Australian Government
Civil Aviation Safety Authority

ADVISORY CIRCULAR
AC 91-14 v1.1

Pilots’ responsibility for collision avoidance

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Advisory circulars are intended to provide advice and guidance to illustrate a means, but not necessarily the only means, of complying with the Regulations, or to explain certain regulatory requirements by providing informative, interpretative and explanatory material.

Advisory circulars should always be read in conjunction with the relevant regulations.

Audience

This advisory circular (AC) applies to all student, private, commercial, air transport, sport and recreational pilots. This includes gliders, ultralights, balloons, and gyroplanes flown on pilot certificates issued by the Australian Ballooning Federation Inc. (ABF), Australian Sport Rotorcraft Association Inc. (ASRA), Hang Gliding Federation of Australia Inc. (HGFA), Gliding Federation of Australia Inc. (GFA), and Recreational Aviation Australia Inc. (RA-Aus).

Purpose

This AC provides advice on 'see-and-avoid', its limitations, and the use of radio and other technologies to provide 'alerted see-and-avoid' in order to enhance and maintain separation in a busy air traffic environment. It provides practical advice to pilots on their role in collision avoidance through the see-and-avoid principle to prevent mid-air collisions or Airprox events, including in the vicinity of non-controlled aerodromes.

This document supports AC 91-10 Operations in the vicinity of non-controlled aerodromes.

For further information

For further information or to provide feedback on this AC, visit CASA's contact us page.

Status

This version of the AC is approved by the National Manager, Flight Standards Branch.

Note: Changes made in the current version are annotated with change bars.

Table 1: Status

Version	Date	Details
v1.1	January 2025	This update includes: • minor changes to Table 7 title • grammatical changes to section 4.1.3 • addition of advice regarding new technology associated with Garmin Emergency Auto Land (EAL) to section 4.1.7
v1.0	October 2021	This AC replaces CAAP 166-2(1) - Pilots' responsibility for collision avoidance in the vicinity of non-controlled aerodromes using 'see-and-avoid'.

Unless specified otherwise, all subregulations, regulations, Divisions, Subparts and Parts referenced in this AC are references to the *Civil Aviation Safety Regulations 1998 (CASR)*.

Contents

Acknowledgement of Country

The Civil Aviation Safety Authority (CASA) respectfully acknowledges the Traditional Custodians of the lands on which our offices are located and their continuing connection to land, water and community, and pays respect to Elders past, present and emerging.

Artwork: James Baban.

1 Reference material

1.1 Acronyms

The acronyms and abbreviations used in this AC are listed in the table below.

Table 2: Acronyms

Acronym	Description
AA	Airservices Australia
AC	advisory circular
ACAS	airborne collision avoidance system
ADS-B	automatic dependent surveillance - broadcast
ADS-C	automatic dependent surveillance - contract
ATC	air traffic control
ATS	air traffic services
CASA	Civil Aviation Safety Authority
CASR	*Civil Aviation Safety Regulations 1998*
EFB	electronic flight bag
ERSA	en-route supplement Australia
FAA	Federal Aviation Administration (of the United States of America)
GNSS	global navigation satellite system
IFR	instrument flight rules
NOTAM	notice to airmen
QNH	Q code for Nil Height (altimeter subscale setting to obtain elevation or altitude)
TCAS	traffic collision avoidance system
VFR	visual flight rules
VHF	very high frequency

1.2 Definitions

Terms that have specific meaning within this AC are defined in the table below. Where definitions from the civil aviation legislation have been reproduced for ease of reference, these are identified by 'grey shading'. Should there be a discrepancy between a definition given in this AC and the civil aviation legislation, the definition in the legislation prevails.

Table 3: Definitions

Term	Definition
airmanship	The consistent use of good judgement and well-developed knowledge, skills and attitudes to accompany flight objectives.
airprox event	A situation in which, in the opinion of a pilot or air traffic services personnel, the distance between aircraft as well as their relative positions and speed have been such that the safety of the aircraft involved may have been compromised.
air traffic service	A generic term meaning variously, flight information service, alerting service, air traffic advisory service, air traffic control service (area control service, approach control service or aerodrome control service). **Note:** a certified air/ground radio service (within the meaning of regulation 139.390) is not an air traffic service.
air traffic services	a. in relation to an air traffic service provided in Australian-administered airspace—means: i an ATS provider; or ii the Defence Force in its capacity as a provider of air traffic services; and b. in relation to an air traffic service provided in airspace that is not Australian-administered airspace—an air traffic service provider authorised by the national aviation authority of the relevant foreign country to provide the air traffic service.
error	Actions or inactions that: • lead to a deviation from crew or organisational intentions or expectations • reduce safety margins, and/or • increase the probability of adverse operational events on the ground and during flight.
in the vicinity of a non-controlled aerodrome:	1. An aircraft is in the vicinity of a non-controlled aerodrome if it is: a. in uncontrolled airspace; and b. within 10 nautical miles of the aerodrome; and c. at a height above the aerodrome that could result in conflict with operations at the aerodrome. 2. For the purposes of paragraph (1)(b), if an aerodrome reference point for the aerodrome is published in the authorised aeronautical information for the flight, the distance must be measured from that point.
military aerodrome	An aerodrome controlled by a part of the Defence Force.
non-controlled aerodrome	An aerodrome at which an aerodrome control service is not operating.
threat	A situation or event that has the potential to impact negatively on the safety of a flight, or any influence that promotes opportunity for pilot error(s).

Term	Definition
threat and error management (TEM)	The process of detecting and responding to threats and errors to ensure that the ensuing outcome is inconsequential, i.e. the outcome is not an error, further error or undesired state.

1.3 References

Legislation

Legislation is available on the Federal Register of Legislation website https://www.legislation.gov.au/

Table 4: Legislation references

Document	Title
Subdivision 91.D.4.4	Avoiding collisions in the air

Advisory material

CASA's advisory materials are available at https://www.casa.gov.au/publications-and-resources/guidance-materials

Table 5: Advisory material references

Document	Title
AC 91-10	Operations in the vicinity of non-controlled aerodromes
AC 91-23	ADS-B for enhancing pilot situational awareness
Resource booklet 8 threat and error management	Safety behaviours and human factors for pilots resource kit

Other

CASA's forms are available at http://www.casa.gov.au/forms

Table 6: Documents

Document	Title
Australian Transport Safety Bureau (ATSB) Aviation Research Report published 1 April 1991	Limitations of the See-and-Avoid Principle
FAA AC 90-48	Pilots' Role in Collision Avoidance Available from Federal Aviation Administration (faa.gov)
Toward a theory of situation awareness in dynamic systems	Endsley MR. *Toward a theory of situation awareness in dynamic systems.* Human Factors 1995;37(1):32–64.

2 Introduction

'See-and-avoid', as a means of separation and collision prevention for two or more vehicles, is an ancient principle and one that in the maritime environment predates aviation by many centuries.

In the early history of aviation, see-and-avoid was the only means for avoiding collision, but as aviation advanced, its limitations have become apparent. Since the early days of flight, additional measures have been sought to reduce the risks of mid-air collision. In parallel with aviation, the maritime industry has adopted, where circumstances have warranted, many of the same means to avoid collisions on the water.

In modern aviation, see-and-avoid is the last line of defence, but usually not the only mechanism for avoiding a collision or an Airprox event.

3 Unalerted see-and-avoid

Unalerted see-and-avoid relies totally on the crew – with no other assistance – to visually detect other aircraft that are on a conflicting flight path. Unalerted see-and-avoid is only viable in a minority of circumstances when all the following factors are present to defend against a mid-air collision or Airprox event:

- horizontal closure rates are slow enough for human reaction
- vertical closure rates are slow enough for human reaction
- aircraft are of sufficient profile to be seen with the available ambient light, or are made sufficiently conspicuous using artificial lighting
- aircraft and/or the ground are sufficiently well lit or ambient light provides sufficient contrast
- the aircraft structure is such that the pilot's visibility is unhindered in all directions (a near practical impossibility).

If traffic densities are high enough, humans inevitably fail in their ability to identify and process all the traffic, and thus the risk of collision becomes unacceptably high.

Improved visual acquisition by pilots alerted to traffic presence (by radio, electronic conspicuity or other means) raises the level of traffic density that can be safely tolerated.

However, despite all its limitations, unalerted see-and-avoid is still a defence against mid-air collisions, and for aircraft without a radio or other situational awareness technologies it is the only defence. Good airmanship dictates that all pilots should be looking out and not be solely reliant on technological means for traffic separation.

Unalerted see-and-avoid is an important mechanism for distinguishing aircraft that have a high surface area, particularly if they move slowly. Balloons, airships, powered parachutes and paragliders can generally be seen in most circumstances by pilots of other aircraft of similar speeds. However, pilots of faster aircraft may find these aircraft (generally except for balloons) can be quite difficult to see.

Gliders and aircraft conducting aerobatics can sometimes be observed more easily because of their constantly changing profile direction, attitude and altitude. These aircraft generally do not remain on a fixed course for a long time, which would provide the human eye the opportunity to more easily obtain a fix than is the case where speed and direction remain constant.

However, glider and aerobatic pilots should be aware that pilots of other aircraft may find their aircraft difficult to spot. This is especially the case if they are unaware of the glider or aerobatic activity.

4 Alerted see-and-avoid

As aviation developed, with increasing aircraft performance, traffic density and flight in non-visual conditions, it became apparent that unalerted see-and-avoid had significant limitations. The need to enhance a pilot's situational awareness led to the principle of 'alerted see-and-avoid'.

The primary tool of alerted see-and-avoid that is common across aviation—from sport and recreational to air transport—is radio communication. Radio allows for the communication of information (in this instance traffic information) to the pilot from the ground (e.g. Air Traffic Services) or from other aircraft.

For this reason, the carriage of radio communication equipment is required in poor weather conditions both in, and outside of, the vicinity of certified, military and other designated aerodromes. According to risk, aerodromes can be designated by CASA to require carriage of radio equipment; however, none are currently designated. If an aerodrome were to be designated, it would be identified/published in the En-Route Supplement Australia (ERSA) and/or by Notice to Airmen (NOTAM).

Other tools of alerted see-and-avoid include:

- Airborne Collision Avoidance System (ACAS)

> **Note:** ACAS relies on transponder information from other aircraft for its pilot alerting and collision avoidance function. TCAS is one type of airborne collision avoidance system.

- Automatic Dependent Surveillance - Broadcast (ADS-B)
- Electronic Conspicuity devices
- FLARM— a traffic awareness and collision avoidance system developed by FLARM Technology Ltd and originally designed for gliders
- Electronic flight bag (EFB) applications that receive traffic information through the mobile phone network or an ADS-B or ADS-C receiver
- Ground-based ATS surveillance system (with traffic information being relayed back to pilots via radio).

Due to their design, packaging, power requirements or cost, not all the tools listed above are suitable in all circumstances. All, however, provide significant safety gains in the aviation environments for which they are designed.

Refer to AC 91-23 for more information on the benefits of using ADS-B for enhancing situational awareness.

4.1 New Technology: Emergency Auto Land

4.1.1 Garmin's Emergency Auto Land (EAL) system is now available for select 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. Aircraft in an emergency 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.

5 Effective lookout

Lookout is the principal method for implementing see-and-avoid. Effective lookout means seeing what is 'out there' and assessing the information that is received before making an appropriate decision.

Vision is the primary source of information for a pilot. Whether it is aircraft attitude, position, physical hazards or other traffic, what a pilot sees is processed by the brain and used to build up situational awareness. In this context, lookout must not be thought of as just scanning the skies to locate other traffic; it also involves the internal and external environment of the aircraft. Vision is used inside an aircraft to interpret flight instruments, flight controls and aircraft systems, and externally to observe and interpret weather, terrain, aircraft attitude and position.

The multitude of factors that can adversely affect vision and lookout includes the amount of ambient light, window posts, the cleanliness and crazing of windscreens, and other physiological and psychological concerns. Failure to address these issues could result in limitations to effective lookout.

Workload mismanagement can lead to excessive ‘head in the cockpit’ with less time spent looking outside the aircraft during busy periods. Pilots need to move their head to see beyond window posts and any other obstructions, such as pilots or passengers in the adjacent seat(s).

6 Alerted search

An alerted search is visual scanning when air traffic information has been provided and a pilot knows where to look. Refer to Chapter 4 for more information on being alerted about other traffic.

The effectiveness of a search for other traffic is eight times greater under alerted circumstances than when just unalerted.

Technology can assist lookout, and pilots should not disregard the benefits of engaging the autopilot so that more attention can be given to visual scanning.

As threats are external to the aircraft, an effective lookout must be maintained. The pilot must:

- consistently look outside the aircraft
- search the available visual field to detect threats that will probably appear in the peripheral vision
- shift vision directly to the threat and, if identified as a collision risk, decide on what effective evasive action to take, and
- manoeuvre the aircraft to avoid collision or an Airprox event.

Pilots must realise that this process takes time, and human deficiencies can reduce the chances of a threat being detected and avoided. The factors affecting lookout may not be errors or poor airmanship, but limitations of the human visual and information processing systems which are present to various degrees in everyone.

There are two main elements to effective traffic avoidance. Firstly, to see an 'object', and secondly, to react appropriately to what has been seen. An object could range from looking like a speck in the windscreen, which is an aircraft at long range, to a large feature. The next step would be to determine whether the object is a threat, and then take avoiding action.

7 Seeing and interpreting

Not only is seeing important, but accurately interpreting what is seen is equally vital. The concept of see-and-avoid is far from reliable. By employing an effective scanning technique and understanding how to enhance visual detection of other traffic, a pilot is more likely to reduce the likelihood of collision. Size and contrast are the two primary factors that determine the likelihood of detecting other aircraft, size being the more important factor. As general aviation, sport and recreational aeroplanes and rotorcraft are usually small or have low visual profiles in certain circumstances, the problem of detecting those aircraft is exacerbated.

The current version of Federal Aviation Administration (FAA) AC 90-48 details a scanning technique that involves eye movements in sectors of 10 degrees of one-second duration per sector. However, scanning a 180-degree horizontal and 30-degree vertical sector would take a minimum of 54 seconds. US military research found that it takes a pilot 12.5 seconds to avoid a collision after target detection. Therefore, it can be deduced that considerable time gaps exist where traffic may not be detected during a normal scan period. Such a structured and disciplined scan technique may also be difficult to achieve. Pilots must develop an effective scan that provides maximum opportunity to see traffic. Passengers in small aircraft may also be utilised to help improve lookout.

Pilots should remain mindful that certain circumstances will make it difficult for their aircraft to be seen. An aircraft (a small one in particular) will often be rendered difficult to see by the patterns in the surface of the earth when viewed from above, and particularly when over urban areas. Conversely, an aircraft when viewed from below can potentially be much more easily seen against a uniformly overcast cloud background or blue sky. All pilots would be aware of the difficulty seeing aircraft that are directly in front of the sun.

Pilots should also be aware that two aircraft converging on a point have the potential to remain fixed in one or both pilots' field of view, i.e. their relative position (in the windscreen) will not change until moments before impact. Therefore, it is essential to remember that if another aircraft appears to have no relative motion, it is likely to be on a collision course with you. If the other aircraft shows no lateral or vertical motion but is increasing in size, take immediate action!

8 Traffic separation by radio

Accurate provision and interpretation of traffic information for the purposes of separation to or from another aircraft is an essential pilot skill. There are four commonly used means of providing and interpreting traffic information by radio communication for the purpose of airborne separation. All methods have their advantages depending upon circumstances.

- Separation by 'clock code'—Pilots maintain traffic separation by reference to the central axis and numbers of an analogue clock face. Particular care must be given to identifying which aircraft is the central axis of the clock. You are at my 2 o'clock and low has the opposite meaning to I am at your 2 o'clock and low. The weakness of this method of separation is that it requires at least one pilot to have seen, identified and made contact with the other aircraft.
- Separation by ground reference—Pilots maintain separation by radio by either identifying that each is in different places relative to a ground feature(s), or by agreeing to remain on different sides of a readily identifiable ground feature such as a runway extended centreline, road, town or railway line. The advantage of this method of separation is that it does not require either aircraft to have seen each other (although this is desirable). The weakness of this method of separation is that ground features could be misidentified. The uncertainty or confusion can distract from the effort of retaining separation through see-and-avoid.

Note: Pilots who offer indistinct local landmarks as separation reference points to other pilots (where they cannot be certain of mutual understanding) may be offering information of limited use.

- Separation by altitude reference—Pilots maintain separation by radio by identifying that each is at a different altitude or by one aircraft descending/climbing to another level. Provided that both aircraft altimeters are set to the correct subscale reference (QNH), this method should provide separation for both aircraft regardless of visual contact
- Separation by navigational or avionic reference—Pilots maintain separation by identifying that each is in a different place relative to a known navigational point or line (radial) or separated by distance from a fixed point (e.g., GNSS waypoint or a radio navigation aid). This method of separation does not require either aircraft to have seen each other (although this is desirable). The weakness of this method of separation is that differing avionic equipment or pilot navigational skill can lead to incorrect assumptions being made about the usability of the separation information offered.

Note: Pilots who offer instrument flight rules (IFR) reference points as separations to pilots operating under the visual flight rules (VFR) may not be offering information that is readily usable.

9 What is situational awareness?

Simply defined, situational awareness is knowing what is going on around you and being able to predict what could happen.

A more comprehensive and technical definition is the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of the status in the near future.[1]

The first definition is generic, applying to life in general and to most occupations. The second definition is more specific to aviation and is often assigned three levels:

- Level 1: Perception of the current environment
- Level 2: Interpretation of the immediate situation
- Level 3: Anticipation of the future environment.

Monitoring and gathering information from both within the cockpit and outside the aircraft, and processing on all three levels, is required to build and maintain comprehensive situational awareness.

[1] Endsley MR. *Toward a theory of situation awareness in dynamic systems.* Human Factors 1995;37(1):32–64.

10 Interaction with other aircraft at, or in the vicinity of, a non-controlled aerodrome

Rules of the air regarding right of way and rules for prevention of collisions must always be respected (refer to Subdivision 91.D.4.4). Pilots of powered aircraft should not normally seek right of way from non-powered aircraft, although the offer of right of way may come if conditions are favourable.

Pilots flying for their own enjoyment or at their own leisure should consider giving way to aircraft being used for commercial aviation if the inconvenience is not great and giving way can be done safely. However, operators of commercial flights should never automatically assume or expect a give way offer. Any offer to give way must be explicit and its acceptance (gratefully) acknowledged.

Operators of commercial flights should also not assume that a sport or recreational aircraft is being operated for purely non-commercial reasons. Many individuals, Australia-wide, derive their income from conducting flying training in sport or recreational aircraft.

Although the conduct of a non-standard circuit join (such as a straight-in approach) may have operational and economic advantages, pilots should be aware that any variations to the recommended circuit join may carry increased collision risks. When varying any standard procedure, it is essential that situational awareness is assessed and maintained.

Pilots should be mindful that transmitting information by radio does not guarantee receipt and complete understanding of that information. Many of the worst aviation accidents in history have their genesis in misunderstanding of radio calls, over-transmissions, or poor language/phraseology which undermined the value of the information being transmitted.

Without understanding and confirming the transmitted information, the potential for alerted see-and-avoid is reduced to the less safe situation of unalerted see-and-avoid.

There are practical limits on how much voice traffic a VHF-band frequency can efficiently carry. Excessively long radio broadcasts or broadcasts that do not add value to situational awareness have the potential to block transmissions being made by other pilots. Radio communications should be to the point, clear, accurate, and necessary. An unnecessary radio transmission that over-transmits another transmission is as hazardous as making no transmission at all.

Under no circumstances should a pilot attempt to direct or control other traffic. Direction or control of air traffic (as opposed to alerting, requesting or advising) is exclusively an ATS function.

Pilots are always expected to operate in a courteous and professional manner. Aviation safety relies upon a cooperative approach between all pilots, particularly on and in the vicinity of aerodromes in times of busy traffic.

Note: AC 91-10 provides guidance on operations in the vicinity of non-controlled aerodromes.