U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject: Pilots' Role in Collision Avoidance | **Date:** 10/20/22 | **AC No:** 90-48E
Initiated by: AFS-800 | **Change:**

1 **PURPOSE OF THIS ADVISORY CIRCULAR (AC).** This AC is issued to assist pilots with their regulatory obligation to see and avoid other aircraft. Specifically, this AC looks to alert pilots to human contributors to midair collisions and near midair collisions (NMAC), and recommend improvements to pilot education, operating practices, procedures, and improved scanning techniques to reduce midair conflicts. This AC is not mandatory and does not constitute a regulation. The contents of this document do not have the force and effect of law and are not meant to bind the public in any way, and the document is intended only to provide clarity to the public regarding existing requirements under the law or agency policies.

2 **AUDIENCE.** This AC is intended to provide guidance to certificated pilots, flight instructors, student pilots, training providers, and pilot examiners to mitigate the risk of a midair collision or NMAC during flight operations.

3 **WHERE YOU CAN FIND THIS AC.** You can find this AC on the Federal Aviation Administration's (FAA) website at https://www.faa.gov/regulations_policies/advisory_circulars and the Dynamic Regulatory System (DRS) at https://drs.faa.gov.

4 **PRINCIPAL CHANGES.** This revision to the AC incorporates additional information regarding pilot actions, procedures, Notices to Air Missions (NOTAM), and aircraft technology to mitigate the risk of a pilot causing or being involved in a ground collision, in-flight collision, or NMAC.

5 **WHAT THIS AC CANCELS.** AC 90-48D CHG 1, Pilots' Role in Collision Avoidance, dated June 28, 2016, is canceled.

6 **REFERENCES AND RELATED READING MATERIALS (current editions).**

6.1 Regulations and Guidance.

- Title 14 of the Code of Federal Regulations (14 CFR) part 91 sections related to preflight, right-of-way rules, operating on or in the vicinity of an airport, operations in classes of airspace, basic and special visual flight rules (VFR) minimums, VFR and instrument flight rules (IFR) cruising altitudes, powered civil aircraft standard category and equipment requirements, and Automatic Dependent Surveillance-Broadcast (ADS-B): §§ 91.103, 91.113, 91.126, 91.127, 91.129, 91.130, 91.131, 91.135, 91.155, 91.157, 91.159, 91.179, 91.205, 91.225, and 91.227.

- AC 90-66, Non-Towered Airport Flight Operations.
- AC 91-73, Parts 91 and 135 Single Pilot, Flight School Procedures During Taxi Operations.
- AC 91-79, Mitigating the Risks of a Runway Overrun Upon Landing.
- Aeronautical Information Manual (AIM):
  - Chapter 4, Air Traffic Control (services available to pilots, communications, and more).
  - Chapter 8, Section 1, Fitness for Flight, Paragraph 8-1-6, Vision in Flight.
- Digital Terminal Procedures Publications (TPP)/Airport Diagrams.
- European General Aviation Safety Team (EGAST) Leaflet GA 1, Collision Avoidance (January 1, 2010). Based on International Civil Aviation Organization (ICAO) Circular 213–AN/130 and a safety leaflet produced by the United Kingdom (UK) Civil Aviation Authority (CAA); aims to help pilots to make "look-out" more effective.
- FAA Safety Team (FAASTeam), General Aviation Pilot's Guide to Preflight Weather Planning, Weather Self-Briefings, and Weather Decision Making (August 2006).
- Pilot/Controller Glossary:
  - See and Avoid: When weather conditions permit, pilots operating IFR or VFR are required to observe and maneuver to avoid other aircraft (refer to § 91.113 for right-of-way rules).
  - Visual Separation: A means employed by air traffic control (ATC) to separate aircraft in terminal areas and en route airspace in the National Airspace System (NAS). There are two ways to effect this separation: 1) The tower controller sees the aircraft involved and issues instructions, as necessary, to ensure that the aircraft avoid each other. 2) A pilot sees the other aircraft involved, and upon instructions from the controller provides their own separation by maneuvering their aircraft as necessary to avoid it. This may involve following another aircraft or keeping it in sight until it is no longer a factor.

6.2 Additional Reading Materials.

- AC 00-65, Towbar and Towbarless Movement of Aircraft.
- AC 150/5200-30, Airport Field Condition Assessments and Winter Operations Safety.
- AC 150/5210-20, Ground Vehicle Operations to include Taxiing or Towing an Aircraft on Airports.
- 437th Airlift Wing, Joint Base Charleston, SC, Mid-Air Collision Avoidance (MACA) (November 2017).

- Aircraft Owners and Pilots Association (AOPA), Maneuvering Flight: Hazardous to Your Health?
- AOPA Safety Publications Articles, Basic VFR: How to Know It When You See It (April 5, 2008).
- *Aviation Safety*, Is See-And-Avoid Dead? (January 6, 2017).
- Colvin, Kurt & Dodhia, Rahul, & Dismukes, R. Key, Is Pilots' Visual Scanning Adequate to Avoid Mid-Air Collisions? (2005).
- Department of Transportation (DOT) FAA General Aviation Accident Prevention Program, Estimating Inflight Visibility.
- FAA Aerospace Medical Education Division (AAM-400), Pilot Vision (October 2017).
- FAA Guide to Ground Vehicle Operations.
- FAASTeam, ALC-683: Conducting Preflight Self-Briefings for Student and VFR Pilots.
- FAASTeam, FLYING LESSONS for October 13, 2011 (October 13, 2011).
- ICAO Circular 213–AN/130, Pilot Skills to Make "Look-Out" More Effective in Visual Collision Avoidance.
- National Transportation Safety Board (NTSB), Safety Alert SA-058, Prevent Midair Collisions: Don't Depend on Vision Alone (April 2021).
    - NTSB, Educating Controllers on Two Midair Collisions (November 16, 2016). The presentation contains associated Safety Alert, midair collision animations, Safety Recommendation Report (ASR-16-06), and accident reports.
    - NTSB Midair Accidents.
    - NTSB, Midair Collision Over George Inlet, de Havilland DHC-2, N952DB, and de Havilland DHC-3, N959PA, Ketchikan, Alaska, May 13, 2019 (Aircraft Accident Report (AAR) 21/04, April 20, 2021).
- Scott Air Force Base Midair Collision Avoidance Pamphlet (March 2017).
- SKYbrary, Inadvertent VFR Flight Into IMC (May 2020).
- SKYbrary, Visual Scanning Technique (October 2019).
- UK CAA, SafetySense Leaflet 13, Collision Avoidance (January 2013).

7 BACKGROUND. The FAA has developed tools and advisory materials designed to reduce the risk of either midair collisions or NMACs. This AC is one of those advisory materials, with a focus on a pilot's responsibility to see and avoid other aircraft.

7.1 ADS-B for Air Tour and NTSB Safety Recommendations. The NTSB released Safety Alert SA-058 on midair collision prevention technology, which states, in part, "The 'see-and-avoid' concept has long been the foundation of midair collision prevention.

However, the inherent limitations of this concept, including human limitations, environmental conditions, aircraft blind spots, and operational distractions, leave even the most diligent pilot vulnerable to the threat of a midair collision with an unseen aircraft." On May 13, 2019 in Ketchikan, Alaska, two aircraft collided. After reviewing the incident, the NTSB released Midair Collision Over George Inlet, de Havilland DHC-2, N952DB, and de Havilland DHC-3, N959PA, Ketchikan, Alaska, May 13, 2019 (AAR-21/04, April 20, 2021), advocating air tour operators to install ADS-B In. However, ADS-B regulatory requirements are for aircraft originally certificated with an electrical system operating at or above 18,000 feet, in Class B and C airspace, or in Class E airspace at and above 10,000 feet mean sea level (MSL), excluding the airspace at and below 2,500 feet above the surface (refer to § 91.225).

7.2 Air Tour Operations. Air tour flights are typically conducted in areas of congested airspace with pilots often distracted by requirements for positioning the aircraft for sightseeing and often narrating the tour for the passengers. Air tour aircraft also tend to congregate around common points of interest/landmarks, thereby creating congestion. NTSB studies of several recent midair collisions conclude that the ADS-B Traffic Advisory System (ATAS) would provide significant advance warning if installed (e.g., 30–39 seconds for the Ketchikan accident; 20+ seconds in most other recent midair collisions) (refer to ADS-B ATAS).

7.3 NTSB Recommendation. Therefore, though not required by regulation for these types of flights, it is recommended by the NTSB that air tour operators install and use an ATAS during these flights. This action would not only increase the safety of such low-altitude operations, but the safety of en route flights that fly through high traffic areas below 2,500 feet above the surface and outside of Class B and C airspace. Refer to §§ 91.225 and 91.227 for ADS-B operational requirements. Consider that see-and-avoid together with ADS-B are lifesavers.

Note: Per the 437th Airlift Wing, Joint Base Charleston, SC, Mid-Air Collision Avoidance (MACA) (November 2017), paragraph 11, "IN ACCORDANCE WITH FAR PART 91.413, WHILE IN CONTROLLED AIRSPACE, EACH PILOT OPERATING AN AIRCRAFT EQUIPPED WITH AN OPERABLE ATC TRANSPONDER MAINTAINED SHALL OPERATE THE TRANSPONDER, INCLUDING MODE C IF INSTALLED, ON THE APPROPRIATE MODE OR AS ASSIGNED BY ATC. IN CLASS G AIRSPACE, THE TRANSPONDER SHOULD BE OPERATING WHILE AIRBORNE UNLESS OTHERWISE REQUESTED BY ATC." For more information, refer to the Joint Base Charleston pamphlet.

8 HUMAN LIMITATIONS AFFECTING SEE-AND-AVOID. Inherent limitations to see-and-avoid expose the most diligent pilot to the threat of a midair collision with an unseen aircraft. These limitations include but are not limited to human limitations,

environmental conditions, aircraft blind spots, and operational distractions (refer to the Scott Air Force Base Midair Collision Avoidance Pamphlet for more information).

8.1 Limitations of the Eye. Pilots rely on their eyes to provide most of the basic input necessary for flying an aircraft (e.g., the aircraft's attitude, speed, direction, and proximity to opposing traffic). As air traffic density and aircraft closing speeds increase, the risk of midair collision also increases, and with it, so does the importance of effective scanning. A basic understanding of the eye's limitations in target detection is one of the best defenses against a collision. The following are the limitations of the eye (refer to the Scott Air Force Base Midair Collision Avoidance Pamphlet for more information).

8.1.1 Other Factors Affecting Vision. In flight, vision is influenced by atmospheric conditions, glare, lighting, windshield deterioration and distortion, aircraft design, cabin temperature, oxygen supply (particularly at night), and acceleration forces.

8.1.2 Detection of Objects. Detection of objects while airborne depends on six conditions:

- Image size—portion of the visual field filled by the object.
- Luminance—degree of brightness of the object.
- Contrast—difference between object and background brightness, color, and shape.
- Adaptation—degree to which the eyes adjust to surrounding illumination.
- Motion—velocity of the object, the observer, or both.
- Exposure time—length of the time the object is exposed to view.

Note: Refer to the Scott Air Force Base Midair Collision Avoidance Pamphlet for more information.

8.1.3 Avoid Complacency: Vision In Flight. The most advanced piece of flight equipment in any aircraft is the human eye, and since the number one cause of midair collisions is the failure to adhere to the see-and-avoid concept, efficient use of visual techniques and knowledge of the eye's limitations will help pilots avoid collisions. Your vision's clarity is influenced by some characteristics of the objects you are viewing, including:

- Your distance from the object.
- The size, shape, and movement of the object.
- The amount of light reflected by the object.
- The object's contrast with the surrounding environment.

Note: Refer to the Scott Air Force Base Midair Collision Avoidance Pamphlet for more information.

8.1.4 Accommodation and Refocusing. One inherent problem with the eye is the time required for accommodation or refocusing. It takes 1 to 2 seconds for eyes to refocus from something up close, like a dark instrument panel 2 feet away, to a bright landmark or

aircraft 1 mile away. The 1-to-2-second delay is significant, when as Table 1 suggests it takes 12.5 seconds to identify, react, and avoid a midair collision.

Table 1. Aircraft Identification and Reaction Time Chart

Event	Seconds
See Object	0.1
Recognize Aircraft	1.0
Become Aware of Collision Course	5.0
Decision to Turn Left or Right	4.0
Muscular Reaction	0.4
Aircraft Lag Time	2.0
TOTAL Time Before Aircraft Begins to Move	12.5

Note: This table uses data from Transportation Safety Board of Canada (TSB) Aviation Investigation Report A99P0168, which references U.S. Naval Aviation Safety Center released data concerning typical recognition and reaction times (in seconds) for pilots confronted with a potential midair collision.

8.1.5 Empty-Field Myopia. If there is little or nothing to focus on, the eyes tend to not focus. This usually occurs on vague colorless days above a haze or cloud layer when no distinct horizon is visible.

8.1.6 Binocular Vision. Binocular vision means using two eyes with overlapping fields of view, allowing good perception of depth. Binocular vision and our perception can be affected (e.g., blurring) when an object is visible to only one eye but hidden from the other by a windshield post or other object, for example. Therefore, it is essential that pilots move their head, not just their eyes, when scanning around obstructions.

8.1.7 Narrow Field of Vision/Tunnel Vision. Another inherent problem with human vision is the narrow field of vision/tunnel vision phenomenon. Although our eyes accept light rays from an arc of nearly 200 degrees, they can only focus on and classify an object within a relatively narrow area of approximately 10 to 15 degrees. As a result, the eye cannot accurately identify what is happening in the distance when experiencing tunnel vision or narrow field of vision, even when the eye senses movement by its peripheral vision. Thus, pilots tend to not believe what they see out of the corner of their eyes.

8.1.8 The Blossom Effect. In aviation, the "blossom effect" refers to the visual phenomenon where two aircraft on a collision course will appear to be virtually motionless to each other. The other aircraft will remain in a seemingly stationary position, without appearing to move or grow in size for a relatively long time, and then suddenly bloom into a huge mass filling one of the windows. Given that we need motion or contrast to attract our eyes' attention, this effect becomes a frightening factor when you realize that a large bug

smear or dirty spot on the windshield can hide a converging plane until it is too close to be avoided.

8.1.9 Environmental Limitations. In addition to its inherent problems, the eye is also limited by the environment. The atmosphere's optical properties alter the appearance of aircraft, particularly on hazy days. VFR requires 5 statute miles (sm) of visibility, but on a hazy day, a pilot may have difficulty detecting opposing aircraft. For this reason, we recommend you fly above a haze layer. For additional information on the effect of haze, refer to the AIM, Chapter 8.

8.1.10 Glare. Glare effects make objects hard to see, and therefore make it harder to scan successfully for other aircraft. This is particularly true on a sunny day over a cloud layer or during flight directly into the sun. An aircraft that has a high degree of contrast against the background will be easy to see, while one with a low degree of contrast at the same distance may be impossible to see. In addition, when the sun is behind the aircraft, a conflicting aircraft will stand out clearly, but if it is flying into the sun, the glare of the sun will often prevent seeing the other aircraft. A dirty, scratched, opaque, or distorted windshield will make matters worse. Therefore, the FAA recommends keeping windshields clean.

9 PREFLIGHT PLANNING. Before flying, § 91.103 requires each pilot in command (PIC) to become familiar with all available information concerning that flight. In addition to the nonexhaustive list of information PICs should consider, the FAA recommends pilots also consider the following items that can affect a pilot's ability to see and avoid other aircraft.

9.1 The Airport's NOTAMs. A NOTAM is a notice containing information concerning the establishment, condition, or change in airport's facility, service, procedures, or hazard in the NAS, which is essential to personnel concerned with flight operations. For example, an airport may issue a NOTAM to inform the public of construction that could affect runways or taxiways, and therefore distract a pilot during landing and ground operations. Also, field condition (FICON) NOTAMs provide a runway's surface friction level and, after applying the recommended 15-percent safety margin to the Aircraft Flight Manual (AFM) or pilot's operating handbook (POH) required landing distance, information on whether there is sufficient runway length to safely stop the aircraft to mitigate a runway overrun. Refer to AC 91-79.

9.2 VFR or IFR Navigation Charts. Reviewing the route of flight on the appropriate VFR/IFR navigation charts can help a pilot identify special use airspace, restricted airspace, and Military Operations Areas (MOA) around the departure and arrival airports, as well as the terrain and its elevation along the route of flight. These include:

- Aeronautical Charts. Use current aeronautical charts for the route and area of flight.
- Terminal Area Charts (TAC), sectional aeronautical charts, and helicopter route charts (refer to https://www.faa.gov/air_traffic/flight_info/aeronav/productcatalog/vfrcharts/).

- Digital Chart Supplements (d-CS). Use current chart supplements. Access the FAA d-CS at https://www.faa.gov/air_traffic/flight_info/aeronav/digital_products/dafd/ and look under the Airport/Nav column to obtain airport-specific information, such as the approach (APP) or departure control (DEP) frequency, or refer to the FAA Aeronautical Information Services (AIS) web page at https://www.faa.gov/air_traffic/flight_info/aeronav/. Either is a source for up-to-date airport information.

9.3 Weather Conditions. A pilot can ensure they will be able to meet any required VFR requirements (e.g., ceiling and visibility requirements) by familiarizing themselves with expected weather conditions along the intended flightpath. For example, weather services can inform the pilot of any adverse meteorological conditions that would affect the ability to see other aircraft, such as smoke, haze, and precipitation, and increase the risk of a midair collision or NMAC.

9.4 Daytime or Nighttime Flight. The FAA recommends that a pilot become aware of the time of day they will be flying to account for the expected light's effect on visibility, and therefore, the effect on a pilot's ability to see and avoid. For example, a pilot's vision will be affected if flying in the direction of the sun due to the sun's glare. A pilot should consider ways to reduce the effect of the sun's glare on their ability to see traffic. If the flight occurs at night, pilots should account for ground, tower, and other nighttime lighting conditions that can affect their ability to see at night.

10 AIRPORT GROUND OPERATIONS. Field of vision is key to a pilot's ability to remain constantly alert to all types of traffic movement on the airport surface and while flying. While operating on the airport surface, remain aware that there is both vehicle and aircraft movement on the ramp and taxiways.

10.1 Pilot's Role. The following are actions pilots can take to reduce the risk of collision on an airport's surface.

10.1.1 Airport Ground Operations. Be aware of vehicle movements, taxiing aircraft, and aircraft being towed.

10.1.2 Pilot Workloads. To mitigate the risk of a collision during ground operations, pilots can reduce distractions that take the pilot's attention away from scanning and being alert to activity within their taxiing area. For example, we recommend that pilots do not perform pretaxi or other checklists while taxiing, or engage in unnecessary conversations with passengers. These actions, and any other actions that take the pilot's attention from scanning outside of the aircraft, can increase the risk of a ground collision.

10.1.3 Human Factors That Affect a Pilot's Performance. A pilot can mitigate against the risk of collision by accounting for the human factors associated with fatigue, "get-there-itis," or distractions during ground operations.

10.1.4 Airport Hot Spots. Airport "hot spot" information forewarns pilots and others operating in the movement area of the airport of confusing airport geometry and intersections. Pilots can reduce the risk of collision by becoming aware of airports' hot spots. A hot

spot is a location within the airport movement area with a history of potential risk of a collision or runway incursion. Therefore, we recommend pilots identify hot spots along their ATC-issued route to their assigned runway, or a route to another location on the airport.

10.2 Airport Communications and Taxi Procedures. Refer to radio communication regulations in §§ 91.126, 91.127, 91.129, 91.130, 91.131, and 91.135.

10.2.1 Radio Communications at Towered Airports. Before operating from the ramp area onto a taxiway (movement area), FAA regulations require establishing two-way radio communications with the airport's ATC facility (refer to §§ 91.126, 91.127, 91.129, 91.130, and 91.131). When contacting the ATC facility, we highly recommend the pilot use the aircraft's full call sign. This will help avoid confusion if there are aircraft on the frequency with a similar call sign. For example, if the pilot mistakenly takes a clearance for another aircraft with a similar call sign and reads back to ATC with their aircraft's full call sign, ATC will acknowledge that the clearance was for another aircraft.

10.2.2 Operations at Non-Towered Airports. To minimize collision risk, we recommend pilots operating at non-towered airports follow the same pretaxi and taxi procedures employed at towered airports. Given that some aircraft at a non-towered airport may operate without radio communication, a pilot should scan their surrounding area; the runway in use; and the final, base, and downwind legs of the runway in use, and be alert for radio transmissions by other pilots, announcing that they are landing or taking off from runways other than the runway that the pilot is using. Additionally, the pilot should self-announce their position and intentions, such as whether they will taxi or are entering the runway in use for takeoff. For additional guidance, refer to AC 90-66 and AIM, Chapter 4.

Note: For ATC issuing an IFR clearance at a non-towered airport, ATC may issue an "IFR departure release," which is not an authorization to the pilot to take off. The pilot must communicate over the airport's common traffic advisory (TA) frequency (CTAF) their call sign, the runway they will use to take off, their departure direction, and their initial climb altitude, and coordinate their takeoff with other inbound aircraft and with aircraft in the traffic pattern before taking off, in order to mitigate the risk of a surface or midair collision. If the departing aircraft has a clearance void time and cannot safely take off, then they are to contact ATC and advise ATC that they need to obtain another clearance void time.

10.3 Airport Communication Procedures. After obtaining the airport's current weather (e.g., through Automatic Terminal Information Service (ATIS)), we suggest the following best practices:

10.3.1 Initiate communication with ATC by stating the aircraft's make and full registration number. After receiving the VFR or IFR departure instructions from ATC, write down the instruction or clearance. Then, initiate a readback to ATC using the same phraseology

used by ATC, stating the aircraft's make and full registration number, as well as the instruction or clearance.

10.3.2 Contact ground control, using the aircraft's full call sign, and write down the taxi route to the assigned runway. Then, read back the instructions as described above in paragraph 10.3.1.

10.3.3 Before taxiing, review the airport's diagram for hot spots along the taxi route and locate where to hold short of any runway that you have not been cleared to cross. This will limit heads-down time, increase scanning outside the aircraft for traffic and other conflicts, and assist in complying with the ATC instruction/clearance.

10.3.4 Finally, when in doubt of where to taxi or hold short of a runway, stop and ask ATC for clarification. For example, "N1234, am I cleared to cross Runway 1?" This will avoid causing a runway incursion and a possible collision with other taxiing and landing aircraft. Remember, you are the final authority in the operation of the aircraft (refer to AC 91-73).

10.4 Suggested Procedures for Collision Avoidance and When to Abort a Takeoff. The FAA suggests the following actions to avoid a takeoff collision and help identify if a takeoff should be aborted. There are two mnemonic devices to help remember the actions.

10.4.1 Lights, Camera, Action. A pilot should take these actions when ATC issues the pilot a takeoff clearance, or before taking the active runway for takeoff at a non-towered airport:

- "Lights": Turn on your landing light and other lights appropriate for the conditions of flight to increase your visibility to other traffic.
- "Camera": Turn on your transponder for ATC identification.
- "Action": At a towered airport, a pilot should read back and state to ATC the aircraft's full call sign. At a non-towered airport, announce your aircraft make, registration number, and model.

Note: When cleared to either line up and wait or takeoff, scan the final approach for landing aircraft and look down the runway for vehicles or aircraft that may be on or crossing the runway before entering the runway safety area. When on the active runway, confirm that the aircraft is aligned on the correct runway by checking that the painted runway numbers, the magnetic "whiskey" compass, and directional gyro all indicate the heading of the assigned takeoff runway.

10.4.2 REACT. When beginning the takeoff roll, perform the "REACT" check. This mnemonic provides decision points to abort the takeoff if any one of the following "related items" are not normal.

- "R": Check engine **r**evolutions per minute (rpm)/manifold pressure. Is it at takeoff power?

- "E": **E**ngine gauges are normal.
- "A": **A**irspeed is continually increasing.
- "C": Maintain runway **c**enterline (RCL).
- "T": Know your approximate **t**akeoff point. This is the distance at which your aircraft should be airborne.

Note: Knowing your airplane's performance, for either a sea-level takeoff or a high-density altitude takeoff, enables a pilot to know their aircraft's approximate takeoff point. This is the "T" in REACT. If any of these items is not within expectation, abort the takeoff by communicating over the tower or common traffic advisory (TA) frequency (CTAF) the aircraft's call sign, announce that you are aborting takeoff, exit the runway, taxi to a safe area, and figure out why one or more of the REACT items was not met.

11 IN-FLIGHT COLLISION AVOIDANCE OPERATIONS.

11.1 Typical Midair Collision Scenarios. The following are typical midair collision scenarios, with the appropriate pilot action to avoid a midair collision (refer to § 91.113).

11.1.1 Approaching Head-On (During Cruise Flight). When aircraft are approaching each other head-on, or nearly so, each pilot of each aircraft shall alter its course to the right.

11.1.2 Overtaking (During Cruise Flight). Each aircraft that is being overtaken has the right-of-way. Each pilot of an overtaking aircraft shall alter its course to the right to pass well clear.

11.1.3 Landing at Non-Towered Airports. As stated in § 91.113(g), "Aircraft, while on final approach to land or while landing, have the right-of-way over other aircraft in flight or operating on the surface, except that they shall not take advantage of this rule to force an aircraft off the runway surface which has already landed and is attempting to make way for an aircraft on final approach. 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."

11.1.4 Landing at Towered Airports. ATC may instruct the pilot to report, for example, when on a 2 mile left base to runway 22. This means that the pilot is to report when on the left base to runway 22 and is to intercept runway 22's extended centerline for a 2-mile final leg for landing. This is typically used by ATC to sequence aircraft for landing.

11.1.5 Avoiding Collisions With Unmanned Aircraft Systems (UAS). Pilots should remain vigilant of UAS at or below 400 feet in uncontrolled airspace and at all times in visual meteorological conditions (VMC). All pilots should remain vigilant of all aircraft if they are able to see them, and take measures to avoid them.

11.2 Collision Avoidance Assistance and Maneuvering and Formation Flights.

11.2.1 Collision Avoidance Assistance. ATC provides ATAS, which is an excellent addition to scanning resources to mitigate midair collisions. To arrange for the service, contact the airport's clearance delivery and request the ATC frequency to contact after takeoff to request ATAS. Further, the ATC facility frequency that can provide this service is available in the d-CS for the respective airport during your preflight planning process. The ATC departure frequency can also be found on the airport's information page or by contacting the Flight Service Station (FSS) after departure by using the flight service common frequency of 122.2 megahertz (MHz). For more information, refer to the Aeronautical Chart Users' Guide.

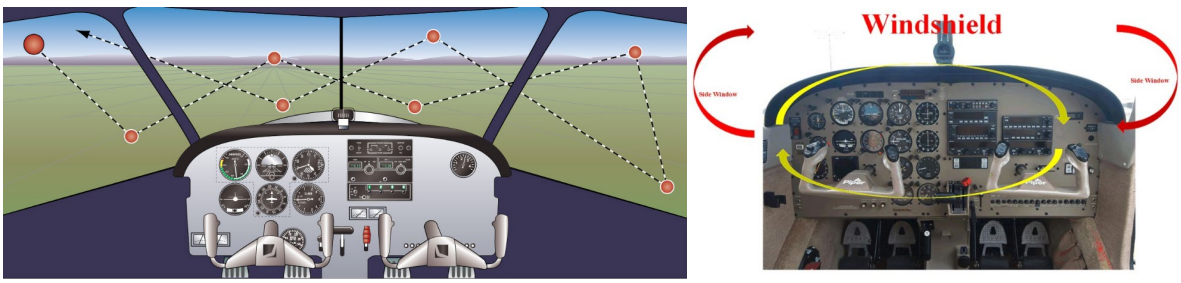
11.2.2 Maneuvering and Formation Flights.

11.2.2.1 Maneuvering Flight Cautions. More than one-quarter (26.6 percent) of all fatal accidents in the last 10 years occurred during maneuvering flight. This includes buzzing, formation flying, aerial work, stalls/spins, canyon flying, aerobatics, and normal flight operation. The distraction created by these maneuvers takes away from scanning for traffic.

11.2.2.2 Formation Flight. Several midair collisions have occurred during recreational formation flights. Formation flights have been enjoying a great deal of popularity among civilian pilots over the past several years. Unfortunately, the increase in the number of formation flights has also led to an increase in midair collisions between the formation flight aircraft. We strongly suggest that pilots looking to fly in pairs or in formation refer to the AOPA Safety Advisor article, "Maneuvering Flight: Hazardous to Your Health?" We also recommend that pilots train with an established formation flying training organization before flying in formation.

12 EFFECTIVE SCANNING TECHNIQUES. Effective scanning is accomplished with a series of short, regularly spaced eye movements that bring successive areas of the sky into the central visual field. Each movement should not exceed 10 degrees, and each area should be observed for at least 1 second to enable detection. Although most pilots seem to prefer horizontal back-and-forth eye movements, each pilot should develop a scanning pattern that is most comfortable and then adhere to it to ensure optimum scanning. See Figure 1 below.

Figure 1. Sample Scan Pattern



12.1 Phases of Flight and Blind Spot Scanning Techniques During All Phases of Flight. Pilots can compensate for blind spots and enhance identifying other aircraft in a climb by adjusting the aircraft's pitch attitude to improve visibility over the nose of the aircraft (which optimizes your scanning for traffic ahead), and when in level cruise or descending, by executing gentle shallow bank turns left and right for a clear view of traffic ahead and from either side, and by scanning the rear of the aircraft by scanning from behind the right wing through the windscreen to the back of the left wing. Finally, when in the traffic pattern, the FAA recommends that pilots continue to scan for other aircraft and check blind spots caused by fixed aircraft structures, such as doorposts and wings. High-wing airplanes have restricted visibility above, while low-wing airplanes have limited visibility below. The worst-case scenario is a low-wing airplane flying above a high-wing airplane. Banking from time to time can uncover blind spots. The pilot should also occasionally look to the rear of the airplane to check for other aircraft. Refer to the Airplane Flying Handbook (FAA-H-8083-3), Chapter 7, Ground Reference Maneuvers.

12.2 See-and-Avoid Reaction Time. Table 1 above provides a pilot's reaction time upon seeing traffic and implementing an avoidance maneuver.

13 NIGHT FLYING. Be aware of night vision limitations and give your eyes time to adjust.

13.1 Scanning at Night. Scanning at night depends almost entirely on peripheral vision. This is due in part to the night-blind spot that involves an area between 5 and 10 degrees wide in the center of the visual field. A pilot can compensate for the night-blind spot through "off-center" viewing, which requires looking approximately 10 degrees above, below, or to either side of an object. To better perceive a dimly lit object in a certain direction, the pilot should scan the area around the object rather than looking directly at the object. Short stops of a few seconds in each scan will help detect the light and its movement. Note that conflicting ground lights at night increase the difficulty of detecting other aircraft. Also, avoid blinding others while taxiing by not using strobe or landing lights until on the active runway for takeoff.

Note: Pilots utilizing a Night Vision Imaging System (NVIS), such as night vision goggles (NVG), must be aware that some light-emitting diode (LED) obstruction and aircraft anticollision lighting may not be visible through the NVG. When flying with NVG, pilots should also be looking around the binocular assembly frequently, outside of the NVG view, to detect lighting that may not be visible through the NVG.

14 AIRCRAFT SYSTEMS AND TECHNOLOGIES FOR GROUND AND AIRBORNE COLLISION AVOIDANCE. The FAA recommends using the following safety equipment to aid in collision avoidance:

- High-intensity anticollision white strobe lights, visible from all directions.
- Pulse light (collision avoidance) systems for aircraft landing lights.

- Dual aircraft communications radios.
- TA systems (TAS), Traffic Alert and Collision Avoidance System (TCAS) I, TCAS II, and the ADS-B In and display capability, required as of January 1, 2020.
- Weather avoidance systems.

14.1 New Technology: Emergency Auto Land (EAL). Garmin's EAL system is now available for aircraft. This technology senses if a pilot becomes incapacitated and takes control of the aircraft. Pilots should listen for EAL transmissions, which will provide the aircraft's registration, and its action to land at a named airport. This system does not currently have any see-and-avoid capability. The FAA deems aircraft operating under EAL to be in distress, and therefore have right-of-way over all other aircraft. Therefore, if you hear an EAL message, be alert and give way. For more information, refer to the Garmin Autonomi video at https://discover.garmin.com/en-US/autonomi/.

14.2 Avoid Inadvertent VFR Into Instrument Meteorological Conditions (IMC). In addition to obtaining current and forecasted en route and terminal weather, be aware of VFR flight into instrument weather conditions. VFR flight with reduced in-flight visibility increases the risk of not seeing conflicting traffic. For more information, refer to the FAASTeam's General Aviation Pilot's Guide to Preflight Weather Planning, Weather Self-Briefings, Weather Decision Making, and the FAA's Estimating In-Flight Visibility, in paragraph 6 above.

15 MAINTAINING VIGILANCE. Air traffic information equipment does not relieve a pilot's regulatory responsibility to see and avoid other aircraft. Pilots should maintain vigilance by managing distractions caused by the use of technology in the flight deck/cockpit, which is critical to the safety of the flight. While new aircraft systems can provide pilots with a wealth of information, they can also cause fixation on the displays and draw a pilot's attention inside the flight deck/cockpit and away from the outside environment.

16 AIR TRAFFIC CONTROLLER LIMITATIONS. Remember that an air traffic controller's view of aircraft on the airport surface is often limited by distance, depth perception, aircraft conspicuity, and normal visual acuity problems. Also, radar limitations and air traffic volume can increase a controller's workload and prevent the controller from providing timely TA information. Therefore, the pilot should not solely depend upon ATC TAs for collision avoidance. The pilot must proactively conduct see-and-avoid procedures.

16.1 Airport Traffic Pattern Collision Avoidance. A significant number of midair collisions and NMACs have occurred within towered and non-towered airport traffic patterns. For additional information on operating within traffic patterns, refer to AIM, Chapter 4; AC 90-66; the FAA Pilot's Handbook of Aeronautical Knowledge (FAA-H-8083-25); and the Airplane Flying Handbook.

17 FLIGHT INSTRUCTORS, PILOT EXAMINERS, AND PERSONS ACTING AS SAFETY PILOTS COLLISION AVOIDANCE RECOMMENDATIONS.

17.1 Collision Avoidance Training. It is critical that flight instructors train pilot applicants to devote maximum attention to collision avoidance while conducting flight operations in today's increasingly complex air traffic environment. For additional details, refer to the FAA's Airplane Flying Handbook, Chapter 1, Introduction to Flight Training.

17.2 Flight Instructor and Safety Pilot Responsibilities. Flight instructors and persons acting as safety pilots can contribute to reducing the risk of aircraft collisions by:

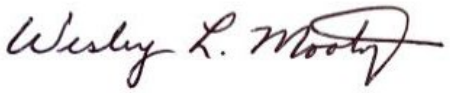
1. Guarding against preoccupation during flight instruction to the exclusion of maintaining a constant vigilance for other traffic.
2. Being particularly alert during the use of advanced flight deck/cockpit technology and the conduct of simulated instrument flight, where there is a tendency to "look inside" excessively and forget see-and-avoid responsibilities.
3. Taking the time to teach new and advanced flight deck/cockpit technology on the ground. Thoroughly review features as well as limitations of the equipment and the pitfalls of fixation and overreliance on technology.
4. Placing special training emphasis on those basic problem areas of concern mentioned in this AC. Improvements in pilot education, operating practices, conflicts, procedures, and techniques are needed to reduce midair conflicts.
5. Student pilots communicating at towered or non-towered airports. Student pilots are advised to inform ATC at a towered airport, and at a non-towered airport announce over the CTAF that they are a student pilot solo.

17.3 Pilot Examiner and Certificated Flight Instructor (CFI) Actions. Pilot examiners and CFIs play an integral role in ensuring pilots have the collision avoidance skills necessary to satisfy their regulatory see-and-avoid obligations. For example, the Private Pilot–Airplane Airman Certification Standards (FAA-S-ACS-6), Appendix 6, Safety of Flight, requires that the evaluator assess an applicant's use of visual scanning and collision avoidance procedures throughout the entire test. Other FAA guidance also encourages CFIs to train and assess an applicant or certificated pilot's knowledge and skill in their use of visual scanning and collision avoidance techniques.

18 COLLISION AVOIDANCE EDUCATIONAL RESOURCES.

For further information on training courses, documents, and events related to collision avoidance and visual scanning techniques, visit https://www.faasafety.gov. Additional information can also be obtained from the FAASTeam Program Manager (FPM). Use the FAASTeam Online Directory to locate an FPM in your state/area.

19 AC FEEDBACK FORM. For your convenience, the AC Feedback Form is the last page of this AC. Note any deficiencies found, clarifications needed, or suggested improvements regarding the contents of this AC on the Feedback Form.



Wesley L. Mooty
Acting Deputy Executive Director, Flight Standards Service

Advisory Circular Feedback Form

If you find an error in this AC, have recommendations for improving it, or have suggestions for new items/subjects to be added, you may let us know by contacting the General Aviation and Commercial Division at 9-AFS-800-Correspondence@faa.gov or the Flight Standards Directives Management Officer at 9-AWA-AFB-120-Directives@faa.gov.

Subject: AC 90-48E, Pilots' Role in Collision Avoidance

Date: _____

Please check all appropriate line items:

☐ An error (procedural or typographical) has been noted in paragraph _____ on page _____.

☐ Recommend paragraph _____ on page _____ be changed as follows:

_____

_____

☐ In a future change to this AC, please cover the following subject:
(Briefly describe what you want added.)

_____

_____

☐ Other comments:

_____

_____

☐ I would like to discuss the above. Please contact me.

Submitted by: _____ Date: _____