Beechcraft Bonanza/Debonair Safety Highlights

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Introduction

The Beechcraft Bonanza aircraft design, in production for more than 50 years, is perhaps the most successful single-engine retractable aircraft ever built for general aviation. There are currently more than 12,000 Bonanzas on the FAA Aircraft Registry. This Safety Highlight analyzes Bonanza/Debonair accidents (models 33, 35, 36) that occurred between 1983 and 1999. Included are 1,143 Bonanza accidents and 2,578 accidents from a comparison group, comprised of the following aircraft: Cessna 182RG Skylane, Cessna 210 Centurion, Mooney M20, Piper PA-24 Comanche, Piper PA-32R Saratoga, and Rockwell 112 and 114.

For comparison purposes, the graphs in this review have been divided into two categories: model 35 and models 33/36. The comparison aircraft are the same for each group.

Statistical Analysis

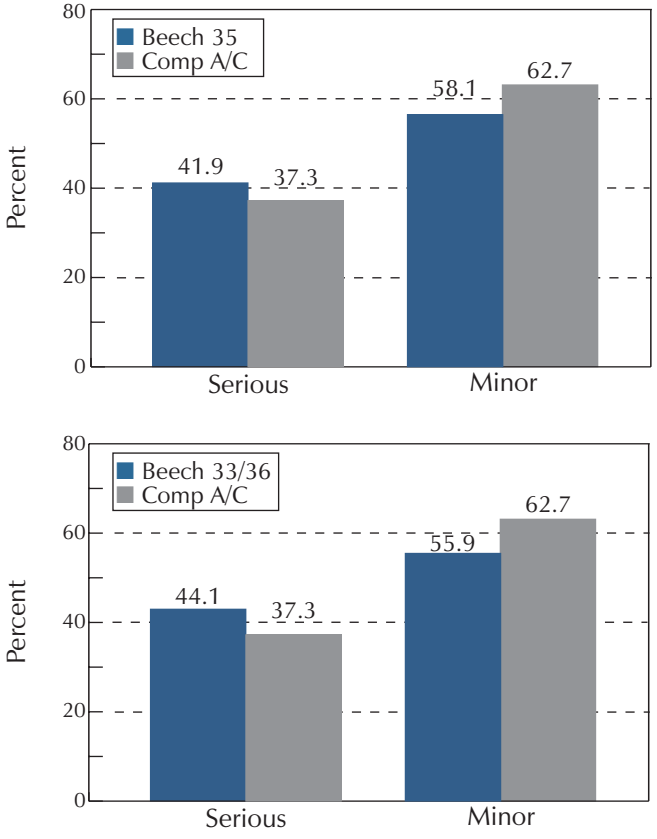
According to FAA estimates, Bonanza/Debonair aircraft flew approximately 20.2 million hours during the years 1983-1999. There were 1,143 accidents during that time, which averages out to 6.72 accidents per 100,000 hours for the Beech 35 model and 4.65 for the Beech 33/36. The accident rate for the comparison group was higher at 7.46 accidents per 100,000 hours.

More than half of the accidents analyzed, or 58.1 percent of BE-35, 55.9 percent of BE-33/36, and 62.7 percent of the comparison aircraft accidents were minor, resulting in little or no injury. (See Figure 1.) Many of these occurred during the takeoff and landing phases of flight, when accidents are likely to result in minor injuries due to the low speed at impact.

Serious accidents accounted for 41.9 percent of BE-35 and 44.1 percent of BE-33/36 accidents, while 37.3 percent of the comparison group met the NTSB Part 830 criteria for serious accidents.

The majority of Bonanza accidents (69.1 percent of Beech 35 and 80.4 percent of Beech 33/36) were due to pilot error. Mechanical/maintenance problems caused about 19 percent and 11

Figure 1. Accident Summary
Serious and Minor

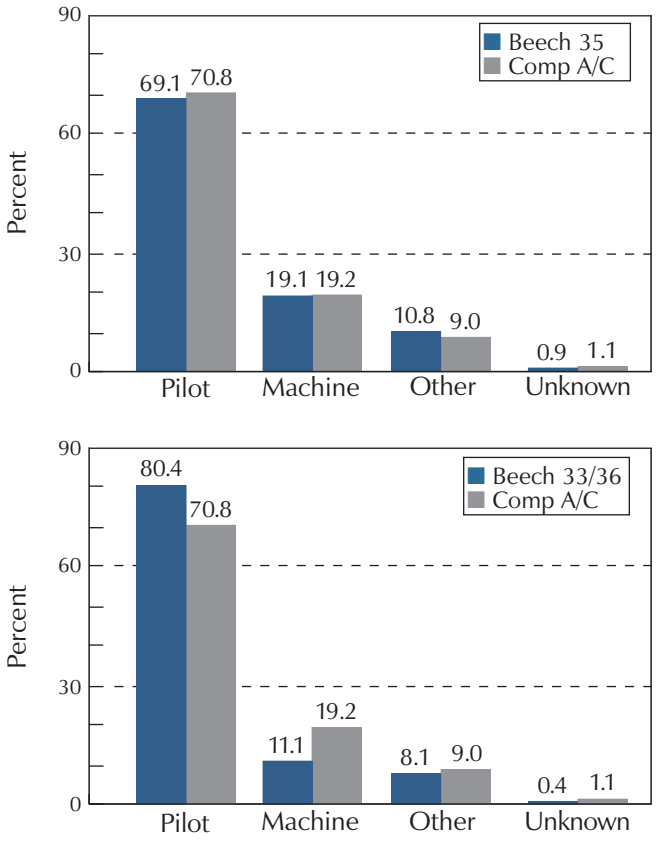


Number	Beech 35	Beech 33/36	Comp A/C
Serious	278	211	962
Minor	386	268	1,616

percent, respectively. Approximately 10 percent were attributed to other causes and unknown factors. (See Figure 2.)

Older aircraft tend to have a higher chance of maintenance-related accidents. The 1947 model 35 Bonanzas were built over 50 years ago and the last 1982 V35B is now nearly 20 years old, with only the 33/36 series having been manufactured since then. Pilots of early model Bonanzas need to be especially cautious and have their aircraft inspected at the appropriate intervals.

Figure 2. Major Cause All Accidents



Number	Beech 35	Beech 33/36	Comp A/C
Pilot	459	385	1,824
Machine	127	53	494
Other	72	39	232
Unknown	6	2	28

Aircraft

Weight and Balance

The 670-hour BE-35 pilot was on a cross-country flight at 4,000 feet. Shortly after a turn was initiated, radio and radar contact were lost. The aircraft, with three passengers plus baggage and fuel on board, was found scattered over a distance of 2,193 feet. The aircraft gross weight was estimated to be close to the maximum, and the CG was about 5.1 inches behind its aft limit.

The weight and balance of any aircraft affects it in all phases of flight. Taking off in an overloaded airplane may be impossible, especially from a short runway. An out-of-balance airplane may rapidly become uncontrollable during the takeoff roll (usually just after liftoff), or later in flight as fuel burn shifts the CG or turbulence is encountered.

The weight and balance section of the Bonanza's POH includes a loading example for your convenience. Pilots should consult the CG chart before each flight to verify they have loaded the aircraft within the CG "envelope," or limitation range.

Be familiar with the weight and balance limitations for the aircraft that you fly. For example, V-tail Bonanzas have a narrower CG envelope than conventional tail Bonanzas. Loading calculations are critical. It is possible to be within the aircraft's weight limitations, but out of CG range, as with the accident report below, left. The following chart shows the calculations for a similar flight in a BE-35. Takeoff weight is within limits (the maximum allowable is 3,400 pounds), but the CG, 88.5, is 4.1 inches behind the aft limit of 84.4 inches.

Item	Weight	Moment/100
Basic empty weight	2,167	1,700
Front seat occupants	170	144
3rd and 4th seat occupants	360	436
Baggage	270	405
Subtotal / zero fuel	2,967	2,685
Fuel loading (74 gal)	444	333
Subtotal / ramp	3,411	3,018
Less fuel for start, taxi, takeoff	-12	-9
Total for takeoff	3,399	3,009

Most Bonanzas have a useful load of 1,100-1,200 pounds. However, useful loads can range from approximately 1000 pounds for the early model 35s to over 1,500 pounds for the B-36TCs. Gross weights across the various models range from 2,550 pounds to 3,850 pounds. Aftermarket auxiliary fuel tip tank and vortex generator installations on many models can increase the gross weight and useful load. Over the years, factory changes to the many different Bonanza/Debonair models, coupled with aftermarket modifications, have resulted in significant differences in aircraft capabilities and systems operations from one aircraft to another.

A thorough checkout and familiarity of each aircraft's systems is essential for the prudent pilot. The actual useful load limit for the aircraft you fly will depend on the particular model, any associated modifications, and the weight of the equipment installed in it. You can likely carry three passengers with baggage and full fuel, but be sure to

calculate the weight and balance for such trips. Local flights with an instructor, a couple of flight bags, and full fuel tanks will not be a problem with this aircraft.

Autopilot

The autopilot is an invaluable piece of equipment that will reduce workload on long flights and under single-pilot IFR conditions. The FAA believes so much in autopilots that they are required for single-pilot IFR air taxi flights. At the very least, the autopilot will maintain a wings-level attitude while the pilot troubleshoots a problem or navigates out of hazardous weather. It should be a part of your aircraft familiarization training. Review its operation regularly and always perform a thorough autopilot preflight.

Some autopilot tips:

- Know how to disengage the autopilot quickly by at least three methods.
- Know where the autopilot derives attitude information–some depend on the attitude indicator, which is usually vacuum powered, others on the turn coordinator. When the vacuum pump fails, the autopilot may be inoperative when needed the most.
- Use the autopilot when programming GPS equipment or consulting charts.
- Many pilots hand fly departures and arrivals to maintain proficiency and let the autopilot handle the long, relatively inactive en route portion of the flight.
- Practice using the autopilot in good weather and practice coupled approaches so on that dark, cloudy IMC night when you're tired, the autopilot will help bring you down safely.
- Be able to hand fly the aircraft at any point, if needed, and don't be reluctant to advise ATC to stand by if you're busy after an autopilot failure.

Fuel

Beech 35 Bonanzas had 18 pilot-related fuel accidents, compared to 83 for the comparison group. Beech 33/36 Bonanzas and Debonairs had six fuel accidents. That equals 8.3 percent of all pilot-related BE-35 accidents, 3.3 percent of the BE-33/36 accidents, and 11.1 percent of the comparison group's pilot-related accidents.

Review the fuel system for the aircraft you fly. Prior to 1961, many BE-35s had two main wing tanks and one or two auxiliary tanks. There was a single fuel gauge with a left/right selector switch to monitor fuel on board. Later models differ from earlier models. Consult the POH for the aircraft you fly.

Keep track of fuel burn by using a fuel log. This will help establish the fuel usage of that aircraft. A 1972 G33 Bonanza has a cruise fuel flow of 11.4 gph at 65 percent power. (Note: ASF recommends adding a safety margin to POH numbers, so the following example is based on a fuel flow of 13.0 gph.) For a flight at 8,000 feet, the zero-wind range (60 gallons/one hour reserve) is 576 nm. With a 20-knot headwind, the range is reduced to 504 nm, a 72 nm difference. Fly based on time, not distance.

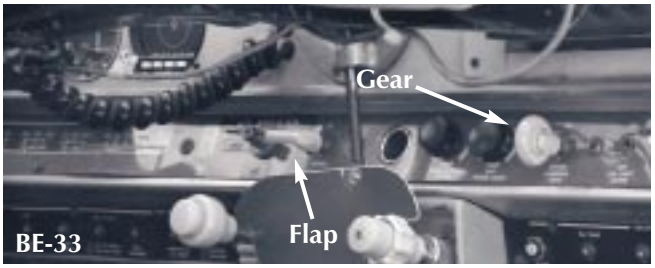
ASF fuel recommendations:

- Land with at least one hour of fuel reserves on board.
- Learn to lean properly and do it on every flight–most engines *may be leaned at any altitude*, provided they are below the approved power setting.
- Add two gallons per hour to book consumption numbers until you have accumulated some experience with that particular aircraft to verify the fuel burn with your leaning techniques. Estimate the fuel consumption for each flight and check that against the actual amount of fuel added.
- Avoid fuel stops within 100 miles or one hour of your destination. There is great temptation to continue on to the destination.
- For more information on fuel management see ASF's *Fuel Awareness* Safety Advisor online at www.aopa.org/asf/publications/sa16.pdf.

Landing Gear

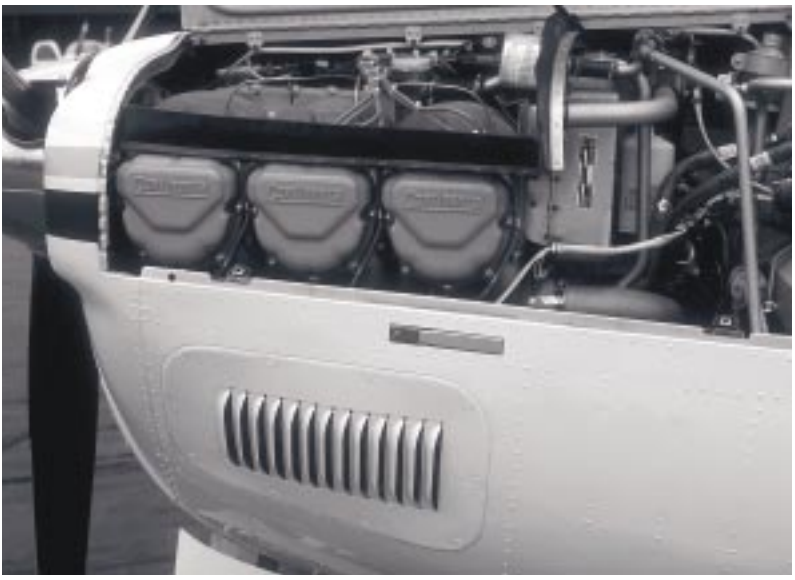
The Bonanza landing gear has changed only slightly since the 1940s. In the early years, Bonanzas were equipped with full swiveling nose wheels. However, the need for nose wheel steering on ice and snow, and in the event of brake failure, caused later models to be fitted with nose wheel steering. Increased gross weights on later models produced the need for a stronger landing gear, so the gear has also been strengthened as needed.

On V-tail Bonanzas and some BE-33/36 models (built prior to 1984), the location of landing gear and flap switches is reversed from the normal position of other retractable-gear aircraft. ASF recommends using extreme caution when operating the flap switch while on the ground. The early model Bonanzas have a significantly higher involvement in inadvertent gear retraction than other aircraft. ASF recommends waiting to perform the after landing check until off the runway.



During landing rollout, while turning off the runway, the pilot inadvertently selected gear up on the BE-35 aircraft. The pilot, who owns a similar aircraft, had borrowed this aircraft. The gear and flap controls on the pilot's aircraft are in the opposite position of those in the borrowed aircraft. The pilot intended to raise the flaps, not the gear.

Mechanical



Of the 180 Bonanza/Debonair and 494 comparable aircraft mechanical/maintenance accidents, approximately 50 percent of each group's were due to powerplant/propeller problems. (See Figure 3.) The fuel system and airframe each caused 22.1 percent of Beech 35 accidents. The fuel system was also a source of difficulty for the Beech 33/36 models, responsible for 28.3 percent of the system-related accidents for those models.

Maintenance involvement with Bonanzas and Debonairs is a little higher than for the comparison group. This may be due to the age of the Bonanza/Debonair fleet. Properly maintained airplanes can serve indefinitely but owners and operators must scrupulously attend to maintenance intervals.

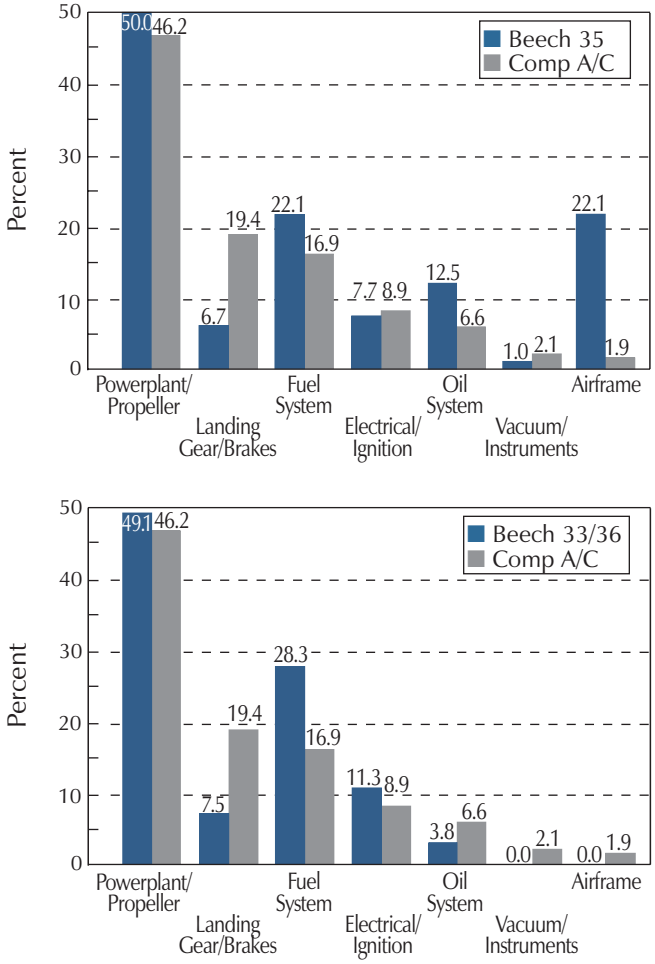
Landing gear mechanical problems caused only 6.7 percent of the BE-35 system-related accidents, and 7.5 percent for the 33/36 models. Many gear-up landings are due to pilot distraction during that critical phase of flight, not a mechanical problem. The "sterile cockpit concept," used by the airlines to eliminate non-operational conversation below 10,000 feet, is recommended for general aviation pilots during critical phases of flight. GA pilots should maintain a sterile cockpit during taxi, takeoff, approach, and landing.

Other mechanical issues are addressed by maintenance personnel in service difficulty reports, or SDRs. The reports for the Beech Bonanza models analyzed are similar and include the following:

- The vacuum pump often fails after 500-700 hours in service. It should be replaced at the time limit recommended by the manufacturer or at about 500 hours, whichever comes first. If the aircraft is used for much IFR flight, ASF recommends redundant power for the vacuum instruments, such as a second pump or standby system.
- Hardened and/or cracked fuel tank cap O-ring seals will lead to water contamination problems in the fuel. Consider replacing O-rings every second or third year. It's cheap insurance.
- Bent/clogged fuel vent lines, cracked and broken engine mounts, and cracked crankcases and cylinders round out the leading SDRs.

Tail flutter is an issue with V-tail Bonanzas. Pilots have reported

Figure 3. System Involvement



Number	Beech 35	Beech 33/36	Comp A/C
Powerplant/Propeller	52	26	224
Landing Gear/Brakes	7	4	94
Fuel System	23	15	82
Electrical/Ignition	8	6	43
Oil System	13	2	32
Vacuum/Instruments	1	0	10
Airframe	23	0	9

experiencing the airplane shake during descents and high speeds. Various Airworthiness Directives (ADs) address this issue by requiring tail inspections and strengthening kits for V-tail Bonanzas. The American Bonanza Society (www.bonanza.org) is a useful source for a variety of information, including ADs, for Bonanza owners.

A Beech 35 was traveling approximately 180 mph at 2,300 rpm and 20-23 inches of manifold pressure in a wings level descent. While descending through 2,500 feet, the pilot felt a minor vibration in the yoke and rudder pedals, which persisted between three and five seconds. The pilot reduced power, the airplane decelerated to 160 mph, and the vibration ceased. The airplane's never exceed speed (Vne) is 202 mph and the maximum cruise speed (Vno) is 176 mph. Examination of the airplane revealed that the aft fuselage sustained damage between the 233.5 and 256.9 bulkheads. The lower longerons were buckled. The belly skin located at the 256.9 bulkhead was separated from the fuselage. The damage was consistent with symmetric downward overload. The ruddervators were checked and determined to be properly balanced. The NTSB was not able to determine the reason for the empennage flutter.

Weather

Weather was the leading cause of pilot-related serious accidents for Bonanzas, Debonairs, and the comparison aircraft group, causing approximately 25 percent of the serious accidents for each. (See Figure 4.) Poor judgment and decision making in regards to weather caused the majority of these accidents. Weather is a crucial part of initial and recurrent training. Most Bonanzas are used to fly long cross-country trips, so pilots must be prepared for a variety of weather.

Preflight should include obtaining the local weather and, for all flights greater than 50 nm, a full weather briefing. However, forecasts don't always hold true. Be prepared for diversions around weather by carrying extra fuel. For example, in a Bonanza, a 100-mile deviation around weather will add approximately 40 minutes to your flight, and the aircraft will burn an extra 10 gallons of fuel.

Use Flight Watch and Flight Service en route for a more precise picture of what you will encounter. Pireps are also a great source of weather information–use them, and supply them when able. ASF's SkySpotter program, available online at www.aopa.org/asf/skyspotter/, is designed to encourage pilots to give pireps during each cross-country flight. Weather information is also available from ASF online at www.aopa.org/asf/publications/wxatcu.pdf and www.aopa.org/asf/publications/sa13.pdf.

Instrument Meteorological Conditions (IMC)

The 124-hour noninstrument-rated private pilot was observed flying a BE-33 in and out of clouds in snow showers. Witnesses saw it pass low overhead before it crashed in a steep nose-down, left-wing-low attitude. It was snowing at the time, and the visibility was about 1½ miles.

Prior to the flight, the pilot had obtained a weather briefing. The area forecast included flight precautions for turbulence and icing conditions along the route.

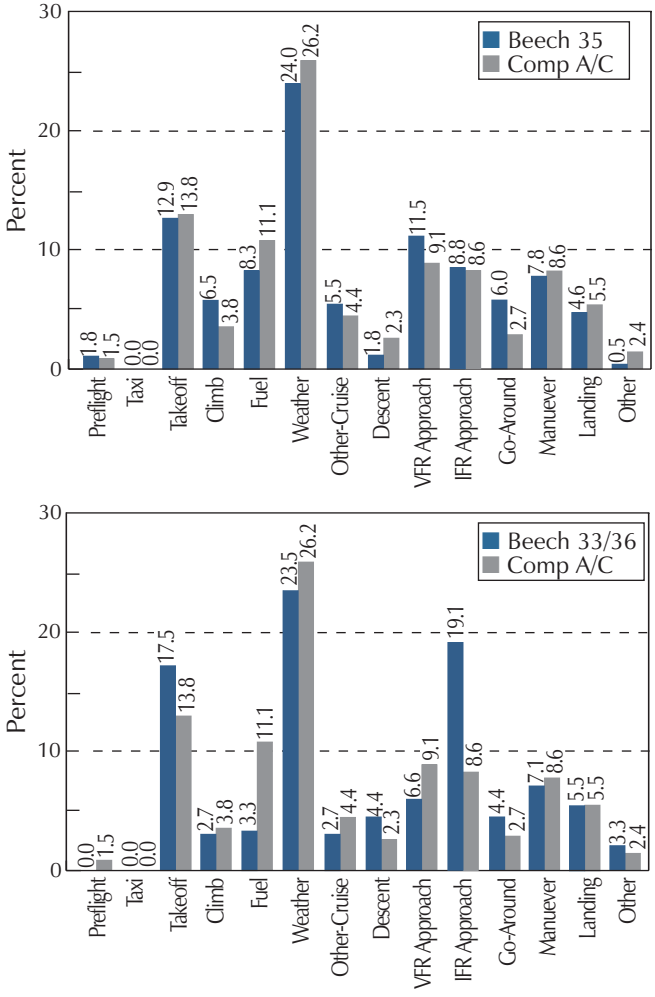
Between the years 1983 and 1999, there were 7.12 Beech 35 and 5.83 Beech 33/36 IMC accidents per 100,000 IMC hours. (See Figure 5.) Of those, 3.14 and 3.80, respectively, were on IFR flight plans. That means 3.98 BE-35 and 2.03 BE-33/36 IMC accidents per 100,000 IMC hours involved pilots who were not appropriately rated, or were instrument-rated but not on an IFR flight plan. The comparison group had 7.74 IMC accidents per 100,000 IMC hours, of which 3.95 were on IFR flight plans.

Note: Although the accidents occurred in instrument conditions, weather may not have been the cause of each accident.

VFR flight into IMC continues to be the most lethal flight condition. VFR pilots must remain in visual conditions to be safe. If the weather deteriorates, turn back to VFR conditions and use ATC services to locate better weather and land if necessary. Extend the landing gear and reduce speed immediately. Use the autopilot to reverse course. IFR pilots are probably safer flying in the clouds than trying to maintain visual ground contact. Climb, avoid airways, and contact ATC immediately to obtain an IFR clearance.

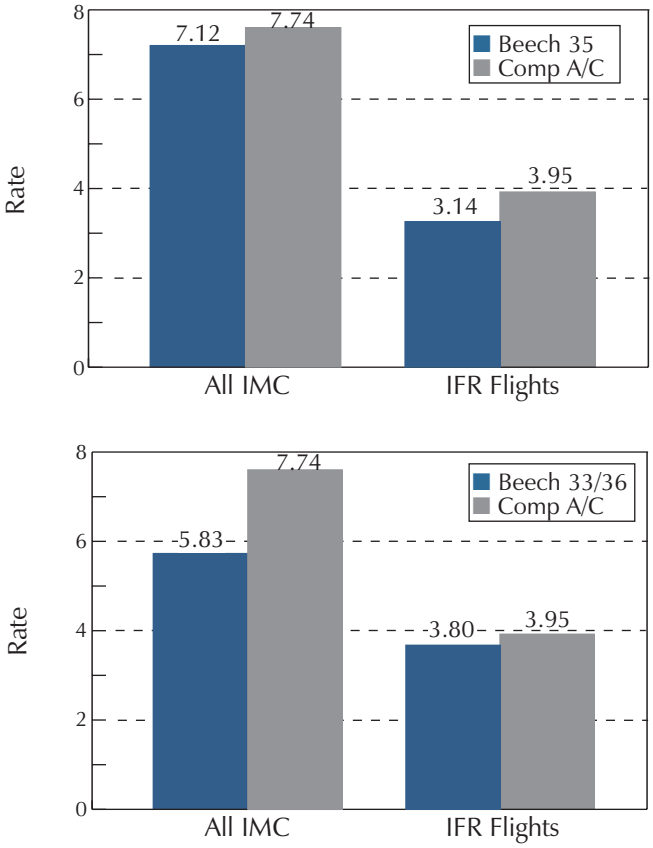
File pireps to alert other pilots to dangerous conditions and be aware that weather that looks similar to what you've encountered before may not be. Night and mountainous terrain compound the problem tremendously. Either one can make a bad situation worse. Combine them and the risk factor skyrockets.

Figure 4. Pilot-Related Causes Serious Accidents



Number	Beech 35	Beech 33/36	Comp A/C
Preflight	4	0	11
Taxi	0	0	0
Takeoff	28	32	103
Climb	14	5	28
Fuel	18	6	83
Weather	52	43	195
Other-Cruise	12	5	33
Descent	4	8	17
VFR Approach	25	12	68
IFR Approach	19	35	64
Go-Around	13	8	20
Maneuver	17	13	64
Landing	10	10	41
Other	1	6	18

Figure 5. IMC Accidents Per 100,000 IMC Hours



Number	Beech 35	Beech 33/36	Comp A/C
All IMC	86	98	368
IFR Flights	38	64	188
Hours	1,208,557	1,682,182	4,753,578

Icing

The 800-hour instrument-rated BE-35 pilot obtained two weather briefings that included forecast icing conditions. The pilot chose to go on the flight, which was uneventful until approaching Denver. The pilot was advised of two pireps of moderate to severe rime icing in the area. The pilot continued the flight. Shortly after, the pilot reported accumulating ice. While being vectored for an approach to land at Denver, the pilot was unable to maintain altitude and crashed one mile short of the runway. The accident report stated at least two inches of rime ice were on the leading edges of the wings. The aircraft was not certified for flight into icing conditions, and had no deicing equipment.

Flight into known icing conditions is prohibited unless the aircraft is properly equipped and certified. Bonanzas, as equipped from the factory, are not approved for flight in icing. Nonetheless, 50 of the Bonanza accidents analyzed for this report involved icing conditions.

Two main types of icing are structural and induction:

Structural Ice: Structural ice disrupts the flow of air over the wing, tail, and prop, which increases drag, decreases lift, and may cause a significant increase in stall speed. Conditions conducive to severe in-flight icing are high moisture content in clouds, relatively warm temperatures, and freezing rain.

The first indication of ice will normally be a buildup on small protrusions, corners, or the base of the windshield. Airspeed will begin to drop shortly after the flight encounters icing conditions. Turn on the pitot heat if not already on and immediately work to get out of the clouds. A 10-knot speed reduction is a mandate to change altitude or divert immediately.

Induction Ice: Induction ice blocks the air intake and can cause the engine to stop. The alternate air source should resolve problems with induction ice.

Note: The J35 model was the first Bonanza with fuel injection. Earlier models are susceptible to carburetor icing.

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

Night

The Beech 35 and 33/36 aircraft had fewer night accidents than the comparison group, with 6.44, 4.81, and 9.77 per 100,000 night hours, respectively. Most of the accidents involved instrument-rated pilots on IFR flight plans.

Since the majority of GA flying occurs during the day, it is important to fly at night regularly to keep those skills sharp. There are many issues specific to night flying, such as airport and aircraft lighting, night vision, fatigue, and spatial disorientation. ASF recommends an instrument rating for night cross-country flights.

FAR 61.57 requires three night takeoffs and landings to a full stop, within the preceding 90 days, to be legal to act as pilot in command of an aircraft carrying passengers at night.

Here are some specific things to be aware of at night:

- Avoid bright lights at least 30 minutes before flying at night. If bright light is needed while flying, close one eye to preserve night vision in that eye.
- Don't descend to pattern altitude before you are in the pattern – descend over the airport. There may be obstructions in the area that cannot easily be seen at night. Instrument-rated pilots should use instrument approach procedures. Try to go to airports with

VASIs or ILS and avoid unfamiliar short fields.

- Spatial disorientation. The horizon is less visible at night, and lights may create an artificial horizon. When a clear horizon is unavailable, trust the flight instruments. Use the autopilot. If uncertain about your orientation, slow down and extend the landing gear. This will decrease the likelihood of entering a spiral and make it easier to recover if one is inadvertently entered.
- Weather and clouds are much harder to see at night. Raise your personal VFR minimums after dark. Get a full weather briefing and update it while en route. Get and give pireps.
- Check the aircraft electrical system thoroughly. Include the ammeter, and alternator annunciator light if your aircraft is so equipped, as part of your scan. Typically, there will be only half an hour from electrical system failure to battery depletion and complete darkness.
- Have more than one flashlight easily accessible in the cockpit.

Wind

Windy conditions were the cause of 44 Bonanza/Debonair accidents analyzed. Most of those accidents resulted from a loss of aircraft control. The maximum demonstrated crosswind component for most Bonanza aircraft is 17 knots. The aircraft may be able to handle greater winds, but most pilots should consider that as limiting until they are highly proficient in crosswinds and have had the opportunity to explore the aircraft's behavior on a long wide runway.

Section 4 of the POH suggests procedures for taking off and landing in crosswinds. Both should be performed with the minimum flap setting necessary for the field length. Consult the appropriate POH for each aircraft model to determine whether the use of flaps is recommended for takeoff.

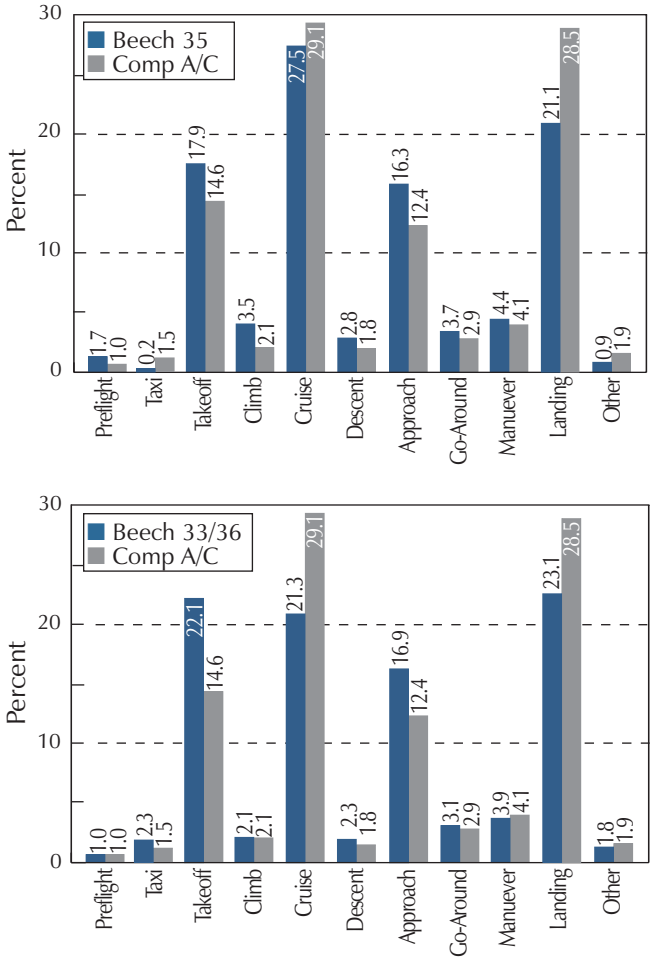
Phase of Flight

Cruise, landing, and takeoff were the most accident-prone phases of flight for all three Bonanza models. (See Figure 6 .) The comparison group's accident statistics were similar to the Bonanza.

Preflight

A thorough preflight includes a check of the airplane as well as the pilot, weather, and flight route. The flight should be conducted only after each component of the preflight has been checked and found to be satisfactory. Plan to arrive at the airport with enough time to thoroughly check each, without feeling pressured or rushed. Many pilots ask their passengers to meet them at the airport. That way the pilot

Figure 6. Pilot-Related Accidents Phase of Flight



Number	Beech 35	Beech 33/36	Comp A/C
Preflight	8	4	18
Taxi	1	9	27
Takeoff	82	85	267
Climb	16	8	39
Cruise	126	82	531
Descent	13	9	33
Approach	75	65	227
Go-Around	17	12	52
Maneuver	20	15	75
Landing	97	89	520
Other	4	7	35

can arrive early and perform critical preflight tasks free of pressure or distraction. Here are some specific items to include in your preflight:

Pilot:

The first step in planning for a flight is to be sure you are ready, physically and emotionally. Here are some things to keep in mind:

- Remember IMSAFE:
  Illness
  Medication
  Stress
  Alcohol
  Fatigue
  Emotion
- Know your personal limitations. Every pilot is different, and individual minimums may even need to change from day to day. The

FAA has published a personal minimums checklist, which is available online at www.faa.gov/avr/news/checklst.pdf.

- Currency and proficiency. Are you safe and legal for this flight? Currency does not always equal proficiency. Use your judgment to determine if you are prepared for the flight.

Weather:

Once you have prepared yourself for the flight, it's important to check the weather along your planned route. A weather briefing is required for cross-country flights greater than 50 nm, but is a good idea for all flights. The following are some weather resources to use during flight planning:

- Flight Service Stations (FSS) may be contacted for weather information, notams, and pireps both before and during flight. You may also submit a pirep after your flight.
- Online services such as AOPA (www.aopa.org/members/wx/), DUATS (www.duats.com/), National Weather Service (NWS) (www.nws.noaa.gov/), and Aviation Digital Data Service (ADDS) (http://adds.awc-kc.noaa.gov/).
- AWOS, ASOS, or ATIS will provide you with the current local weather at your departure airport. Listen to airports while en route to monitor the trend. This is vitally important for flights in IMC, in case there is need to divert.

Airplane:

The airplane preflight consists of a thorough check of the aircraft and its paperwork:

- Review the airplane's airworthiness status, including an inspection as described in the *Pilot's Operating Handbook* (POH).
- Paperwork associated with the airplane (ARROW):
  Airworthiness certificate
  Registration certificate
  Radio station license (for international flights only)
  Operating limitations (*Pilot's Operating Handbook*)
  Weight and balance records
- Weight and Center of Gravity (CG) limits specific to your Bonanza. Each aircraft is unique. For example, V-tail Bonanzas have narrower weight and balance limits than other Bonanzas. Consult Section 6 of your POH.
- Fuel requirements. ASF recommends landing with at least one hour of reserves on board. Add a safety margin to POH consumption numbers until you are familiar with that particular aircraft.
- Takeoff and landing distances. Add 50 percent to the POH distance numbers to allow for less-than-perfect technique and equipment, as well as nonstandard conditions.

Flight:

It is especially important to review the flight route before departing if the route is unfamiliar, or if an unfamiliar airport will be encountered. A thorough review includes the following:

- Airport/runway conditions at the departure and arrival airports.
- Notams and Temporary Flight Restrictions, if any.
- Runway lengths and LAHSO distances at the departure and arrival airports. Taxi diagrams for U.S. towered airports are available on ASF's Web site at www.aopa.org/asf/taxi/.
- Obstructions en route and near the airports.
- Special use airspace along your route of flight, i.e., restricted areas, prohibited areas, MOAs, and MTRs.

Takeoff

Pilot-related takeoff accidents accounted for 17.9 percent of BE-35 pilot-related accidents, 22.1 percent of BE-33/36 pilot-related accidents, and 14.6 percent for the comparison group.

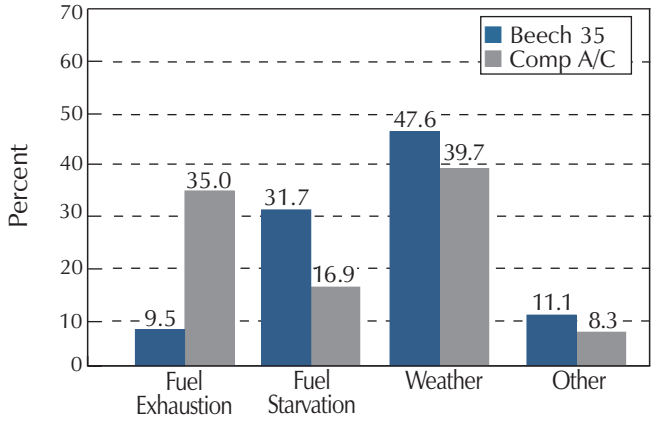
All high performance aircraft benefit from a smooth application of power – it's easier on the engine and allows the pilot to adjust rudder input to compensate for torque, P-factor, and left turning tendency. While many aircraft manufacturers use "plunger" type engine controls, the Bonanza series aircraft use "vernier" type controls. These controls screw in and out for smooth application but also have a button in the control knob that, when depressed, allows the control to be used as a "plunger" type for faster engine control movement.

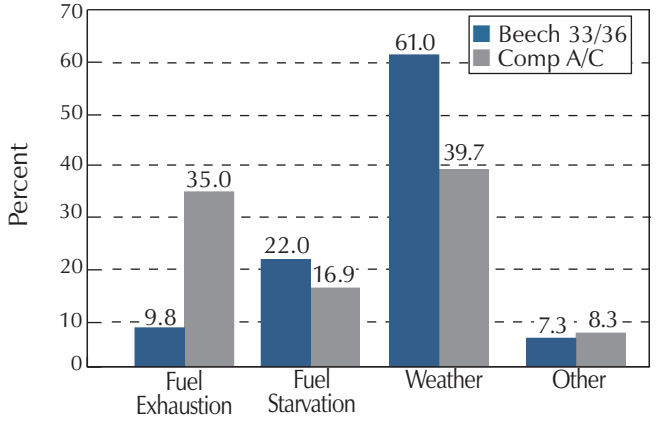
Some of the earlier model Bonanzas had factory installed vernier type controls for the throttle only, some for the throttle and fuel mixture controls only, and some for the throttle, fuel mixture, and propeller governor. Many earlier Bonanzas have been modified to add vernier controls where they did not exist and the later models came factory equipped with all three vernier controls. Proper use of these controls requires some practice to operate effectively under varying operating conditions. Also, to avoid damage to either the controls or the engine components to which they are attached, the control knobs should not be forcefully twisted after reaching the full "in" or "out" limits of travel.

Cruise

For all three groups of aircraft, weather caused the most accidents during the cruise phase of flight. (See Figure 7.) The aircraft studied in this analysis are used extensively for cross-country trips, where most hazardous weather is encountered. Training aircraft that remain in the local area are not as affected by such weather.

Figure 7. Phase of Flight Cruise





Number	Beech 35	Beech 33/36	Comp A/C
Fuel Exhaustion	12	8	186
Fuel Starvation	40	18	90
Weather	60	50	211
Other	14	6	44

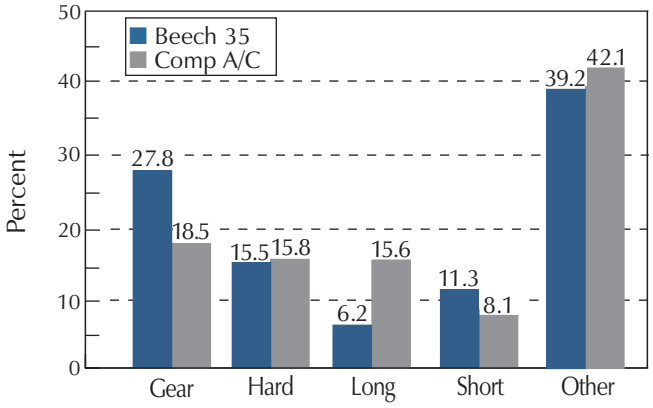
Landing

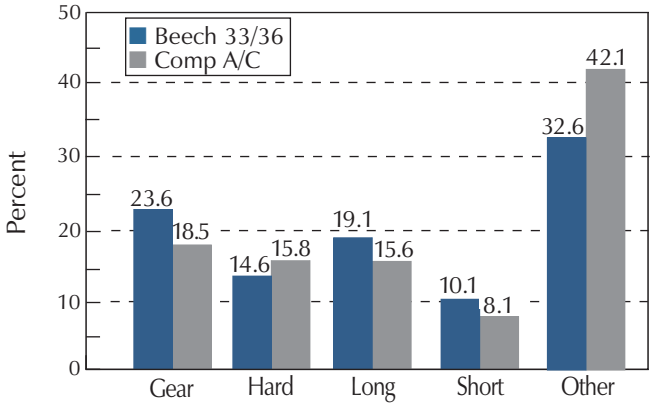
Gear problems during landing, including gear-up landings, were the second highest cause of landing accidents for both the BE-35 and BE-33/36 aircraft, causing 27.8 percent and 23.6 percent, respectively. (See Figure 8.)

The early model Bonanzas had flap and gear controls which were reversed from most other airplanes. Pilots transitioning from other aircraft have reached for "flaps up" during landing roll, and accidentally selected "gear up" instead. Beginning with the P35 model in 1962, the Bonanza "piano key" switches were replaced with more user-friendly switches, including "sight and touch" identification of landing gear and flap switches to reduce the occurrence of the inadvertent "gear up" selection. Regardless of the model Bonanza it is recommended that, while on the ground, the flap switch be carefully identified and the flaps not be retracted unless the aircraft is stopped and clear of the runway. "Touch and go" operations have been the source of many inadvertent landing gear retractions due to premature gear retraction or mistakenly retracting the gear instead of the flaps. Consequently, full stop takeoffs and landings are recommended.

Recurrent training is a necessity in any airplane. Information about the Bonanza Pilot Proficiency Program can be found online at www.bppp.org.

Figure 8. Phase of Flight Landing





Number	Beech 35	Beech 33/36	Comp A/C
Gear	27	21	96
Hard	15	13	82
Long	6	17	81
Short	11	9	42
Other	38	29	219

Beech Bonanza/Debonair Test Questions

The purpose of this open-book test is to familiarize the pilot with the Bonanza and its corresponding POH. **The POH for Bonanza models V35 (1966-67), V35A (1968-69), and V35B (1970-76) was used for this test; answers given pertain to those aircraft and other models may differ significantly. Refer to the POH for your aircraft as you complete the test.**

1. Total usable fuel is _____ gallons.

2. What is the correct fuel grade? _____

3. What is the maximum gross takeoff weight? _____

4. What is the endurance with a 45-minute reserve at a cruise altitude of 10,000 feet at standard temperature? Include startup, taxi, takeoff, and climb fuel.

   With 74 gallons at 75% power: _____
   With 44 gallons at 75% power: _____

5. The maximum oil capacity is _____ quarts.

6. How much payload will the airplane carry with maximum fuel? _____

7. How much fuel can you carry with the following payload? _____

Front seats:	400 lb.
Middle seats:	300 lb.
Rear seat/Baggage:	200 lb.

   Assuming a 40-gallon fuel burn, will the CG be within limits on landing? _____

8. What is the maximum demonstrated crosswind? _____

9. What is the maneuvering speed? _____

10. What limitation applies when fuel is less than 1/4 tank?

11. What is the configuration for maximum glide:

    Landing gear _____
    Flaps _____
    Cowl flaps _____
    Propeller _____
    Airspeed _____

12. What are the indications of a vacuum system failure?

13. What instruments/systems would be affected by a complete vacuum failure?

14. List the manual gear extension sequence.

15. List the number of fuel sump drains and locations.

16. What is the procedure following engine roughness?

17. What are the indications that the alternator (generator) has failed?

    How would you bring it back online?

    What is the procedure if unable to restore the alternator/generator?

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

19. What is the procedure for an unlatched door in flight?

20. What is the emergency descent procedure?

21. List the appropriate indicated airspeeds below.

    Vx _____
    Vy _____
    Vlo _____
    Vle _____
    Vne _____
    Vfe _____
    Vs _____
    Vso _____

22. What is the normal full-flaps approach speed?

23. What is the procedure for a go-around?

24. When is the auxiliary fuel pump used?

25. What is the engine failure procedure immediately after takeoff?

Answers to Beech Bonanza/Debonair Test Questions

1. Total usable fuel is 44 gallons (standard), or 74 gallons (optional).
   Refer to POH, Section 1, General.

2. The correct fuel grade is 100LL (blue) or 100 (green).
   Refer to POH, Section 1, General or Section 2, Limitations.

3. The maximum gross takeoff weight is 3,400 lb.
   Refer to POH, Section 1, General.

4. The endurance with a 45-minute reserve at a cruise altitude of 10,000 feet at standard temperature is :
   4.7 hours with 74 gallons at 75% power.
   2.5 hours with 44 gallons at 75% power.
   Refer to POH, Section 5, Performance.

5. The maximum oil capacity is 12 quarts.
   Refer to POH, Section 1, General.

6. The airplane will carry 789 pounds of payload with maximum fuel (74 gallons).
   Refer to POH, Section 6, Weight & Balance.

7. You can carry 55 gallons of fuel with the following payload.

Front seats:	400 lb.
Middle seats:	300 lb.
Rear seat/Baggage:	200 lb.

   Assuming a 40-gallon fuel burn, the CG will not be within limits on landing.
   Refer to POH, Section 6, Weight & Balance.

8. The maximum demonstrated crosswind is 17 knots.
   Refer to POH, Section 4, Normal Procedures.

9. The maneuvering speed is 134 knots IAS.
   Refer to POH, Section 2, Limitations or Section 4, Normal Procedures.

10. No maneuvers are permitted with less than 10 gallons in each main tank. Manuevers include chandelles, steep turns, lazy eights, and stalls.
    Do not take off with less than 13 gallons in each main tank.
    Refer to POH, Section 2, Limitations.

11. The following is the configuration for maximum glide:
    Landing gear - UP
    Flaps – UP
    Cowl flaps - CLOSED
    Propeller – Pull for low RPM
    Airspeed – 105 knots
    Refer to POH, Section 3, Emergency Procedures.

12. In the event of a vacuum system failure, the suction gauge will read below normal and the annunciator light, if installed, will be on.
    Refer to POH, Section 7, Systems Descriptions.

13. The attitude indicator, heading indicator (if vacuum driven), and possibly the autopilot would be affected by a complete vacuum failure.
    In the event of a vacuum failure, ASF recommends extending the landing gear to stabilize the aircraft.
    Refer to POH, Section 7, Systems Descriptions.

14. The following is the manual gear extension sequence:
    1. Pull the landing gear motor circuit breaker.
    2. Landing gear switch handle – DOWN.
    3. Remove the handcrank handle cover.
    4. Handcrank – ENGAGE, and turn counterclockwise as far as possible (about 50 turns).
    5. If electrical system is operative, check landing gear position lights and warning horn (check LDG GEAR INDICATOR and LDG GEAR WARNING circuit breakers engaged).
    6. Handcrank – DISENGAGE
    Refer to POH, Section 3, Emergency Procedures.

15. There are three fuel sump drains – one under the left wing, one under the right wing, and one under the belly (adjacent to the left wing).
Refer to POH, Section 4, Normal Procedures or Section 7, Systems Descriptions.

16. The following is the procedure following engine roughness:
1. Mixture – Full RICH, then LEAN as required
2. Magnetos/start switch – check LEFT, then RIGHT, then BOTH
3. Alternate Air T-handle – Pull and release
Refer to POH, Section 3, Emergency Procedures.

17. The annunciator light will illuminate if the alternator (generator) has failed.
Attempt to bring it back on online by turning the battery switch and alternator switch to OFF, then ON.
If unable to restore the alternator/generator, turn the alternator switch OFF and turn off all nonessential electrical equipment.
Refer to POH, Section 3, Emergency Procedures.

18. The following is the procedure for a short-field takeoff:
1. Set take-off power, full throttle.
2. Release brakes and accelerate to 71 knots.
3. Climb at 77 knots until clear of obstacles, then climb at 96 knots (Vy).
4. Retract landing gear when positive rate of climb is established and insufficient runway remains for landing.
Refer to POH, Section 4, Normal Procedures.

19. If you have an unlatched door in flight, return to the field in a normal manner.
If possible, have the passenger hold the door during landing.
Refer to POH, Section 3, Emergency Procedures.

20. The following is the emergency descent procedure:
Power – IDLE
Propeller – HIGH RPM
Landing gear – DOWN
Airspeed – 154 knots
Refer to POH, Section 3, Emergency Procedures.

21. The appropriate indicated airspeeds (KIAS) are:
Vx 77
Vy 96
Vlo 145
Vle 154
Vne 196
Vfe extension 117
extended 123
Vs 64
Vso 52
Refer to POH, Section 2, Limitations, and Section 4, Normal Procedures.

22. The normal full-flaps approach speed is 70 knots.
Refer to POH, Section 4, Normal Procedures.

23. The following is the procedure for a go-around:
1. Power – FULL (2,700 rpm)
2. Airspeed – 70 knots until clear of obstacles, then normal climb speed
3. Flaps – UP
4. Landing gear – UP
5. Cowl flaps – OPEN
Refer to POH, Section 4, Normal Procedures

24. The auxiliary fuel pump is used during start-up and during emergency operation.
Refer to POH, Section 7, Systems Descriptions.

25. If an engine failure occurs immediately after takeoff, land straight ahead if possible. If sufficient altitude is remaining to maneuver:
1. Fuel selector valve – switch tanks
2. Auxiliary fuel pump – ON
3. Mixture – Full RICH, then LEAN as required
4. Magnetos – Check LEFT, then RIGHT, then BOTH
5. Alternate Air T-handle – Pull and release
Refer to POH, Section 3, Emergency Procedures.

Beech Bonanza/Debonair 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. For example, a thorough discussion of IFR procedures and regulations is recommended for pilots who are not current. For more proficient pilots, this much instruction may not be necessary and training should be adjusted accordingly.

Beech Bonanzas and Debonairs are very sophisticated, high-performance, single-engine airplanes, and in order to fully use their capabilities, pilots should be instrument-rated and proficient in instrument operations. Therefore, the AOPA Air Safety Foundation believes that instructors administering this training should have at least five hours of pilot-in-command time as sole manipulator of the controls in the corresponding Bonanza/Debonair model and hold an instrument instructor certificate.

Pilots should perform all tasks to practical test standards (PTS) and receive, at the satisfactory conclusion of training, a flight review endorsement and an instrument proficiency check. Pilots who complete this training will also receive a high-performance and complex aircraft endorsement, if required.

This training course outline is divided into four blocks of instruction. The first block, consisting of three hours of ground orientation, concentrates on the aircraft, 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 high-altitude operations and cross-country flight. **The time required to complete this training will vary with pilot proficiency and experience.** Average time to complete each block is indicated beside each topic.

Block 1: Ground Orientation

The pilot will thoroughly review the *Pilot's Operating Handbook* and all documents covering modifications to the aircraft and electronic equipment installed. In-cockpit familiarization will be accomplished and the appropriate model Beech Bonanza/Debonair accident history will be discussed.

The lesson will be complete when the pilot is able to accurately describe applicable aircraft operating systems and their operations, emergency procedures, aircraft limitations (including airspeeds for various operations), performance determination, weight and balance calculations, and proper aircraft servicing. The pilot will also be familiar with the accident history of the airplane.

Ground: 3.0 hours

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

Aircraft Servicing
- 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 loading situations

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

Normal Procedures
- Speeds for normal operation
- Preflight inspection
- Engine start and runup
- Taxiing
- Normal, short-field, soft-field, and crosswind takeoffs
- Normal and maximum performance climbs
- Cruising flight
- Descents
- Normal, short-field, soft-field, and crosswind landings
- Balked landings and go-arounds
- Flap retraction procedures
- After landing checklist, 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
- 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, if so equipped, and fuel flow on climb and cruise

Block 2: General Flight Operations

The pilot will become acquainted with Beech Bonanza/Debonair aircraft. Preflight, in-flight, and postflight operations will be discussed and practiced.

Ground: 1.0 hour
Review Weight and Balance Calculation
Review of Normal and Emergency Procedures
Determination of PIC and Transfer of Control

Flight: 1.5 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
- Door open just after rotation

Airwork
- Climbs
- Turns
- Slow flight
- Approaches to stalls/full stalls
- Steep turns
- Cruise configuration
- Approach/landing configuration

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

Emergency Procedures
- Emergency gear extension
- Engine failure
- Fire in flight
- Induction ice
- Alternator failure
- Vacuum pump failure

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

Block 3: IFR Operations

The pilot will review the requirements, regulations, and procedures for IFR flight operations.

Ground: 1.5 hours
Requirements for Instrument Flight
- Pilot
  - Certificates, ratings, and currency
  - High performance endorsement
  - Six-month currency
  - 90-day currency

- Aircraft
  - Required equipment
  - Equipment certification
  - RNAV/Loran/GPS
  - Autopilot/Flight Director
  - Other

- Periodic Inspections
  - Transponder
  - Pitot-static system
  - ELT
  - Annual/100 Hour
  - ADs/Service Bulletins
  - Recommended service intervals
  - Preflight line inspection

FARs for Instrument Flight
- Flight plan/clearance required
- Compliance with ATC instructions
- Alternate criteria
- Lost communication procedures
- Required reporting points
- PIC authority and responsibility

Charts
- SIDs / STARs
- Low-/high-altitude en route
- Instrument approach procedures

Preflight Briefing
- Lesson content
- Instructor/pilot roles and responsibilities
- Transfer of control
- Collision avoidance procedures

Flight: 1.5 hours
Clearance Copy, Accurate Readback
- Accurate copy and readback
- Proper nav and com radio configuration
- SID (if appropriate)

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

Pretakeoff
- Checklist use
- Instruments
- Avionics
- Charts
- Departure procedure review

Departure
- Heading and altitude
- Route interception
- Amended clearance
- Climb and cruise checklists

Holding
- Holding clearance copy and readback
- Aircraft configuration prior to holding fix
- Entry procedure
- ATC reporting

NDB Approach
- Approach clearance
- Checklist, aircraft configuration
- Tracking, orientation
- Altitudes, MDA
- Interception of bearings
- Timing, MAP
- ATC coordination

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

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

VOR Approach
- Approach clearance
- Checklist, aircraft configuration
- Tracking, orientation
- Altitudes, MDA
- Timing, MAP identification
- ATC and CTAF coordination

GPS Approach
- Approach clearance
- Approach programming
- Approach arm
- Missed approach
- ATC and CTAF coordination

Circling Approach
- Altitude
- Distance from airport
- Traffic avoidance
- Missed approach procedure
- ATC and CTAF coordination

ILS Approach
- Approach clearance
- Checklist, aircraft configuration
- Tracking, orientation
- Altitudes, DH
- MAP procedure
- ATC and CTAF coordination

Partial-Panel Approach
- Approach clearance
- Checklist, aircraft configuration
- Orientation
- Altitudes, MDA
- ATC and CTAF coordination

Inoperative Equipment
- Lost communication
  - Route and altitude
  - Position reporting
- Lost Navigation Equipment
  - Revised minimums
  - ATC report
- Alternator Failure
  - Load shedding
  - Flight plan revision
  - ATC notification and coordination

Emergency Procedures
- Engine failure
- Airframe ice
- Vacuum pump/gyro failure
- Fire
- ATC notification and coordination

Block 4: High-Altitude Operations and VFR/IFR Cross-Country Flight

The pilot will gain understanding of the elements of high-altitude operations and demonstrate proficiency in VFR and IFR cross-country operations.

Ground: 1.5 hours
The High-altitude 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

Physiological Training
- Respiration
- Hypoxia
- Effects of prolonged oxygen use
- Decompression sickness
- Vision
- Altitude chamber (optional)

Emergency Operations
- Turbocharger malfunction
- In-flight fire
- Flight into severe turbulence or thunderstorms
- Ice
- Use of autopilot to assist in some emergency situations

Flight: 1.5 hours
Preflight Briefing
- Line check
- Oxygen system and equipment
- Charts, documents
- Checklist use
- Clearance copy and readback

Departure
- Checklist
- SID (if appropriate)

Climb
- Checklist

Cruise
- Checklist
- Power setting
- Mixture setting

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

Descent
- Planning
- Engine temperature monitoring
- Airspeed
- STAR (if appropriate)

Approach and Landing
- Checklist use

421 Aviation Way • Frederick, Maryland 21701
Phone: (800) 638-3101 • Internet: www.aopa.org/asf • Email: asf@aopa.org
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