S A F E T Y   A D V I S O R

Operations and Proficiency No. 4

Collision Avoidance
Strategies and Tactics

Maintaining Separation

Despite improvements in the general aviation (GA) safety record in recent years, the number of midair collisions (MACs) shows no corresponding decline. MACs continue to occur about 13 times a year on average, often resulting in multiple fatalities. On the ground, collisions caused by runway incursions are still a concern for GA. Instead of waiting until after takeoff to begin their collision avoidance scan, pilots can avoid a runway incursion by increasing their vigilance immediately after engine start.

Collision avoidance, both in the air and on the ground, is one of the most basic responsibilities of a pilot flying in visual conditions. During primary training, pilots are taught to keep their eyes outside the cockpit and look for conflicting traffic. However, little formal instruction is usually given on the best way to visually identify potential collision threats – nor in procedures that can lessen their risk of occurring. Make the strategies and tactics in this Safety Advisor part of your standard procedures for your own safety, and the safety of everyone flying.

Collision avoidance, both in the air and on the ground, is one of the most basic responsibilities of a pilot flying in visual conditions.

History of MACs

Many of the rules and procedures that apply to flight in controlled airspace are the legacy of MACs. In 1956, all 128 people aboard lost their lives when a DC-7 and a Lockheed Constellation collided over the Grand Canyon in VFR conditions. This tragedy led to public outcry for the modernization of the Air Traffic Control system, resulting in the more effective system that we have today. A 1978 collision over San Diego involving a Boeing 727 and a Cessna 172—both under radar control—caused the deaths of 144 people and resulted in even tighter restrictions on flights in heavily trafficked areas. Congress passed the Airport and Airway

Pilots need to know how to look and what to look for.

It is the pilot's responsibility to see and avoid other traffic.

Safety Expansion Act after the 1986 collision of a DC-9 and a single-engine Piper over Cerritos, California, which claimed the lives of 82 people in the aircraft and 15 on the ground. The Airport and Airway Safety Expansion Act now requires all civil air carrier aircraft to be equipped with Traffic Alert and Collision Avoidance Systems (TCAS).

No MACs involving an air carrier aircraft have occurred in over a decade, thanks in part to TCAS equipment. But the possibility still exists, and a midair collision involving a passenger airliner and a GA aircraft would create pressure for further regulation, impairing the flexibility and convenience of aviation for all.

See and Avoid

The rules for maintaining separation from other aircraft during VFR operations are spelled out in FAR 91.113: "When weather conditions permit, regardless of whether an operation is conducted under instrument flight rules or visual flight rules, vigilance shall be maintained by each person operating an aircraft so as to see and avoid other aircraft." See and avoid is the common terminology for this method of collision avoidance.

It is worth noting that the NTSB's probable cause of the 1956 MAC over the Grand Canyon is true of almost any MAC today: "The pilots did not see each other in time to avoid the collision. Evidence suggests that it resulted from any one or a combination of the following factors: intervening clouds, visual limitations due to cockpit visibility, preoccupation with normal cockpit duties, preoccupation with matters unrelated to cockpit duties…(and) physiological limits to human vision reducing the time and opportunity to see and avoid the other aircraft."

The most important tool pilots have to see and avoid other aircraft is their vision. But simply looking out of the cockpit isn't enough. Pilots need to know how to look and what to look for, which requires an understanding of the limitations of human vision and tactics to compensate for its deficiencies.

The Physiology of Vision

A safe, conscientious pilot wouldn't take off as PIC in an airplane without knowing its performance limitations and how to operate the equipment aboard. Yet most pilots routinely fly without knowing the limitations and operating rules for the most important collision avoidance equipment in the plane – their eyes. Eighty percent of the information we absorb in everyday life is obtained through our eyes. In order to use this input to see and avoid other aircraft, we must develop an effective scanning technique. An effective scan begins with an understanding of how vision works.

The Foveal Field

The central part of the retina, where vision is most acute, is called the fovea (see Figure 1). But this is a

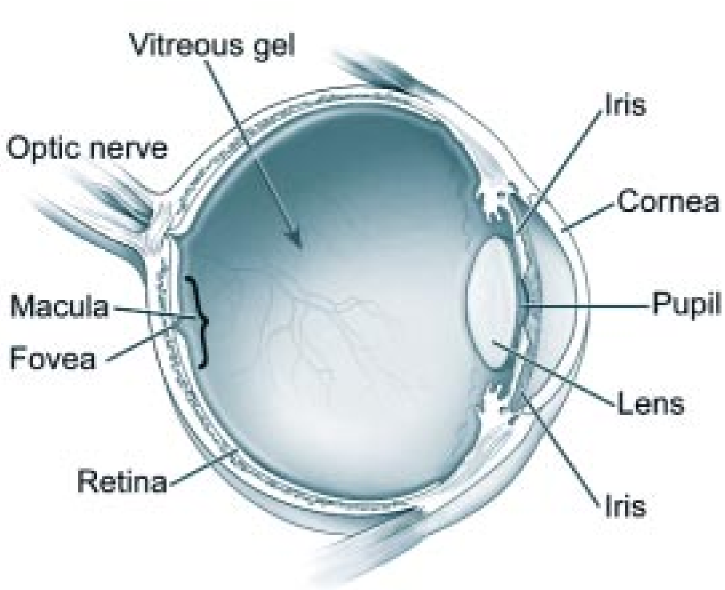


Figure 1.

very small part of vision, comprising just one degree of horizontal and vertical vision. As a demonstration, this area of focus is the equivalent of a quarter seen from one eye at a distance of four and a half feet. Anything outside this small area will not be seen in detail. Outside of a 10-degree cone concentric to the foveal cone, visual acuity is only 10 percent of that of the foveal field of vision. In practical terms, a plane that was visible in the foveal field from 5,000 feet away would only be visible at 500 feet or less if it was more than five degrees on either side of this central vision. Therefore, if you're simply staring straight ahead while flying, you're missing a vast amount of the sky.

Focus

Without proper focus, an object can be right in front of a pilot yet still remain unseen. In order to spot aircraft at a distance, the eyes must be focused for distant vision. Yet without something distant to focus on, after 60 to 80 seconds the eyes naturally relax to an intermediate focal distance somewhere just in front of the propeller. To counteract this tendency, known as "empty field myopia," the eyes must be periodically refocused on the farthest object within sight – a cloud on the horizon, another aircraft at a distance, or a point on the ground. This refocusing needs to be incorporated in a pilot's scan technique.

Atmospheric Conditions

Haze, flight over open water, or an obscured horizon can make it difficult to see distant objects, impairing the ability to refocus vision. The same phenomenon can occur when you are over a haze or cloud layer with a high overcast layer above. This problem can be overcome by focusing on the farthest point visible; even the wing tip will suffice. In times of poor visibility, this form of refocusing should be repeated every minute or so.

The position of the sun must also be considered. When low on the horizon, it makes any traffic between the observer and the sun very difficult to see. Thus, operating in these conditions requires extra vigilance. For all practical purposes, traffic conflicts may be visible from only one aircraft.

Optical Illusions

Optical illusions can affect what we see in flight. For example, an aircraft at a slightly lower altitude coming toward you may look like it's above you and appear to descend as it comes closer. At night, a pilot's ability to judge distance above the ground while on visual approach to a runway is impaired. Fortunately, spotting aircraft in flight isn't usually much of a problem at night, since a properly illuminated aircraft is much easier to see at night than an aircraft operating in daylight hours. The exception to this rule is identifying aircraft below you that blend in with lighting on the ground.

Haze and fog can impact the eyes' ability to discern collision threats.

Other Factors
Pilots need to understand not only the general limitations of human vision, but also any individual physiological factors that might compromise their ability to see and avoid other aircraft. Irritants in the air, fatigue, age, residual alcohol in the bloodstream, and lower oxygen levels can all impact the ability of your eyes to perform at the optimum level.

Aircraft Design Considerations
The design of the aircraft itself can also hinder visibility. Windshield distortion, placement of window and windshield posts, and other structural elements can affect what a pilot sees. The brain requires input from both eyes to accurately interpret the visual cues it receives. If a windshield post or other obstruction blocks the vision of one eye, the brain may not perceive the object - even with the other eye providing input. The NTSB has concluded this could be a causal factor in some midair collisions. A high glare shield can also block vision, which is especially problematic during climbout.

No matter how good the visibility is from the cockpit, all aircraft have blind spots. High-wing aircraft have reduced visibility of aircraft above them, and can have their view of traffic blocked when making turns in the pattern as the wing is lowered in the direction of the turn. Low-wing aircraft have a large blind spot beneath them that may obscure conflicting traffic when descending into the pattern or while on final approach. Pilots must recognize and compensate for visual limitations, whether it's raising a wing to check for traffic before making a turn in a high-wing airplane, or making shallow S-turns when climbing or descending in any aircraft.

When and Where

Knowing when and where MACs are most likely to occur enables you to tailor your see and avoid strategies to any given situation. Most MACs occur in daylight and in VMC conditions – the times of best visibility. They can also be correlated to traffic levels: most occur between 10 a.m. and 5 p.m. on weekends during the warmer months, essentially the times when the most traffic is in the air. Less than two percent of MACs occur after sundown.

When scanning for traffic, the pilot must be aware of the blind spots that can be created by aircraft design.

In addition, most MACs occur within five miles of an airport. About 80 percent occurred at or below 3,000 feet above ground level and one third (31.1 percent) occurred at or below 500 feet. These statistics illustrate an important fact: most MACs occur in the traffic pattern, with a significant number on final approach.

Many pilots envision MACs as high-speed, head-on collisions when this is rarely the case. The closure rate of a typical MAC is rather slow because it usually involves two aircraft going in the same general direction, most often with a faster aircraft overtaking a slower aircraft. Studies of MACs have found that 82 percent were at overtaking convergence angles, and about a third (35 percent) were from zero to ten degrees, almost straight from behind. Only five percent were from a head-on angle (see Figure 2).

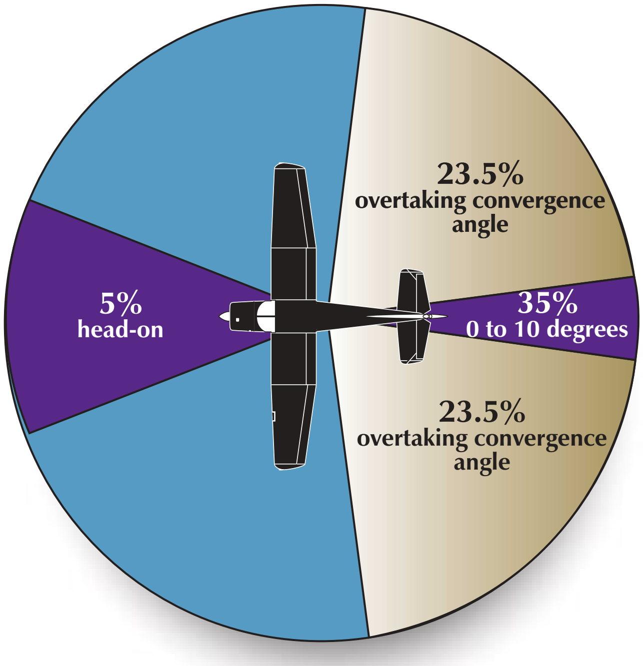


Figure 2. Note: Percentages are based on a study of 105 MACs. Some of the angles were unreported.

Studies of MACs have found 82 percent were at overtaking convergence angles. About a third (35 percent) of those were from zero to ten degrees, almost straight from behind.

Pilot Experience

Flight time is not a major risk factor when it comes to MACs, considering accident reports list pilots from 12 hours to 37,000 hours total time. Whether it's inexperience or complacency, hours of uneventful flying can lead to one lapse that ends in tragedy.

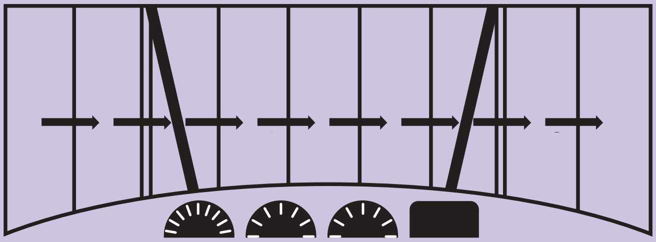
Ironically, although two sets of eyes are supposed to be better than one, training flights are among the most dangerous from a MAC perspective. Flight instructors comprise less than 10 percent of the pilot population, yet a flight instructor was aboard one of the aircraft in more than one third (35.5 percent) of MACs. A possible explanation for this statistical anomaly is that flight instructors spend more time aloft than most pilots, much of it operating near airports (the most hazardous environment for MACs) and their attention is often focused on teaching, rather than scanning for traffic. Instrument flight training poses a unique hazard because the student's vision is often restricted by some type of view-limiting device. In addition, a lot of attention is directed inside the airplane at the instruments and IFR charts.

The Scan

The scan is the technique used to optimize our vision for collision avoidance. However, the term may be a misnomer; scan implies a sweep of the eyes, while a proper scan for conflicting traffic is actually a sequence of intense, fixated observations. The eyes need one to two seconds to adjust before they can focus; a continuous sweep blurs the vision.

There is no "one size fits all" technique for an optimum scan. Many pilots use some form of the "block" system scan (see Figure 3). This method divides the sky into blocks, each spanning 10 to 15 degrees of the horizon, and 10 degrees above and below it—for a total of 9 to 12 blocks, or scan areas. The block scan is based on imagining a point in space at the center of each block. Focusing on each point allows the eye to detect a conflict within the foveal field, as well as objects in the peripheral area between the center of each scanning block.

One common block scan technique is the "side-to-side" scan: Starting on one side of the aircraft, the pilot sweeps to the other side block by block. Another is the "front-to-side" scan: Starting with the block straight ahead, the pilot scans the blocks to one side of the aircraft, returns to the center, and repeats the process to the other side. Having a variety of scanning techniques available helps avoid the monotony of using one method all the time.

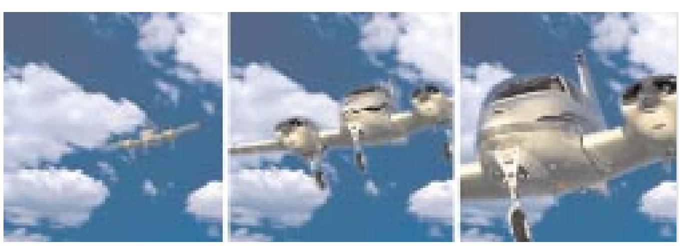


Side-to-side scanning method.
Start at the left of your visual area and make a methodical sweep to the right, pausing in each block of viewing to focus your eyes. At the end of the scan, return to the panel.

Front-to-side scanning method.
Start at the center block of your visual field (center of front windshield); move to the left, focusing in each block then swing quickly back to the center block after reaching the last block on the left and repeat the performance to the right.

Figure 3.

The block scan is an effective way to search the sky, but it does have limitations. Most MACs are the result of an aircraft overtaking another, yet the typical scan area excludes the area behind the aircraft. The overtaking aircraft has the best chance to see and avoid because the traffic is inside their typical scan area, nearly straight ahead. Conversely, the aircraft being overtaken is at a disadvantage because the traditional block scan leaves out a great majority of the statistical threats behind the aircraft. Make an effort to check for overtaking aircraft every few scans. This is particularly important during approach and landing when these collisions are most likely to occur. It's important to scan vertically as well as horizontally. The area 10 degrees above and below your flight path contains virtually all potentially conflicting traffic. Unless the target is climbing or descending rapidly, aircraft outside that range can be discounted as a threat.



Blossom Effect

The "Blossom Effect"

Motion is invaluable in drawing the eye's attention. Yet two aircraft on a collision course will appear virtually motionless to each other, maintaining a constant relative bearing. When observed from the cockpit, the conflicting target will look like a small, stationary speck until it is at a distance from which it may be too close to react to, when it suddenly appears to grow much larger, a phenomenon called the "blossom effect." If a pilot sees an aircraft that remains in the same spot in the windshield (unless it is directly ahead and moving in the same direction), there is a high probability the two aircraft will collide unless one changes their course. Once a threat has been identified, it's essential to keep the other aircraft in sight until the threat is resolved.

Crew Resource Management

Effective Crew Resource Management (CRM) requires an efficient scan. The more quickly instruments and gauges can be monitored and interpreted, the more time will be available to scan for conflicting traffic. An experiment conducted with military pilots found the average time needed to conduct an effective scan was a total of 20 seconds – 17 seconds for the outside scan, and three seconds for the panel scan. As demonstrated by the military pilots, considerably more time should be devoted to scanning outside than inside.

Efficient scanning requires effective management of other flight tasks.

GPS receivers should be programmed on the ground to provide more time for scanning in the air.

CRM also includes effective management of distractions such as passengers, avionics, and chart management tasks. Today's GPS receivers are extremely capable, but they are also pilot workload intensive – particularly when multiple waypoints must be inserted into a flight plan. GPS receivers should always be programmed on the ground to provide more time for scanning in the air.

Phases of Flight

Midair collisions can happen in any phase of flight. Avoidance strategies need to be adjusted to reflect the flight environment and risks associated with each particular phase.

Takeoff and Climb
Nearly 11 percent of all midair collisions occur during takeoff and climb. Ensure that the runway is clear before departing and listen for other inbound aircraft. Don't forget to make position reports and understand other's reports at nontowered airports. Use shallow S-turns to get a better view of the area and lower the nose occasionally. Although cruise-climb airspeeds sacrifice some climb performance, you gain better forward visibility over the nose.

Cruise
Just over 27 percent of midair collisions occur during cruise flight with altitude, power setting, and heading established. According to the NTSB, one common thread links the majority of these accidents: inattention on the part of the crews of both aircraft. In almost all cases, both crews were in a position to see the other aircraft in enough time to take evasive action. Without the distractions created by arrival and departure, cruise is the phase of flight when pilots have the most time to look for traffic. However, it is also the longest phase of flight and the time of greatest complacency. Now is the time to be disciplined with the block scan, possibly alternating side-to-side and front-to-side methods. Enlist the help of your passengers. Don't fly directly over NAVAIDs, as a lot of other planes will also be there. When not flying at required cruising altitude (below 3,000 feet AGL), fly at atypical altitudes as discussed later. Fly perpendicular to any Military Training Routes (MTRs) that intersect the route whenever possible.

Approach, Descent and Landing
Nearly 45 percent of collisions occur in the traffic pattern and of these, 76 percent occur during approach and landing – when aircraft are on final or actually on or over the runway. Given the small funnel of airspace airplanes occupy during landing, any confusion about who's landing in what order, and where they are, can have tragic consequences. If there is any consolation about collisions occurring during landing, it's that there are often survivors.

MACs can also occur while maneuvering in the traffic pattern as a result of improper or misunderstood position reports, which can lead to erroneous assumptions. This is particularly true at nontowered airports. A pilot may conclude, for example, that no aircraft are in the pattern because of lack of activity on the frequency. But aircraft without radios may be operating at these airports, or an inbound or outbound aircraft may be transmitting on the wrong frequency.

In addition to looking for other traffic, remember the rules for right of way on final as defined by CFR Part 91.113 (g): "When two or more aircraft are approaching an airport for the purpose of landing, the aircraft at the lower altitude has the right-of-way, but it shall not take advantage of this rule to cut in front of another which is on final approach to land or to overtake that aircraft." When entering an airport area, ensure that you are following all communication requirements and AIM recommendations, especially at nontowered airports. Check behind and below your aircraft throughout the traffic pattern. When in the traffic pattern, make sure final is clear before turning – due to fixation with the runway and poor rearward visibility, it is difficult to detect threats once estab-

Almost 45 percent of collisions occur in the traffic pattern and of these, 76 percent occur during approach and landing.

lished. Be prepared to make S-turns or 360-degree turns for spacing.

For a detailed discussion of flight safety around nontowered airports see *Operations at Nontowered Airports* **www.aopa.org/asf/publications/sa08.pdf**

Maneuvering Flight

Although we do maneuver in the traffic pattern, the maneuvering phase of flight cited in accident reports typically refers to aerobatics, formation flying, air-to-air photography, and even flight training maneuvers. Seventeen percent of MACs occur during maneuvering flight. The best way to avoid these MACs is to seek specialized training before attempting any type of aerobatic or formation flight. Formation flight must be carefully planned on the ground, so that the pilots of both aircraft are fully briefed, properly trained, and know exactly how the flight will be conducted. Safety pilots should be used whenever possible. Avoid MACs during flight training by always using clearing turns before each maneuver. Recall that the Practical Test Standards cite, "Failure to use proper and effective visual scanning techniques to clear the area before and while performing maneuvers" as a condition for unsatisfactory performance.

Avoidance Strategies

Altitudes

Flying at proper cruising altitudes can reduce the risk of MACs and help pilots focus their scans in areas where threats are most likely to appear. For VFR flights at 3,000 feet AGL and above, the correct cruising altitudes are MSL altitudes of odd thousands plus 500 feet on courses of zero degrees through 179 degrees, and even thousands plus 500 feet for courses of 180 degrees through 359 degrees. This rule can help pilots develop a scanning strategy for any given flight.

Aircraft operating under instrument flight rules (IFR) usually maintain cardinal altitudes (2,000, 3,000, 4,000, etc.), providing a 500-foot altitude buffer from VFR aircraft.

This strategy doesn't preclude the need to scan in areas where threats are less likely, since airplanes climb and descend, and not all pilots fly according to regulations. But it can help deploy limited cockpit resources where they're most needed.

When cruising at altitudes where no en route cruising level is mandated (i.e., 3,000 feet AGL and below), avoid flying at 1,000-foot or 1,000 plus 500-foot altitudes (e.g., 1,500 feet, 2,000 feet, 2,500 feet). These tend to be more crowded than other available altitudes below 3,000 feet AGL.

Congested Airspace

When flying VFR, avoid over-flying approach fixes or holding points, such as VORs, that may attract other aircraft. Even in the GPS era of point-to-point navigation, NAVAIDs can still draw a crowd. If they are on your route, fly to the right of course and maintain special vigilance in the vicinity.

When getting a briefing, find out which special use airspace areas along your route are active. Stay clear of Military Training Routes (MTRs) whenever possible. If you're crossing a MTR, fly across it at a perpendicular angle to minimize the time spent in the area. However, pilots should be on the lookout for fast moving military aircraft even if they are just flying near charted MTRs. A recent collision between a Cessna 172 and an Air Force F-16 near Sarasota, Florida illustrates this hazard; two F-16s were en route to an entry point for an MTR when the trailing F-16 collided with the 172. If you see a military fighter, look for the wingman – they usually travel in pairs.

The MTR program is a joint venture by the FAA and the Department of Defense (DOD). Generally, MTRs are established below 10,000 feet MSL for operations at speeds in excess of 250 knots. However, some MTRs may have segments with higher altitudes to accommodate descent, climbout, and mountainous terrain.

If you see a military fighter, look for the wingman–they usually travel in pairs.

MTRs above 1,500 feet AGL are usually flown under IFR and are designated with the letters IR and a three-number route identification number, such as IR008. MTRs at 1,500 feet AGL and below are usually flown under VFR, and are designated with the letters VR and a four-number route identification number, such as VR1007. Some MTRs alternate between IR and VR, e.g., VR008A, IR1007B.

Only the centerline of an MTR is depicted on sectional charts, even though the routes may be 20 miles wide. Because MTRs are subject to change more frequently than VFR sectional charts are updated, pilots are advised to contact Flight Service for route dimensions and the current status of those routes affecting their flight. VFR flight following or an IFR flight plan is recommended, whenever possible, to increase coordination and collision avoidance services. Remember, however, in VFR conditions the pilot has primary responsibility for collision avoidance.

Lighting

Exterior lights can make your aircraft more visible to others, even during daylight hours. Consider installing recognition lights if your aircraft isn't already equipped with them because they can increase an aircraft's visibility by a factor of 10. An anticollision system, which includes strobe lights, also increases the visibility of your aircraft. Use your landing light on approach and departure, even during daylight hours. On approach to a towered airport, the landing light will help the controller visually identify your airplane. When ATC alerts you to traffic ahead or when you see oncoming traffic, turn your landing light on to help the traffic see you.

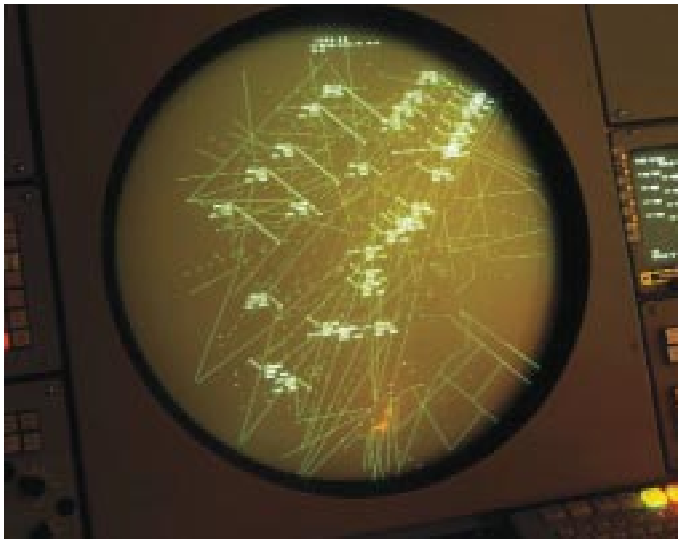
Sterile Cockpit

Complacency and lack of attention are the enemies of MAC avoidance strategies. To keep crews focused, airlines mandate a "sterile cockpit" at altitudes below 10,000 feet AGL; that is, all conversation not pertaining to operation of the aircraft is forbidden during these times. Maintaining this altitude standard may not be practical for most GA pilots, who often don't fly as high as 10,000 feet AGL, but the concept of sterile cockpit is still relevant. Limit idle conversation during the first and last 10 minutes of a flight in order to concentrate on scanning for conflicting traffic and other operational concerns.

Flight Following

Radar advisories from ATC, known as flight following for VFR aircraft, are another useful collision avoidance tool. It gives pilots another set of eyes to watch for traffic: those of an ATC controller who monitors radar returns and advises them of potential traffic conflicts. Flight following advisories are provided on a work-load permitting basis, and separation from other aircraft remains the responsibility of the pilot in command.

If an aircraft doesn't have a transponder – or doesn't have it turned on – it paints a much weaker image on the radar screen. That can make it difficult for the controller to see and warn other aircraft should the transponder-less aircraft pose a threat. This may have been a contributing factor in a 1998 midair collision involving a Cessna 172 and a Cessna Citation inside Atlanta's Class Bravo Mode C veil. After the accident, the transponder in the 172, whose pilot was not in contact with the approach facility, was found in the off position. No traffic advisory was issued to the jet. Though on an IFR flight plan, the Citation was in VFR conditions, and it was the responsibility of each PIC to see and avoid other aircraft.



Flight following is recommended when flying VFR.

Note: Even if you're not receiving advisories, monitoring ATC and the Common Traffic Advisory Frequency (CTAF) can give you valuable information about traffic in your area.

Most MACs occur at nontowered airports.

Nontowered Airports

Many MACs occur near nontowered airports, in part because no one person is organizing the airplanes in the pattern or coordinating landing traffic at these facilities. Use these procedures to reduce the risk of a MAC:

- Have radio frequencies dialed in and verified before you enter the airport vicinity.
- If communicating with approach control while inbound to a nontowered airport, monitor the CTAF frequency on your second radio, if available.
- Report your position 10 miles out and listen for position reports from other inbound pilots. Report each leg of the traffic pattern, including your entrance and exit.
- State the name of the airport at the beginning and end of each transmission.
- If you're unsure about the position of an aircraft on the frequency, clarify.
- Remember that airplanes without radios can be operating at nontowered airports.
- Fly the published approach speeds for your aircraft. A high-speed approach may put you at risk for the most common type of MAC, a faster aircraft overtaking a slower one.
- If possible, check behind and below you for conflicting traffic at least once on final.
- Report your position outbound. Be aware that most outbound pilots don't give position reports after departure. Remain on the CTAF frequency until clear of the area in order to avoid a conflict with inbound aircraft.
- If you're on an IFR approach at a nontowered airport, remember to include directions and distances from the field in your position reports, just as you would for VFR operations. Merely naming instrument approach fixes may not give all pilots in the area the complete picture.

Runway Incursions

History's deadliest collision did not occur in the air, it happened on the ground. In 1977, two Boeing 747s collided on the runway while trying to depart Tenerife in the Canary Islands, claiming 583 lives.

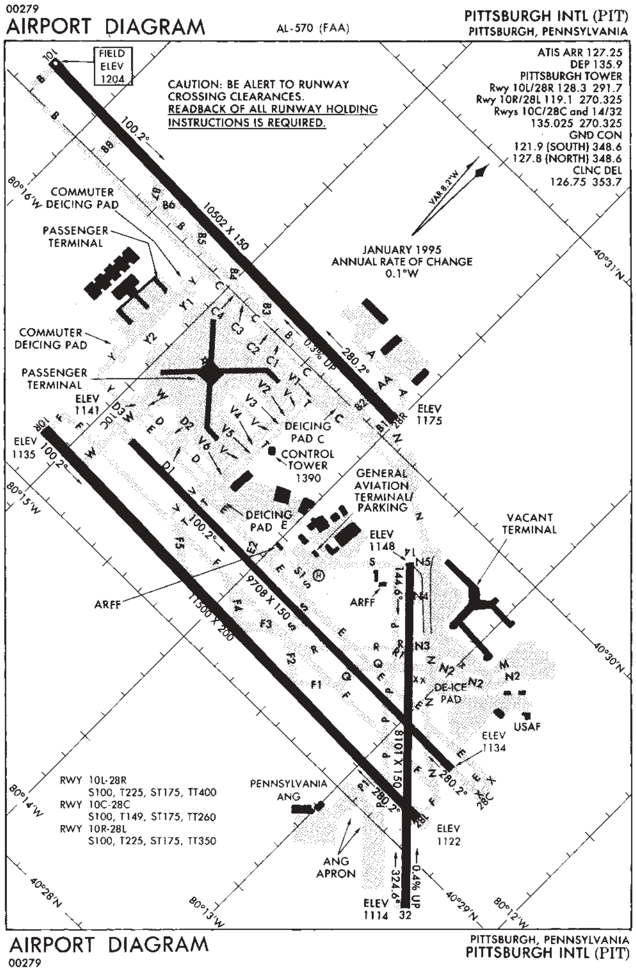
Runway incursions are defined as any occurrence at an airport involving an aircraft, vehicle, person, or object on the ground that creates a collision hazard or results in loss of separation with an aircraft taking off or intending to takeoff, landing or intending to land.

Between 1996 and 2003, reported runway incursions rose 21 percent. Since GA aircraft make up approximately 95 percent of all civil aircraft in the United States, it's not surprising that the FAA attributes a significant percentage of incursions to GA pilots who mistakenly taxi onto an active runway.

Always review the layouts of destination and en route airports during your flight planning. Charts can be just as important for navigating across an airport as through the airspace overhead.

Situational awareness is critical on the ground as well as in the air.

Situational awareness is critical in avoiding runway incursions. Miscommunication, inattention, and lack of information are usually at the root of a typical runway incursion. Pilots may misunderstand taxi instructions, controllers may misunderstand an aircraft's position, or a preoccupied pilot may taxi past an assigned hold short position. It is also possible that the pilot may not even know where he is if he's unfamiliar with the field. Typically, incursions by GA aircraft result in go-arounds or reduced separation between conflicting traffic rather than accidents. But these incursions can also have catastrophic results, whether they occur at towered or nontowered airports, as recent accidents prove. A Cessna 172 and a Cessna 152 collided on the runway at Sarasota, Florida's towered airport, resulting in four fatalities. According to the NTSB report, confusion in the tower and lack of attention in the cockpit were factors in the accident. The 152 had been cleared for takeoff. The 172, which was holding short for an intersection departure, was then cleared onto the runway, and taxied right into the path of the 152 on its takeoff roll. The controller thought the 172 he'd cleared onto the active was the aircraft waiting behind the 152. And those aboard the 172 involved in the accident apparently didn't look for traffic before proceeding onto the active runway. This accident underscores the fact that pilots need to maintain constant vigilance, whether under the control of ATC personnel or not. Announce your position to controllers, particularly when making intersection departures. Always look for conflicting traffic before taxiing onto or across any runway. And remember, your N number may not be visible to controllers, even with binoculars.



The November, 1996 collision of a Beech King Air and a Beech 1900 in Quincy, Illinois illustrates the potential consequences of incursions at nontowered airports. Cockpit Voice Recorder (CVR) tapes from the 1900 indicate that confusion and lack of attention and communication played prominent roles in this disaster. The 1900 was on a straight-in approach for Runway 13, and announced its intentions on the CTAF. The King Air announced it was going to takeoff on Runway 4. The crew of the 1900 asked if the King Air was going to hold until they landed. However, a third aircraft at the airport, a Piper Cherokee behind the King Air on Runway 4, responded that he would hold, and that transmission was partially blocked, apparently leading the 1900 crew to believe the transmission was from the King Air. The 1900 continued with its landing as the King Air commenced its takeoff roll. They collided at the intersection of the two runways, claiming the lives of all those aboard both aircraft.

Avoiding Runway Incursions –

- Review the anticipated taxi route before taxi (prior to departure) and en route (prior to landing).
- Listen carefully to ATC instructions at towered fields. The route you're given may not be the one you expected.
- Read back all taxi instructions.
- If uncertain, confirm permission to cross any and all runways prior to crossing them.
- Acquire airport diagrams for all airports, especially those with which you are unfamiliar. To print free airport diagrams, go to **www.aopa.org/asf/taxi.**
- If in doubt, ask for progressive taxi instructions.
- Look for traffic before taking the runway. Ensure that no conflicting traffic exists before beginning the takeoff.
- At nontowered airports with intersecting runways, check for traffic on the crossing runway as well as the one you intend to use for departure; do the same when landing at these airports.
- At airports with parallel runways, be aware of the potential for confusion created by the "left" and "right" runway designations.
- Be familiar with all relevant taxiway and runway signage.
- Stay up to speed with ASF's free online course *Runway Safety* at **www.aopa.org/asf/runway_safety** and print flashcards for learning or reviewing airport markings and signage at **www.aopa.org/asf/flashcards.**

Always review the layout of your destination airport during your preflight planning. Charts can be just as important for navigating across an airport as through the airspace overhead. The AOPA Air Safety Foundation website has airport diagrams available for many of the nation's busiest airports; they can be easily downloaded and printed out by anyone with a computer and Internet connection **(www.aopa.org/asf/taxi).** Remember to pay attention while taxiing – don't use the time to program the GPS or dig for charts. As always, make sure you understand the things that you hear over the radio, whether it's ATC instructions or radio calls made by pilots at non-towered airports.

To learn more about runway incursion avoidance, view ASF's interactive Runway Safety Program online at **www.aopa.org/asf/runway_safety/**

Collision Avoidance Technology

Technology in the cockpit can help pilots to see and avoid other aircraft. All air carrier aircraft are equipped with Traffic Alert and Collision Avoidance Systems, commonly referred to as TCAS. There are two versions: TCAS I and TCAS II.

TCAS I indicates the relative altitude, distance, and bearing of transponder-equipped aircraft within a selected range, generally up to 40 miles. With color-coded symbols and aural warnings called Traffic Advisories (TAs), the system indicates which aircraft pose a potential threat. TCAS I identifies potential problems, but it does not offer solutions in terms of what evasive action to take. However, it is still a valuable tool because it supplies pilots with important data they can use in determining the best course of action.

TCAS II, in addition to a traffic display, provides pilots with Resolution Advisories (RAs) when needed. The system determines the course of each aircraft and whether it is climbing, descending, or flying straight and level. TCAS II then issues a RA advising the pilots to climb or descend as necessary to avoid the other aircraft. If both planes are equipped with TCAS II, then the two computers offer deconflicting RAs, ensuring pilots' actions minimize, rather than exacerbate, a collision threat.

GA pilots also have access to three types of technology that provide information to determine relative altitude, distance, and bearing to assist in collision avoidance: passive, active and datalink. A passive system simply picks up on the results of other third party radar interrogations and the corresponding transponder replies, which can come from ATC, military radar, and active collision avoidance systems. Ryan International's Traffic Collision Avoidance Device (TCAD) is an example of a passive system. An active system, such as TCAS I, continuously interrogates other Mode A, Mode C, and Mode S transponders. Ryan International has introduced an active system for GA pilots called Traffic Advisory System (TAS), which interrogates other transponders within a range of over 20 miles. Datalink systems, often referred to as Traffic Information Systems (TIS) require a Mode S transponder and a Mode S radar-equipped facility to convert ATC data into collision avoidance information for pilots.

Ryan International's Traffic Advisory System (TAS).

ADS-B, Automatic Dependent Surveillance Broadcast, represents the next generation collision avoidance technology. An ADS-B equipped aircraft broadcasts a signal that contains a GPS-derived location. The signal, rebroadcast by a ground station or satellite, can be displayed in other ADS-B equipped aircraft, giving pilots critical collision avoidance information without input from ground-based ATC controllers. In addition, ADS-B is not dependent on Mode S equipment, which is not installed in all aircraft nor available from all radar facilities. This same technology also offers real-time weather and text messaging capabilities.

Collision Avoidance Checklist

You now have the knowledge to minimize the threat of collisions in the air and on the ground. Use the following tactics to enhance the safety of every flight.

Plan your flight

Know your route, the frequencies you'll need along the way, and the pertinent information for your destination. Fold charts and preset navigational aids to maximize scan time. Program your avionics (including GPS units) on the ground to minimize heads-down time in the air. Anticipate where you may find high traffic/high workload areas. Avoid these areas if possible or plan on being extra vigilant during those phases of the flight.

Improve your visibility

Bugs or other contaminants on your windshield can block an aircraft from view and make it more difficult to focus properly. During climbout, make S-turns for improved forward visibility. Once you've reached a safe altitude, use cruise-climb airspeeds to get a better view over the nose.

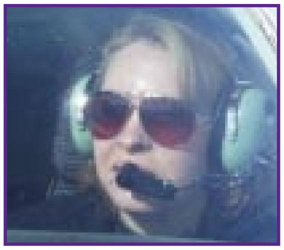
Educate passengers

As part of your preflight briefing, explain basic scanning procedures to passengers and have them assist in spotting traffic. Explain FAA radar advisory procedures, so they can help locate traffic called by ATC.

Use aircraft lights

Install and use additional lighting to help other pilots see your aircraft. Use your landing light on approach, departure, and climbout – especially within 10 miles of any airport.

Use sunglasses



Sunglasses that block out UV rays help protect your vision and reduce eye fatigue. Red/yellow spectrum lenses make it easier to see through haze. Polarized lenses reduce glare, but this may be a detriment to spotting traffic as the glint of light bouncing off an aircraft is often the very thing that helps make it visible.

Observe proper procedures

Use correct cruising altitudes and traffic pattern procedures. Announce your position at nontowered airports. Recognize that not everyone follows the rules.

Communicate

When flying in controlled airspace, familiarize yourself with the required communication procedures. At non-towered airports, begin announcing your position when 10 miles out.

Equip yourself

If you operate an aircraft without radios or transponders, consider installing them to enhance your safety. Regulations require that aircraft equipped with transponders must have them on during flight in controlled airspace.

Scan for traffic!

Use the techniques presented in this Safety Advisor (see Page 5). Remember to devote more time to scanning for traffic outside than scanning the instruments inside.

AOPA AIR SAFETY FOUNDATION

maintains a highly active Website, filled with GA Safety topics.

www.asf.org

FREE ONLINE COURSES

Courses to improve piloting skills. Many qualify for the FAA Wings Proficiency Awards Program. Many courses to choose from:

- Single Pilot IFR
- IFR Adventure: Rules to Live By
- Runway Safety Program
- Know Before You Go
- Say Intentions
- SkySpotter®
- Safety Quizzes

CFI TRAINING

ASF recertifies more Flight Instructors than any other course provider. ASF is the best in CFI renewal and now the CFI has the convenience of selecting the In-Person or Online course.

SAFETY TOPICS

View an array of information from accident analysis to weather. Here are some of the topics listed:

- Aircraft Equipment
- Airport Operations
- Bird Hazards
- Fuel Mismanagement
- Wake Turbulence

ACCIDENT ANALYSIS

View the extensive ASF Accident database which is comprised of NTSB accident reports.
Also view information on:

- Taxi Diagrams
- Annual Nall Report
- Safety Articles

FREE SAFETY SEMINARS

ASF holds 200+ Free Safety Seminars a year.
Topics range from:

- Single Pilot IFR
- Operations Airspace
- Ups and Downs of Takeoffs and Landings
- And many more topics

SEMINAR-IN-A-BOX®

Educate pilots in your area and conduct your own quality safety seminar. Various safety topics available.

ASF PRODUCT CATALOG

DVDs and books to keep you flying safely.

Chartered in 1950, the AOPA Air Safety Foundation is the nation's largest nonprofit organization providing aviation safety education and programs to the general aviation community.

The mission of the Foundation is to save lives and promote accident prevention through pilot education. ASF serves all of the nation's 640,000 general aviation pilots.

You can help make Safe Pilots. Safe Skies.

ASF products and programs are funded by tax deductible donations from pilots like you. For further information on how to make a charitable gift go to

www.aopa.org/asf/development

AOPA AIR SAFETY FOUNDATION

421 Aviation Way • Frederick, MD 21701 • 800.638.3101 • www.asf.org

Be Prepared!

Visit www.aopa.org/asf/runway_safety/

to take ASF's FREE online Runway Safety Program.

"This interactive program offers the opportunity to learn at a pace that suits the user without removing the required detail. Thank you for a user-friendly and fun learning experience."
-John Collins
Martinsburg, WV

Note: This program satisfies the seminar attendance requirement of FAA's WINGS program.

---

421 Aviation Way, Frederick, MD 21701
800/638-3101
E-mail: asf@aopa.org
Web: www.asf.org
Publisher: Bruce Landsberg
Editors: John Steuernagle, Kathleen Roy, Jennifer Storm
Writer: James Wynbrandt
Intern: Bill Mastick

SA15 8/04