, which was added to prevent gear-up landings. A service bulletin was issued by Piper recommending that the system be disabled. If the system has not been disabled on your aircraft, the following applies. If the aircraft reaches a certain speed (usually 75-95 KIAS) and the gear is not yet down, it lowers automatically regardless of the gear selector switch position. An override switch is provided to allow pilots to

Figure 7. Night Accidents Per 100,000 Night Hours
PA-28(F)



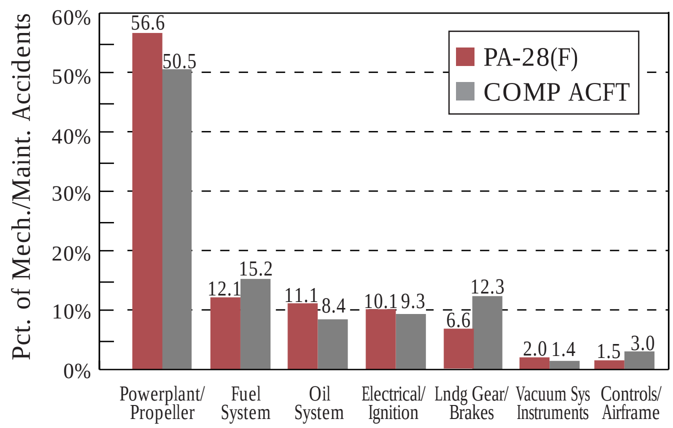
	Total	In IMC	IFR in IMC
PA-28(F)	388	106	23
COMP ACFT	628	148	42

PA-28R



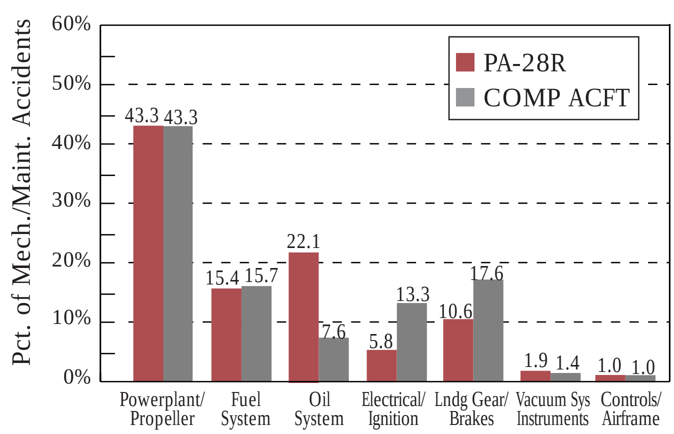
	Total	In IMC	IFR in IMC
PA-28R	114	34	15
COMP ACFT	191	62	35

Figure 8. System Involvement
PA-28(F)



	Powerplant/ Propeller	Fuel System	Oil System	Electrical/ Ignition	Lndg Gear/ Brakes	Vacuum Sys Instruments	Controls/ Airframe
PA-28(F)	112	24	22	20	13	4	3
COMP ACFT	222	67	37	41	54	6	13

PA-28R



	Powerplant/ Propeller	Fuel System	Oil System	Electrical/ Ignition	Lndg Gear/ Brakes	Vacuum Sys Instruments	Controls/ Airframe
PA-28R	45	16	23	6	11	2	1
COMP ACFT	91	33	16	28	37	3	2

retract the gear at slower speeds. Remember to promptly return the switch to its original position to activate the automatic system again; you may need it later in the flight. The POH requires disabling the system for optimal climb performance. If departing from a runway in which the deciding factor on clearing the obstacles at the end depends on getting the gear up in time, the safety margin is too thin and a longer runway is recommended.

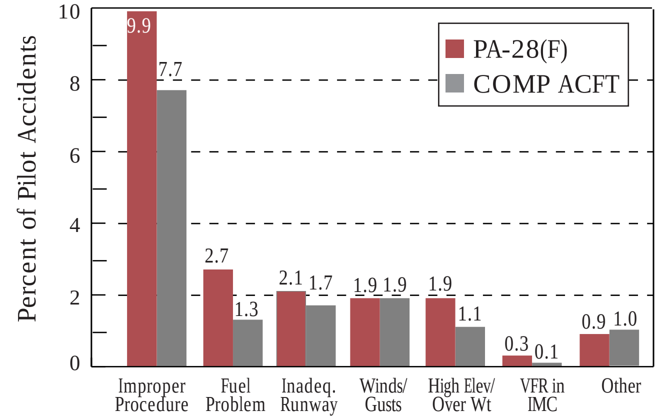
All aircraft must be maintained as recommended by the manufacturer, including engine overhauls and annual inspections. Even as a renter, the pilot in command is the final authority as to safety of flight. If you rent, the owner has some responsibility to maintain the aircraft, but the decision to fly is yours alone. If maintenance does not appear to be well done, take your business elsewhere. Your safety and that of your passengers depend on it.

The pilot and three passengers departed a valley airport after dark in their rented Arrow III. Because the runway was relatively short, 2,200 feet, the pilot elected to use short field takeoff and climb procedures. The aircraft flaps were set at 25 degrees for the takeoff and the flight departed in night VFR conditions. About 4 minutes after takeoff the airplane impacted trees near the top of a mountain ridge. All occupants survived the crash with minor injuries. The accident investigation revealed that the pilot had not flown the recommended departure procedure posted in the airport office. Even so, the aircraft was capable of clearing the ridge but climb performance was reduced because the landing gear failed to retract. The pilot had neglected to engage the automatic gear extension override and the climb speed was not sufficient to allow the gear to retract.

Takeoff

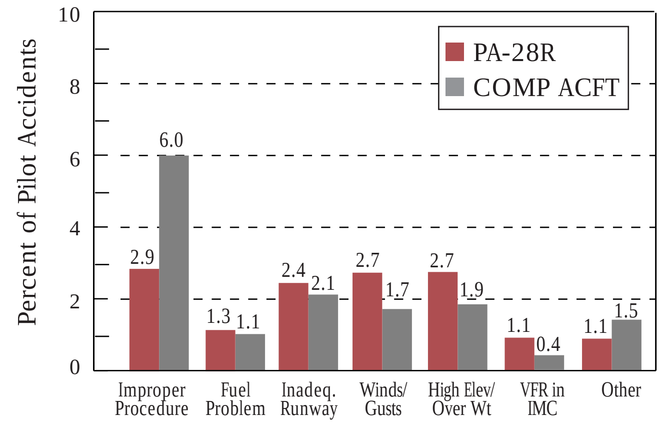
Before attempting to take off, the pilot should ensure that – considering aircraft performance, wind direction and speed, runway length, and obstructions – the takeoff can be made safely. The Archer II

Figure 9. Critical Phase of Flight–Takeoff
PA-28(F)



PA-28(F)	170	46	36	32	33	5	16
COMP ACFT	326	54	73	81	47	6	41

PA-28R



PA-28R	11	5	9	10	10	4	4
COMP ACFT	49	9	17	14	16	3	12

POH states that, for a normal takeoff under standard weather conditions, 1,800 feet is required to clear a 50-foot obstacle. That increases to 2,550 feet with a 10 knot tailwind. The obstacle clearance distance with 25 degrees of flaps is 1,600 feet, and 2,300 feet with a 10 knot tailwind. The Air Safety Foundation recommends adding 50 percent to allow for less than perfect performance from the aircraft or the pilot. For example, if it takes 1,800 feet to clear a 50-foot obstacle, the recommended takeoff distance is 2,700 feet. This also allows the pilot to reject the takeoff and stop on the remaining runway.

The majority of PA-28 takeoff accidents were due to improper procedures, such as loss of directional control, premature rotation/liftoff, and improper flap setting. (see Figure 9). Use of flaps decreases the takeoff over an obstacle under standard conditions by 200 feet, from 1,800 feet to 1,600 feet. For the fixed-gear Cherokees, improper procedure was the cause of the overwhelming majority of takeoff accidents, which is not surprising since many PA-28(F)s are training aircraft. Procedural problems tend to diminish as pilots gain skill, experience, and flight time.

The Arrow's takeoff accidents were primarily due to improper procedure, inadequate runway, winds/gusts, and high density altitude/overloaded aircraft.

Wind

The PA-28 series aircraft have a maximum demonstrated crosswind of 17 knots. This means that they were tested in winds up to 17 knots, but may actually be able to endure stronger winds. The PA-28 has the reputation of being a good crosswind airplane, due to the low wings and wide gear. However, the pilot's capabilities may be less than the aerodynamic limitations.

Taxiing in crosswinds requires caution. When taxiing in a quartering headwind, remember to turn the ailerons into the wind. Turn the ailerons away from the wind and move the control yoke forward, or "dive away," if in a quartering tailwind. That will keep the upwind wing from lifting when the wind pushes on it.

There are two crosswind landing methods, the wing low method and the crab, or kickout, method. Practice with an instructor to see which one works for you.

Approaches

Prepare for arrival in the cruise phase of flight, *before* entering busy terminal areas. Review appropriate aspects of the approach:

✓ Obstructions in the area
✓ Runway lengths
✓ Wind direction and speed
✓ Radio frequencies
✓ Sectional and/or approach charts and airport taxi diagrams
✓ Landing minimums
✓ Missed approach procedures

When in the traffic pattern, be aware of other traffic. Scan constantly, and stay alert. Most PA-28(F) approach accidents occurred in VFR conditions, while the Arrow was involved in most approach accidents under IFR flight. (see Figure 10).

Note: VFR pilots should be familiar with instrument fixes near the airport. That will help them to visualize traffic and lessen confusion from IFR terminology.

The Wind Got Me

Just how much crosswind an airplane can tolerate is determined during certification testing and published in the Pilot's Operating Handbook (POH). Airplane accidents generally involve a pilot somewhere in the process, though, and how much wind a pilot can handle varies from person to person and, even in one person, from day to day. Pilot competency is determined during the certification checkride and, in many cases, begins to deteriorate immediately. Master aviators not only learn their lessons well, they continually practice to keep piloting skills honed to perfection.

Let's review how wind affects airplanes. On the ground, an airplane, be it conventional or tricycle gear, acts like a weather vane, rotating around the vertical axis to point into the wind. This tendency, although more pronounced in tailwheel airplanes, is common to all and pilots must know how to cope or suffer the consequences. A steady state wind aligned with the runway increases the airplane's performance with no control penalty, providing the pilot takes off or lands into the wind. Tailwinds increase airplane takeoff and landing distances and crosswinds require compensation from the pilot. The effect of crosswind is greatest when the wind is 90 degrees to the runway and decreases the closer the wind is to the runway heading. Many POHs contain taxi charts that depict control placement to compensate for various wind conditions, and all provide maximum demonstrated crosswind performance data.

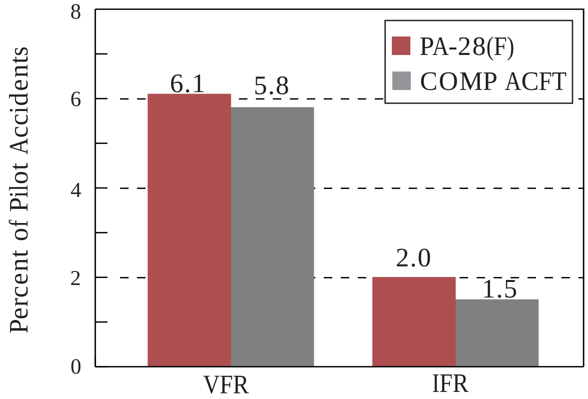
Wind shear, a sudden change in wind direction or speed, is a common atmospheric phenomenon that has caused many airplane accidents over the years. Wind can shear in the horizontal plane and, especially in convective weather, the vertical. It is possible for wind to shear from a headwind to a tailwind or vice versa while an airplane is close to the ground on final approach. The headwind to tailwind shear is particularly dangerous because it can cause an airplane to stall or land short of the runway.

Terrain features near airports can generate impressive shear. Many runways are known to have "air pockets" at one or both ends. The sinking sensation pilots experience when approaching these runways is more often than not a decrease in headwind component due to wind shear. A study of the terrain around an airport will often reveal features that consistently promote wind shear. Local pilots familiar with the environment usually cope well with shear conditions at their field, but many an itinerant pilot has had a wild ride on short final.

No matter what the wind, pilots must cope or divert to a more suitable field. The secrets to coping are good initial and recurrent training, and practice.

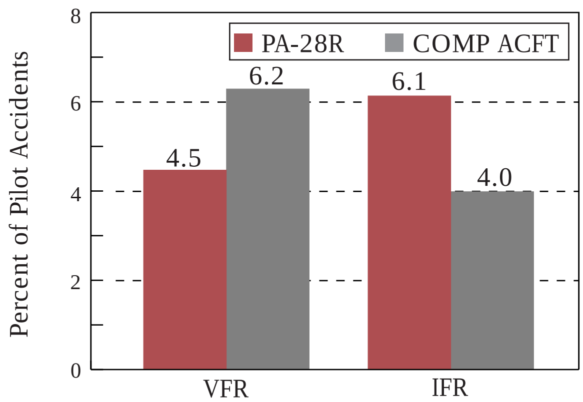
Figure 10. **Critical Phase of Flight–Approach**

PA-28(F)



PA-28(F)	106	34
COMP ACFT	246	65

PA-28R



PA-28R	17	23
COMP ACFT	51	33

Regular practice of short field, soft field, and emergency procedures will increase pilot proficiency and confidence. Towered airports are prime places to be faced with various types of approaches. Air traffic controllers may clear you to base, or for a straight-in approach, instead of having you fly a standard traffic pattern. At nontowered airports, IFR traffic will often fly straight-in approaches. ASF recommends dual instruction for new pilots before flying at unfamiliar airports with short runways or high density traffic.

The Air Safety Foundation's Safety Advisors, *Operations at Towered Airports* (www.aopa.org/asf/publications/sa07.html) and *Operations at Nontowered Airports* (www.aopa.org/asf/publications/sa08.html) are helpful tools for all pilots.

Landing

Landing was the phase of flight with the highest number of PA-28 accidents. Ground effect is more pronounced in low wing aircraft so it's not surprising that landing long is the most common fixed-gear Cherokee landing problem. Precise airspeed control will minimize float. The comparison aircraft group had landing accidents mostly as a result of hard touchdowns. (see Figure 11).

The most common landing problem for Arrow pilots and the comparison group is landing hard. Airspeed control and proper flare are necessary for soft landings.

Go-arounds result in many accidents. If you are not down safely in the first third of the runway, go around immediately. Practice go-arounds regularly.

Note: Periodic dual instruction is an excellent way for pilots to maintain takeoff and landing proficiency. During these training sessions pilots should practice takeoffs and landings at gross weight. Airplanes perform very differently when loaded at or near their limits. ASF recommends a "full load" checkout for all transitioning pilots.

After landing, remember that ground operations may be as complicated as flight and full attention should be devoted to taxiing. Taxi diagrams are available from ASF at www.aopa.org/asf/taxi.

Emergency Procedures

Emergencies are rare so regular practice is recommended. **Be prepared**. Pilots who are familiar with aircraft systems and equipment are better prepared to troubleshoot problems. For instance, Arrow pilots should be familiar with emergency gear extension procedures. Emergency checklists should be readily available and pilots should practice emergency procedures regularly.

In any emergency, remember to do the following:

- ✓ Aviate – Aircraft control is the most important task.
- ✓ Navigate – Decide on a destination, and turn to the appropriate heading.
- ✓ Communicate – Reaching for the mic is not the first item on the priority list and should be done only after all other items are completed.

Don't let a distraction lead to disaster. Fly the aircraft first. Prioritize and evaluate the situation. For example, an open door in flight is not nearly as serious as an engine failure. When simulating emergencies, reduce the risk by:

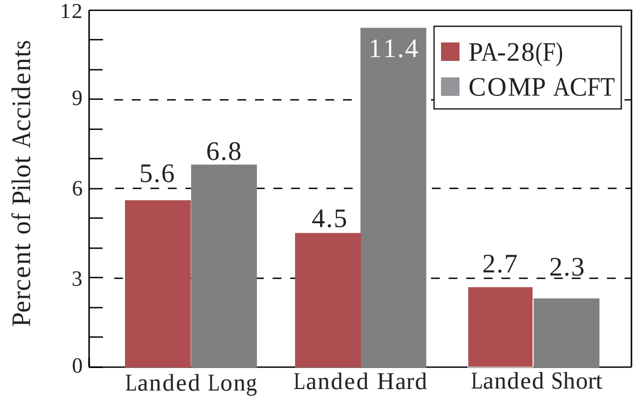
- ✓ Avoiding low altitude flight
- ✓ Avoiding disabling the aircraft during a simulated emergency. (Poor practice includes pulling the mixture, turning the mags off, or shutting off the fuel.)
- ✓ Using checklists

The accident below occurred because the pilot failed to conduct a thorough preflight examination and was not prepared to fly the aircraft with inoperative equipment. Airspeed should be checked early in the takeoff roll. If a discrepancy is noted, reject the takeoff. If the problem occurs in flight, routine power settings and pitch attitudes will yield routine performance.

Just after takeoff, the 560-hour commercial pilot noticed that the airspeed indicator was inoperative. The pilot returned for landing. During the turn from base to final approach, the pilot overshot both the right and left runways. The aircraft was landed to the left and short of the runways where, during the landing roll, the aircraft collided with two parked vehicles. Inspection of the aircraft revealed that there were no mechanical failures or malfunctions, but duct tape was found wrapped around the pitot tube. Examination of the aircraft logbooks revealed a pitot/static test was accomplished just prior to this flight. The mechanic who performed the test stated that he did not remove the tape.

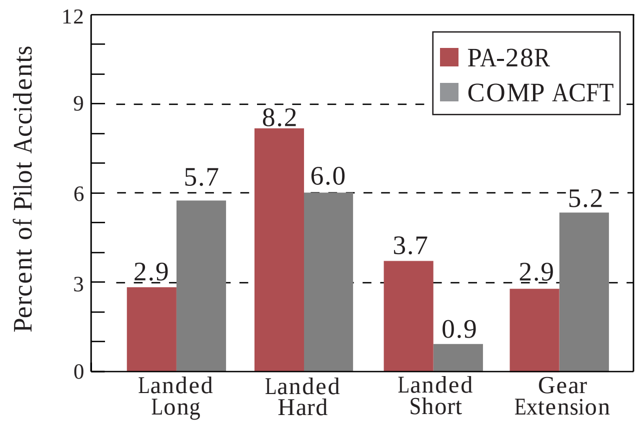
Figure 11. Critical Phase of Flight–Landing

PA-28(F)



	Landed Long	Landed Hard	Landed Short
PA-28(F)	96	77	47
COMP ACFT	288	487	96

PA-28R



	Landed Long	Landed Hard	Landed Short	Gear Extension
PA-28R	11	31	14	11
COMP ACFT	47	49	7	43

PA-28(F) and PA-28R Test Questions

The purpose of this open-book test is to familiarize the pilot with the PA-28(F) Cherokee and PA-28R Arrow, and their corresponding POHs. There are many variations in the models. The 1976 Archer II was chosen as the test airplane; answers given pertain to that aircraft. Refer to the POH for your aircraft as you complete the test. The questions preceded by an asterisk (*) pertain to retractable-gear only (Arrow). Those questions preceded by two asterisks (**) pertain to fuel-injected engines. The test airplane for those questions is the 1979 Arrow IV.

1. What is the total fuel capacity? ___________ gallons Usable? ___________ gallons

2. What is the correct fuel grade? ______________________________

3. Where are the fuel drains located, and when are they drained? ______________________________

4. What is the recommended grade and type of oil? ______________________________

5. What is the minimum operating oil level? ______________________________

6. Empty weight? ___________ Useful load? ___________

7. Maximum gross takeoff weight? ___________

8. What are the recommended airspeeds (KIAS) and flap settings for:

   Normal takeoff, flaps up ___________ Soft-field landing, flaps down ___________

   Normal landing, flaps down ___________ Short-field takeoff, flaps 25 degrees ___________

   Soft-field takeoff, flaps 25 degrees ___________ Short-field landing, flaps down ___________

9. What is the economy cruise fuel consumption at 65% power, 8,000’ density altitude, and maximum gross weight? ___________

10. List the following airspeeds:

   Best rate of climb (Vy) ___________ Stalling speed, clean (Vs) ___________

   Best angle of climb (Vx) ___________ Stalling speed, full flaps (Vso) ___________

   Maneuvering speed, gross weight (Va) ___________ * Stalling speed full flaps, gear down (Vso) ___________

   Maximum flap extension (Vfe) ___________ Best gliding ___________

   * Maximum gear extension (Vlo) ___________ Never exceed (Vne) ___________

11. What is the maximum demonstrated crosswind component? ___________

12. * What are the unsafe gear indications? ______________________________

13. * What is the procedure for emergency gear extension? ______________________________

14. How do you detect carburetor or induction ice? ______________________________

15. How do you prevent carburetor or induction ice? ______________________________

16. In the event of carburetor or induction ice, what is the proper procedure? ______________________________

17. ** What is the purpose of the engine alternate air control? ______________________________

18. What would be the indication of alternator or generator malfunction? ______________________________

19. How would you restore electrical power? ______________________________

20. What would you do if unable to restore the alternator/generator power? ______________________________

21. In the event the vacuum pump failed (no backup systems), what flight instruments would **not** be available? ______________________________

22. In the event the electrical system failed, what flight instruments would **not** be available? ______________________________

23. Where is the alternate static source (if installed) located? ______________________________

24. What flight instruments would be available if the static system was plugged up and there was no alternate static source? ______________________________

____

25. What is the power setting, TAS, and fuel consumption for the following at maximum gross weight?

65% power, 7,000’, standard temperature

   Manifold pressure/rpm ___________ TAS ___________ Fuel consumption ___________

26. What aircraft documents must be on board during flight? ______________________________

27. What is the engine failure procedure immediately after takeoff? ______________________________

Answers to PA-28 and PA-28R Test Questions

1. The total fuel capacity is 50 gallons; 48 gallons are usable. Refer to POH, Section 2, Limitations.

2. The correct fuel grade is 100LL Aviation Fuel (blue) or 100 Grade A Aviation Fuel (green). Refer to POH, Section 2, Limitations.
   ASF recommendations:
   - Always lean the mixture for improved engine performance and fuel economy.
   - Always land with at least 1 hour fuel reserves on board.
   - Never plan a fuel stop within 1 hour or 100nm of your destination.

3. There is one fuel drain under each wing near the main gear and one on the lower left side of the engine cowl. Drain them when preflighting and after refueling. Refer to POH, Section 4, Normal Procedures.

4. The recommended type of oil for use after engine break-in is ashless dispersant; the grade for use between 30 degrees F and 90 degrees F is SAE 40; for use above 60 degrees F, SAE 40 or 50; and for use above 80 degrees F, SAE 60. Refer to POH, Section 1, General.

5. The minimum operating oil level is 2 quarts, but ASF recommends a minimum of 6 quarts. Refer to POH, Section 8, Handling, Servicing, and Maintenance.

6. Standard empty weight is 1416 lb. The useful load is 1134 lb. Refer to POH, Section 1, General.

7. The maximum gross takeoff weight is 2550 lb. Refer to POH, Section 1, General.

8. The recommended airspeeds (KIAS) and flap settings for:

Normal takeoff, flaps up:	65
Normal landing, flaps down:	66
Soft-field takeoff, flaps 25 degrees:	Rotate at 49, accelerate to 54, climb out at Vy
Soft-field landing, flaps down:	66
Short-field takeoff, flaps 25 degrees:	Rotate at 49, accelerate to 54, climb out at Vx (for obstacle clearance) or Vy
Short-field landing, flaps down:	66

   Refer to POH, Section 4, Normal Procedures.

9. The economy cruise fuel consumption at 65% power, 8,000' density altitude, and maximum gross weight is 7.6 gph. This is based on economy leaning procedures as recommended by the manufacturer. Refer to POH, Section 5, Performance.

10. V speeds, KIAS:

Best rate of climb (Vy)	76
Beset angle of climb (Vx)	64
Maneuvering speed, gross weight (Va)	113
Maximum flap extension (Vfe)	102
* Maximum gear extension (Vlo)	130
Stalling speed, clean (Vs)	55
Stalling speed, full flaps (Vso)	49
* Stalling speed full flaps, gear down (Vso)	53
Best gliding speed	76
Never exceed (Vne)	154

    Refer to POH, Section 2, Limitations and Section 4, Normal Procedures.

11. The maximum demonstrated crosswind component is 17 knots. Refer to POH, Section 2, Limitations.
    ASF recommends regular crosswind takeoff and landing practice.

12. * The unsafe gear indications are a red "Warning Gear Unsafe" light on the panel and a warning horn. The warning horn will activate if the gear is up and power is reduced below 14" manifold pressure. Refer to POH, Section 7, Description and operation.

13. * The procedure for emergency gear extension is to fly at 87 KIAS and put the gear selector switch down. If the gear has failed to lock down, raise the emergency gear lever to the OVERRIDE ENGAGED position. If the gear has still failed to lock down, move the emergency gear lever to the DOWN position. If the gear has still failed to lock down, yaw the airplane abruptly from side to side with the rudder. Refer to POH, Section 3, Emergency Procedures.

14. Carburetor/induction ice is detected by engine roughness and/or a drop in rpm or manifold pressure. Refer to POH, Section 3, Emergency Procedures.
15. Prevent carburetor/induction ice by avoiding weather conditions conducive to icing. Refer to POH, Section 3, Emergency Procedures. Conditions conducive to carburetor or induction icing include:
    - High humidity
    - Temperature between 14°F and 77°F
    - Low power or closed throttle settings
16. In the event of carburetor/induction ice, apply FULL carburetor heat. (Partial carb heat applications can worsen the situation.) Refer to POH, Section 3, Emergency Procedures.
17. **The engine alternate air control provides an alternate path for airflow, in case the primary path becomes blocked. Refer to POH, Section 7, Description and Operation.
18. Alternator or generator malfunction is indicated by an ammeter indication of zero with an electrical load and/or alternator annunciator illuminated. Refer to POH, Section 3, Emergency Procedures.
19. In the event of loss of electrical power:
    - Reduce electrical load as much as possible
    - Check alternator circuit breakers
    - Attempt to restore electrical power by turning the ALT switch OFF for 1 second, then ON

    Refer to POH, Section 3, Emergency Procedures.
20. If unable to restore the alternator/generator power, turn ALT switch OFF and land as soon as practical. Refer to POH, Section 3, Emergency Procedures.
21. In the event the vacuum pump failed (no backup systems), the attitude indicator and heading indicator would **not** be available. Refer to POH, Section 7, Description and Operation. ASF recommends regular partial panel practice, and installing a standby vacuum system in the aircraft.
22. In the event the electrical system failed, the turn coordinator would **not** be available. Refer to POH, Section 7, Description and Operation.
23. The alternate static source (if installed) is located below the left side of the instrument panel. Refer to POH, Section 7, Description and Operation.
24. If the static system was plugged up and there was no alternate static source, the turn coordinator, attitude indicator, and DG would be available. Refer to POH, Section 7, Description and Operation.
25. At 65% power, 7,000', and standard temperature, the manifold pressure/rpm is 2500 rpm, the TAS is 112 kt., and the fuel consumption is 7.6 gph. Refer to POH, Section 5, Performance.
26. The following documents must be on board during the flight: ARROW – airworthiness certificate, registration certificate, radio station license (for international flight only), operating limitations (*Pilot's Operating Handbook*), weight & balance data, and aircraft equipment list. Refer to POH, Section 8, Handling, Servicing, and Maintenance.
27. If an engine failure occurs immediately after takeoff, lower the nose to maintain the best glide speed, land straight ahead, full flaps if possible, and touchdown slightly above stall speed. Refer to POH, Section 3, Emergency Procedures.

PA-28 and PA-28R Training Course Outline

INTRODUCTION

This outline is a training guide for pilots and flight instructors. Because of variables involving pilot experience and proficiency, the training should be flexible. Pilots should perform all tasks to practical test standards (PTS). At the satisfactory conclusion of training, the pilot should receive a flight review endorsement and, if instrument-rated, an instrument proficiency check.

This training course outline is divided into four blocks of instruction. The first block, consisting of two hours ground orientation, concentrates on the PA-28, 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 flight. The time required to complete this training will vary with pilot proficiency. Average time to complete each block is indicated below.

Block 1: Ground Orientation

The pilot will review normal and emergency operations, calculate weight and balance, and calculate takeoff and landing performance data. All documents covering aircraft and electronic modifications will be reviewed.

Ground: 2.0 hours

Airplane and Systems
- Flight controls
- Installed instruments, avionics, and autopilot
- Landing gear and hydraulic system
- Brakes
- Seats, seat belts, and doors
- Engine and engine instruments
- Propeller
- Fuel system
- Electrical system, ground service plug
- Lighting systems
- Environmental control system
- Pitot-static system and instruments
- Vacuum system and instruments
- Anti-ice systems
- Supplemental oxygen system
- Turbocharged engine system

Aircraft Inspections and Handling
- Required inspections
- Ground handling
- Fueling
- Oil, hydraulic, oxygen replenishment

Performance
- Use of performance charts
- Takeoff distance, time, fuel, and distance to climb charts
- Cruise performance charts
- Range and endurance charts
- Landing distance charts

Weight and Balance
- Review of Aircraft Equipment List
- Determination of weight and balance from sample loadings

Limitations
- Airspeeds
- Powerplant
- Fuel system
- Operating instrument indications

Normal Procedures
- Speeds for normal operation
- Preflight inspection
- Engine start and runup
- Taxiing
- Normal, short-field, and crosswind takeoffs
- Normal and maximum performance climbs
- Cruising flight
- Descents
- Normal, short-field, and crosswind landings
- Balked landings and go-arounds
- Flap retraction procedures
- After landing, securing the aircraft

Emergency Procedures
- Airspeeds for emergency operations
- Engine failure procedures
- Emergency and precautionary landings
- Fires
- Icing
- Vacuum, pitot, and static system failures
- Electrical system malfunctions
- Emergency landing gear extension (if applicable)
- Emergency descents
- Inadvertent door opening in flight

Troubleshooting
- Autopilot and electric trim malfunctions
- Relationship of vacuum failures to autopilot operation
- Electrical system and what to do if charging system fails
- Load shedding and estimated time of usable battery life
- Hung starter indications and remedies
- Emergency checklists
- Relationship between EGT and fuel flow on climb and cruise

Block 2: General Flight Operations

The pilot will review instrument regulations, requirements, and local approach procedures.

Ground: 1.0 hours

Weight and Balance

Review of Normal and Emergency Procedures

Flight: 2.5 hours

Preflight Operations
- Takeoff, climb, landing performance calculations
- Preflight line check
- Starting:
  Normal
  Hot
  External power
- Pretakeoff 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

Instrument
- Turns, climbs, descents
- Slow flight
- Unusual attitude recovery
- Recovery from approaches to stalls

Emergency Procedures
- Engine Failure
- Fire in flight
- Induction ice
- Alternator failure
- Fuel pump failure
- Vacuum pump failure
- Landing gear extension (if applicable)

Landings
- Normal
- Crosswind
- No flap
- Short field
- Soft field
- Balked (go around)
- Failed engine

Block 3: IFR Operations

The pilot will review equipment requirements, charts, and aircraft-specific procedures.

Ground: 1.5 hours
Requirements for Instrument Flight
- Pilot – certificates, ratings, and currency
- Aircraft – required equipment certification RNAV/Loran/GPS

Autopilot

Preflight Briefing

Flight: 1.5 hours
Clearance copy, accurate readback
- Avionics configuration

Pretakeoff
- Checklist
- Clearance copy and readback
- Instruments
- Avionics
- Charts

Departure
- Heading and altitude
- Route interception
- Amended clearance

Holding
- Aircraft configuration
- Entry procedure
- ATC reporting

NDB Approach
- Approach clearance
- Configuration
- Tracking, orientation, altitude, MDA
- Interception of bearings
- Timing, MAP
- ATC coordination

Missed Approach
- Climb, heading, altitude
- Course interception
- Climb checklist
- ATC and CTAF

DME Arc
- Arc interception
- Orientation
- Radial identification
- ATC and CTAF

VOR Approach
- Approach clearance

Aircraft Configuration
- Tracking, orientation
- Altitudes, MDA
- MAP identification
- ATC and CTAF

GPS Approach
- Approach clearance
- Approach programming
- Approach arm
- Missed approach

Circling Approach
- Altitude
- Distance from airport
- Traffic avoidance
- MAP procedure
- ATC and CTAF

ILS Approach
- Approach clearance
- Aircraft configuration
- Tracking, orientation
- Altitudes, DH
- MAP procedure
- ATC and CTAF

Block 4: Cross-Country IFR/VFR Operations

The pilot will demonstrate proficiency in VFR and/or IFR cross-country operations.

Ground: 1.0 hours

The Flight Environment
- Airspace
- FAR Part 91

Weather
- The atmosphere
- Winds and clear air turbulence
- Clouds and thunderstorms
- Icing
- Weather products and services available for pilot use

Flight Planning and Navigation
- Fuel: Wind and ATC routings
- Navigation
- Charts
- Navaids
- Planned descents

Emergency Operations
- In-flight fire
- Turbulence
- Thunderstorms
- Ice

Flight: 1.5 hours

Preflight Briefing
- Line check
- Charts, documents
- Checklist use
- Clearance copy and readback
- Departure

Climb
- Checklist

Cruise
- Checklist
- Power setting
- Mixture

Emergencies
- Descent (discussion only)
- Alternator failure
- Load shedding
- Flight plan change
- ATC coordination
- In-flight fire
- Checklist use

Descent
- Planning
- Engine temperature
- Airspeed

Approach and Landing
- Checklist use

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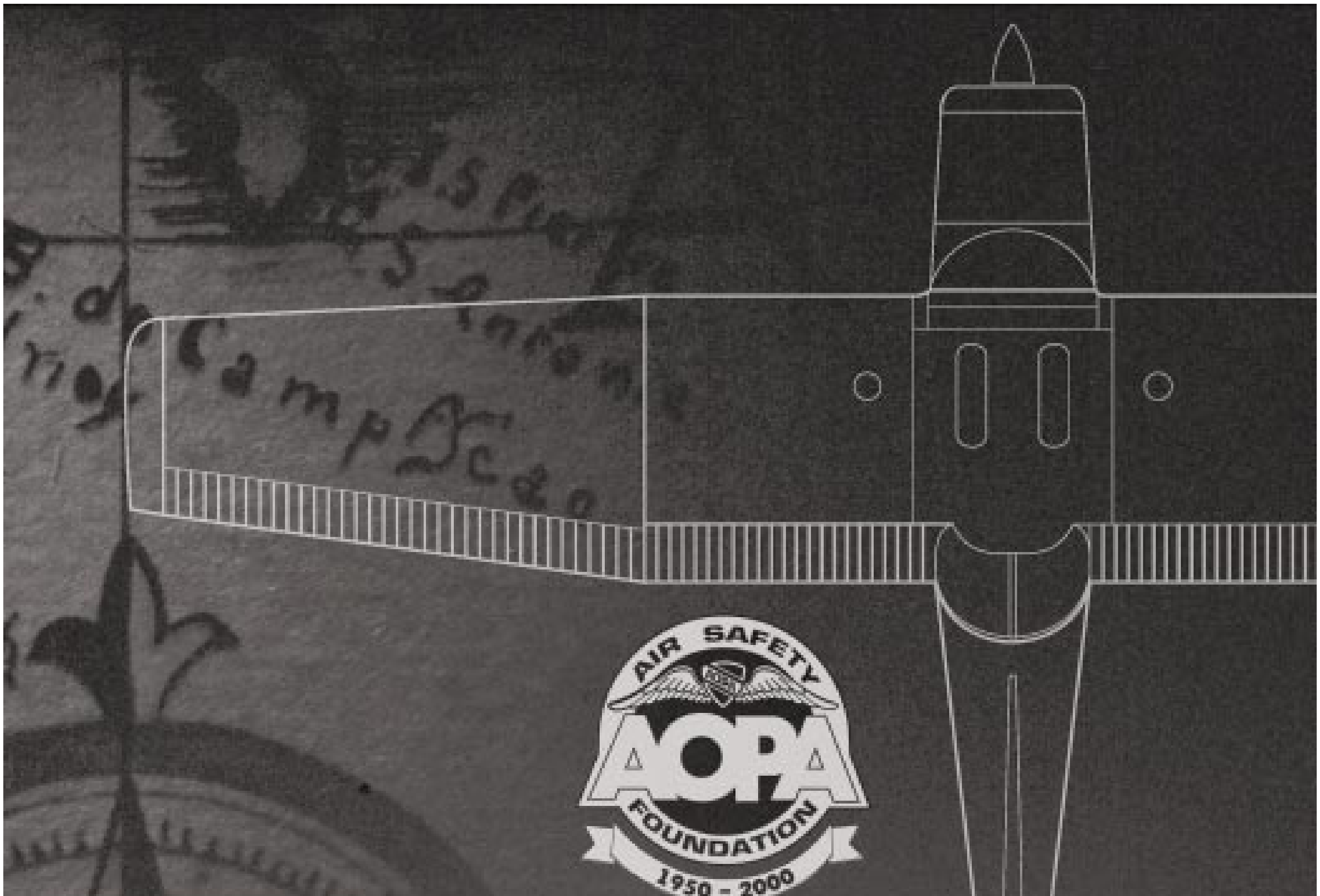

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