EGAST
Component of ESSI

COLLISION AVOIDANCE

METHODS TO REDUCE THE RISK

SAFETY PROMOTION LEAFLET

GA 1

CONTENT

INTRODUCTION

A ›› ‘See-and-avoid’ is recognised as the main method that a pilot uses to minimise the risk of collision when flying in visual meteorological conditions. It is an integral part of a pilot’s ‘situational awareness’, in other words the skill involved in looking outside the cockpit or flight deck and becoming aware of what is happening around the aircraft.

The skill includes the application of:

- effective visual scanning
- the ability to gather information from radio transmissions from ground stations and other aircraft,
- creating a mental picture of the traffic situation, and
- the development of ‘good airmanship’.

B ›› This Leaflet, based on ICAO Circular 213–AN/130 and a Safety leaflet produced by the UK CAA, aims to help pilots to make ‘look-out’ more effective. It should be of interest to all pilots, regardless of the type of aircraft they fly.

C ›› Statistic shows that mid-air collisions can occur in all phases of flight and at all altitudes. However, nearly all mid-air collisions occur in daylight and in excellent visual meteorological conditions. A collision is more likely where aircraft are concentrated, especially close to aerodromes, and when one or both aircraft is turning, descending, or climbing.

D ›› Both experienced and inexperienced pilots can be involved in a mid-air collision. While a novice pilot has much to think about and so may forget to maintain an adequate look-out, the experienced pilot, having flown many hours of routine flight without spotting any hazardous traffic, may grow complacent and forget to scan.

E ›› There appears to be little difference in mid-air collision risk between high-wing and low-wing aircraft.

F ›› If you learn to use your eyes and maintain vigilance, you can reduce the risk of mid-air collisions. Studies show that there are certain definite warning patterns.

AIRPROX REPORTING
If you consider that your aircraft has been endangered during flight by the proximity of another aircraft such that a risk of collision existed, report it by radio. If this is not possible, immediately after landing telephone or by other means contact the Air Traffic Service unit.

MID-AIR COLLISION CAUSES

Undoubtedly, traffic congestion and aircraft speeds are part of the problem. In the head-on situation, for instance, a jet and a light twin-engine aircraft may have a closing speed of about 650 kt. It takes a minimum of 10 seconds for a pilot to spot traffic, identify it, realise it is a collision risk, react, and have the aircraft respond.

But two aircraft converging at 650 kt could be less than 10 seconds apart when the pilots are first **ABLE** to see each other! Furthermore, the aircraft's design may limit the field of view from the flight deck. In addition, some air traffic control and radar facilities could be overloaded or limited by terrain or weather, and thus not be able to offer a service to assist.

Limitations of the eye

The eye is vital to the 'see-and avoid' principle.

A ›› The human eye is a very complex system. Its function is to receive images and transmit them to the brain for recognition and storage. About 80 per cent of our total information is received through the eye, which is therefore our prime means of identifying what is going on around us.

B ›› In the air we depend on our eyes to provide most of the basic input necessary for flying the aircraft, e.g. attitude, speed, direction and proximity to opposing traffic. As air traffic density and aircraft closing speeds increase, the problem of mid-air collision increases considerably, and so does the importance of effective scanning. A basic understanding of the eyes' limitations in target detection will help a pilot avoid a collision.

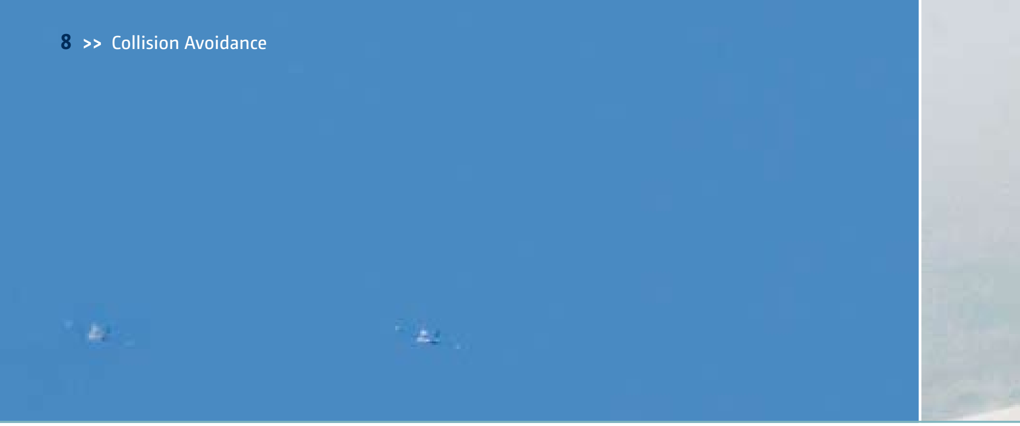
C ›› The eye, and consequently vision, is vulnerable to many things including dust, fatigue, emotion, germs, fallen eyelashes, age, optical illusions, and the effect certain medications. In flight, vision is influenced by atmospheric conditions, glare, lighting, windshield deterioration and distortion, aircraft design, cabin temperature, oxygen supply (particularly at night), acceleration forces and so forth. If you need glasses to correct your vision, make sure that you have regular checks that the prescription is still correct and that you carry any required second pair.

D ›› Most importantly, the eye is vulnerable to the vagaries of the mind. We can 'see' and identify only what the mind permits us to see.

E ›› One inherent problem with the eye is the time required for 'accommodation' or refocusing. Our eyes automatically accommodate for near and far objects, but the change from something up close, like a dark instrument panel, to a bright landmark or aircraft several miles away, takes one to two seconds. That can be a long time when you consider that you need 10 seconds to avoid a mid-air collision.

F ›› When the eye has nothing to specifically focus on, which happens at very high altitudes, but also at lower levels on vague, colourless days above a haze or cloud layer with no distinct horizon, people experience something known as 'empty-field myopia', and opposing traffic entering the visual field is just not seen.

G ›› To accept what we see, we need to receive cues from **BOTH EYES** (binocular vision). If an object is visible to only one eye, but hidden from the other by a windshield post or other obstruction, the total image is blurred and not always acceptable to the mind. Therefore, it is essential that pilots move their heads when scanning around obstructions.



↑ FIELD OF VISION (H)

H ›› Another inherent eye problem is the narrow field of vision. Although our eyes accept light rays from an arc of nearly 200°, they are limited to a relatively narrow area (approximately 10–15°) in which they can actually focus on and classify an object. Anything perceived on the periphery must be brought into that narrow field to be identified.

I ›› Motion or contrast is needed to attract the eyes' attention, and the field of vision limitation can be compounded by the fact that at a distance **AN AIRCRAFT ON A STEADY COLLISION COURSE WILL APPEAR TO BE MOTIONLESS.** The aircraft will remain in a seemingly stationary position, without appearing to move or to grow in size, for a relatively long time, and then **SUDDENLY** bloom into a huge mass, almost filling up one of the windows. A large insect smear or dirty spot on the windshield can hide a converging aircraft until it is too close to be avoided.

J ›› In addition to its inherent problems, the eye is also severely limited by environment. Optical properties of the atmosphere alter the appearance of aircraft, particularly on hazy days. 'Limited visibility' actually means 'reduced vision'. You may be legally VFR when the in-flight visibility is 5 km, but even though another aircraft may become visible at that range, a collision may be **UNAVOIDABLE** because of the high closing speeds involved. Consider flying above a haze layer if you can.

↑ **HAZE (J)**

↑ **OVERINVERSION (K)**

K ›› Light also affects our visual efficiency. Glare, perhaps on a sunny day over a cloud layer or during flight directly into the sun, makes objects hard to see and scanning uncomfortable. An aircraft that has a high degree of contrast against the background will be easy to spot, while one with low contrast at the same distance may be impossible to see (especially against a cluttered background). A dirty, scratched, opaque or distorted windshield will make matters worse.

L ›› Aircraft at night must show lights, which are generally easy to see. However, they may disappear into a background of other lights, and determining the course of an aircraft from the lights alone requires concentration. In very dark conditions, the light sensitive cells, the ‘cones’, in the centre of the eye, are unlikely to detect objects. The ‘rods’, oriented around the centre of the retina, are more sensitive and may identify objects if a pilot looks slightly to one side of them. However, the rods take perhaps 30 minutes to adapt after being exposed to bright lights, so pilots should try to avoid looking at bright lights at night.

M ›› Perception is affected by many factors. Pilots, like others, tend to **OVERESTIMATE THEIR VISUAL ABILITIES** and to misunderstand their eyes’ limitations. Since a major cause of mid-air collisions is the failure of the ‘see-and-avoid’ principle, it can be concluded that the best way to avoid collisions is to learn how to use your eyes for an efficient scan.

METHODS TO REDUCE THE RISK

VISUAL SCANNING

Techniques

A ›› To avoid collisions you must scan effectively from the moment the aircraft moves until it comes to a stop at the end of the flight. Collision threats are present on the ground, at low altitudes in the vicinity of aerodromes, and at cruising levels.

B ›› Before take-off, check the runway visually to ensure that there are no aircraft or other objects in the take-off area. Check the approach and circuit to be sure of the position of other aircraft. Assess the traffic situation from radio reports. After take-off, continue to scan to ensure that there will be no obstacles to your safe departure.

C ›› During the climb and descent beware of the blind spot under the nose – manoeuvre the aircraft so that you can check. Also look behind, if you can, while climbing, you may be in a faster aircraft's blind spot.

D ›› Listen to radio exchanges and form a mental image of the traffic situation. Scan with particular care in the area of intersections between airways or commonly used routes, and when near radio beacons, visual reporting points (VRPs), or where traffic is funnelled between hills and airspace restrictions. Remember that the performance capabilities of many aircraft, in both speed and rates of climb/descent, result in high closure rates, limiting the time available for detection, decision, and evasive action.

↑ **FINAL APPROACH (D)**

E ›› Several systems are available commercially which can provide information to a pilot about the relative position of some other aircraft. These range from the FLARM device fitted to many gliders, through receivers of SSR transponder codes in Mode A or Mode S, up to certificated Airborne Collision Avoidance Systems (ACAS) which use the SSR codes of other aircraft to not only indicate relative positions but in their most advanced form give guidance on recommended avoiding action.

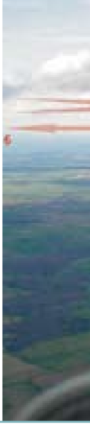
How to scan

A ›› There is no one technique that is best for all pilots. Each pilot must develop a scan that is both comfortable and workable.

B ›› Glancing out and moving your eyes around without stopping to focus on anything is practically useless; so is staring out into one spot for long periods of time.

C ›› Concentrate your search on the areas most critical to you at any given time. In the circuit especially, **ALWAYS** look out before you turn and make sure your path is clear. Look out for traffic making an improper entry into the circuit.

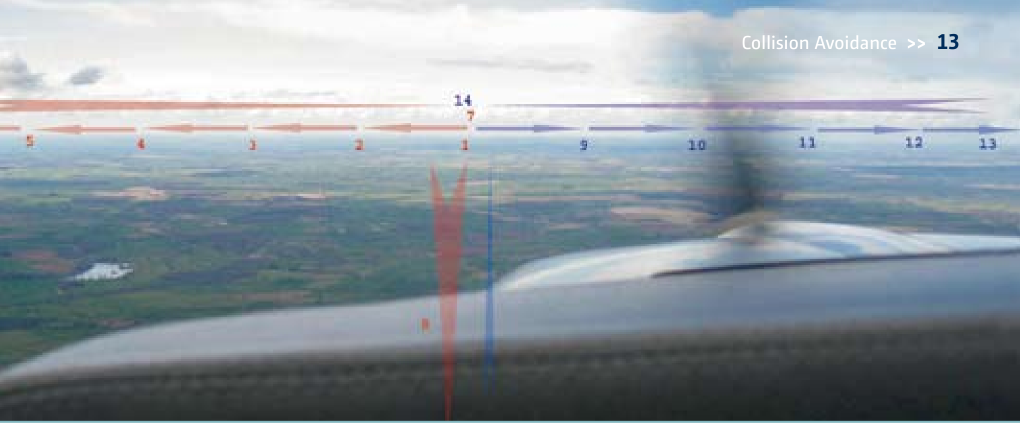
D ›› During that very critical final approach stage, do not fix your eyes on the point of touchdown, but scan all around. Another pilot may be aiming for the same point!



E ›› In normal flight, most collision threats will come from an area within 60° left and right of your flight path. However, do not forget the rest of the sky around you. You should also scan at least 10° above and below the projected flight path of your aircraft, because collision threats may be climbing from below or descending from above.

F ›› The more you look outside, the less the risk of a collision. Looking well ahead for weather and pre-planned navigation features can help. Proper scanning requires sharing attention with other piloting tasks, and can be easily degraded by distraction, fatigue, boredom, illness, anxiety or preoccupation.

G ›› Effective scanning is accomplished by 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°, and each area should be observed for at least one second to enable detection. Horizontal eye movements seem preferred by most pilots, but each should develop the scanning pattern that is most comfortable while being effective for their type of flying, and then keep to it. When scanning, be ready to concentrate on any movement seen in your peripheral vision, but remember your biggest threat. If another aircraft shows no horizontal or vertical motion on the windshield, but is increasing in size, **TAKE IMMEDIATE EVASIVE ACTION.**



↑ **FRONT-TO-SIDE SCANNING METHOD**

Scan patterns

A ›› Two scanning patterns described below have proved to be very effective for pilots and involve the 'block' system of scanning. Traffic can only be detected when the eye is not moving, so the viewing area (wind-shield) is divided into segments. The pilot methodically scans by stopping his eye movement in each block in sequential order.

i. Side-to-side scanning method

Start at the far left of your visual area and make a methodical sweep to the right, pausing for a second in each 10° block to focus your eyes. At the end of the scan, return to the front, check the instruments, and then repeat the external scan.

ii. Front-to-side scanning method (pictured)

Start in the centre block of your intended flight path; move to the left, focusing for a second in each block, then swing quickly back to the centre block after reaching the last block on the left. A quick glance at the instruments should be followed by another look ahead, then repeat the action to the right. Then, after a further check of the instruments, repeat the external scan. Although a scan for straight and level flight is shown, it **MUST BE CENTRED ALONG YOUR INTENDED FLIGHT DIRECTION,** for example above your head in a thermalling glider or before aerobatics.

B ›› There are other methods of scanning, some of which may be as effective as the two described above. However, unless your eyes have focussed for enough time, you are unlikely to be able to detect all targets in your scan area. When the head is in motion, vision is blurred and the mind will not register threats.

The time sharing-plan

A ›› The external scan should take considerably longer than the look at the instrument panel. Trials suggest 3 seconds for the instrument check and 20 seconds outside.

B ›› An efficient instrument scan is good practice, even when flying VFR. The ability to scan the panel quickly permits more time to be allotted to looking out.

C ›› Developing an efficient time-sharing plan takes a lot of work and practice, but it is as important as developing good landing techniques. Practise your scan on the ground, and then use it in the air.

D ›› During flight, if one crew member is occupied with essential work inside the cockpit, another crew member, if available, must expand his scan to include both his usual sector of observation and that of the other crew member.

METHODS TO REDUCE THE RISK
OPERATIONAL TECHNIQUES

Collision avoidance involves more than proper scanning techniques.

1. **CHECK YOURSELF**
   Your eyesight, and your safety, depends on your mental and physical condition. If you are preoccupied you should not fly – distraction is the main enemy of concentrated attention. Have regular eye checks. If you need glasses to correct your vision, wear them and ensure that you have the required spare pair with you.

2. **PLAN AHEAD**
   Plan your flight, have charts folded in proper sequence and within reach. Be familiar with and have notes of your headings, frequencies, distances, etc. so that you spend minimum time with your head down in your charts. Lift anything you need to read up to the coaming, rather than look down, and mature pilots may wish to consider 'half-moon' reading glasses for map details etc. Check your maps, NOTAM, etc. in advance for potential hazards such as military low-level routes and other high-density areas.

3. **CLEAN WINDOWS**
   Make sure your windshield is clean and in good condition. Keep all windows clear of obstructions such as opaque sun visors and curtains.

SOARING GLIDERS

4. NIGHT FLYING
Give your eyes time to adjust. Avoid blinding others with the careless use of your strobes or landing lights on the ground.

5. ADHERE TO PROCEDURES
Follow established operating procedures and regulations, such as correct cruising flight levels and proper circuit practices. Serious hazards include: entering a right-hand circuit at an airport with left-hand traffic or entering downwind so far ahead of the circuit that you may interfere with traffic taking off and heading out in your direction. Beware of pilots flying large circuits with long final approaches. **IN MANY IN-FLIGHT COLLISIONS AT LEAST ONE OF THE PILOTS INVOLVED WAS NOT WHERE HE WAS SUPPOSED TO BE.**

6. AVOID CROWDED AIRSPACE
Avoid airspace where there will be lots of traffic, and if you cannot, concentrate your attention in that direction. Aircraft train over navigation beacons, even in good weather. If you cannot avoid aerodromes en route, fly over them well above ATZ height and if appropriate give them a call stating your intentions. If following a GPS track to a database waypoint, consider keeping to the right of the direct track, as you do for a line feature on the ground. Apart from the hazard of colliding with a launch cable, many gliders congregate in their local area. Aeroplanes towing gliders are less manoeuvrable than individual aircraft. Soaring gliders can be frequently found climbing under cumulus clouds many miles from their base. Pay special attention for areas

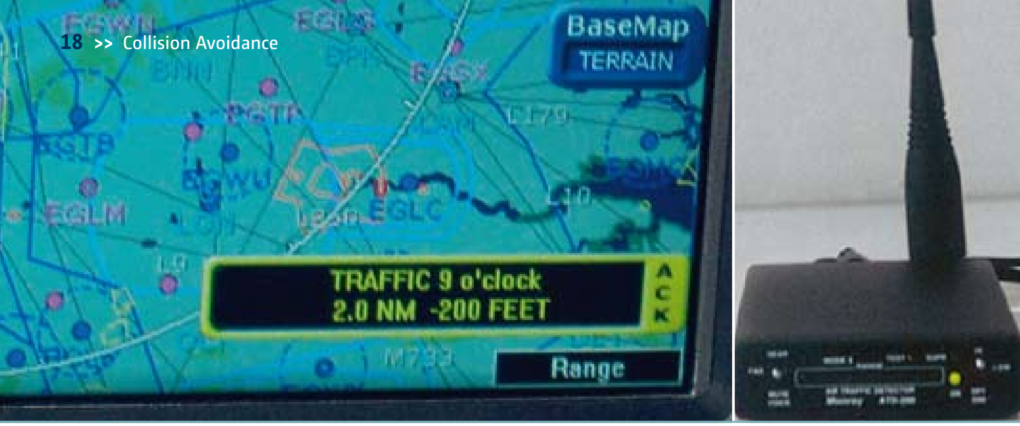
of parachuting activities – avoid them until you are able to confirm no dropping is in progress.

7. **COMPENSATE FOR BLIND SPOTS**

Compensate for your aircraft's design limitations. If you are short, or the aircraft has a high coaming, a suitable cushion can be helpful. All aircraft have blind spots; know where they are in yours. For example, the wing of a high-wing aircraft will block the view of the area you are turning into, so lift the wing slightly for a good look **BEFORE TURNING.** Collisions have occurred on final approach when a faster low-wing aeroplane has overtaken and descended onto a high-wing aircraft.

8. **EQUIP TO BE SEEN**

YOUR AIRCRAFT LIGHTS can help avoid collisions. High intensity strobe lights increase conspicuity a certain amount by day and even more by night. Consider the use of landing lights, especially in the traffic pattern and on hazy days. **TRANSPONDERS,** especially with altitude encoding (Mode C) allow radar controllers to identify your aircraft in relation to other traffic and provide you with traffic information. They also highlight your aircraft's presence to aircraft which carry ACAS. If you show mode C, ACAS may be able to guide the other aircraft away from you! The carriage of transponders is now mandatory in some airspace, even when operating VFR. If ATC do not allocate you a code, use code 7000 (with Mode C), and only switch it off if instructed.



↑ 3 EXAMPLES OF ONBOARD EQUIPMENTS INCREASING PILOT SITUATION AWARENESS

COLOUR; Aircraft finished in one high contrast colour can be seen more easily than those with a pattern or one low contrast colour.

9. **TALK AND LISTEN**

Take advantage of all the information that you receive over the radio (but beware, non-radio aircraft may be in the same airspace). Pilots reporting their position to an air traffic unit are also reporting to you. Approaching an aerodrome, call the tower when you are 10 km away, or such other distance or time prescribed by the ATS authority, and report your position, altitude and intentions. En-route, make use of a Radar Service if available. When flying in areas where there are no air traffic services, change to the FIR or nearest aerodrome frequency.

10. **TRAFFIC DETECTION SYSTEMS**

An approved ACAS fitted to your aircraft can be of great assistance. Other commercial devices which give electronic indication of the presence of other traffic will increase your awareness. These should have audio warnings and direct your eyes to the 'threat'. However, such devices can only warn about an aircraft which is fitted with a transponder or another transmitter which your own device can receive. There are likely to be many other aircraft in the sky without appropriate transmitters, **SO IT IS VITAL TO CONTINUE TO SCAN VISUALLY,** only glancing at the device indicator for the minimum amount of time.

11. MAKE USE OF INFORMATION

Since detecting a small aircraft at a distance is not the easiest thing to do, make use of any hints you get over the radio or from an electronic device. Your job is much easier (studies suggest up to 8 times easier) when you are aware that traffic is 'three miles at one o'clock'. **ONCE THAT PARTICULAR TRAFFIC IS SIGHTED, DO NOT FORGET THE REST OF THE SKY.** If the traffic seems to be moving on the windshield, you're most probably not on a collision course, so continue your scan but watch the traffic from time to time. **IF IT HAS LITTLE RELATIVE MOTION YOU SHOULD WATCH IT VERY CAREFULLY – HE MAY NOT HAVE SEEN YOU.**

12. USE ALL AVAILABLE EYES

If you normally fly with another pilot, establish crew procedures which ensure that an effective scan is maintained at all times. Otherwise, brief your passengers to help you in looking for all traffic.

If you keep yourself and your aircraft in good condition, plan your route carefully to recognise likely busy areas, look well ahead and develop an effective scanning system, you will have the basic tools for avoiding a mid-air collision.

SUMMARY OF GOOD PRACTISES FOR REDUCING COLLISION RISK

Stick to good airmanship; if you keep yourself and your aircraft in good condition, plan your route carefully, avoiding or noting likely busy areas, and develop an effective time-sharing scan system, you will have the basic tools for avoiding a mid-air collision.

SEE ↓

BE SEEN ↓

- If you need glasses, carry any required spare pair.
- Clean the windshield and side windows (if either is badly scratched, have a new one fitted).
- If you are short, or the aircraft has a high coaming, use a cushion.
- Beware of blind spots; move your head or manoeuvre the aircraft.
- Encourage your passengers to assist in the look-out.
- Develop and use an effective scan pattern around your intended flightpath.
- Don’t move the eyes continuously; stop and focus a few seconds on sections of your field of view.
- The external scan should take much longer than your instrument scan.
- Spend the minimum time with your head down checking the charts or GPS, changing radio frequencies, etc.
- When you have spotted another aircraft, do not fix on it and forget the rest of your surroundings.
- Aircraft below you may blend into the background of buildings etc.
- The aircraft with little or no relative motion is the hardest to see – and the most hazardous.

- Select 7000 with ALT on your transponder at all times unless told otherwise.
- Use landing lights in the circuit.
- High intensity strobes can be useful on dull days.

LOOK OUTSIDE AND REPORT ANY AIRPROX.

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