Australian Government
Civil Aviation Safety Authority

ADVISORY CIRCULAR
AC 61-08 v1.1

Teaching and assessing non-technical skills for single-pilot operations

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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 pilots, but particularly to:

- instructors
- flight examiners
- other training and checking pilots.

Purpose

This AC provides guidance to instructors when teaching non-technical skills for single-pilot operations. Although this subject has a theoretical knowledge component, this AC concentrates on the application of non-technical skills in the flying environment. Every flight crew licence, rating and endorsement flight test, proficiency check and flight review includes assessments of these skills.

For further information

For further information, contact CASA's Flight Standards Branch (telephone 131 757).

Status

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

Note: Changes made in the current version are not annotated. The document should be read in full.

Version	Date	Details
v1.1	December 2022	Administrative review only.
v1.0		First release of this AC. Incorporates the former Civil Aviation Advisory Publication (CAAP) 5.59-1(0)—*Teaching and Assessing Single-Pilot Human Factors and Threat and Error Management*.

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

1 Reference material

1.1 Acronyms

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

Acronym	Description
AC	advisory circular
ADS-B	automatic dependent surveillance broadcast
ATC	air traffic control
ATS	air traffic services
ATSB	Australian Transport Safety Bureau
CASA	Civil Aviation Safety Authority
CASR	*Civil Aviation Safety Regulations 1998*
EGPWS	enhanced ground proximity warning system
FAA	Federal Aviation Administration (of the USA)
HF	human factors
ICAO	International Civil Aviation Organization
LOSA	line operations safety audit
NOTAM	notice to airmen
NTS	non-technical skills
SOP	standard operating procedure
TAWS	terrain awareness and warning system
TCAD	traffic collision alerting device
TCAS	traffic alert and collision avoidance system
TEM	threat and error management
USA	United States of America
VFR	visual flight rules
V_{YSE}	best single-engine rate of climb speed [blue line speed]
V_{XSE}	best single-engine angle of climb speed

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.

Term	Definition
Airmanship	The consistent use of good judgement and well developed skills to accomplish flight objectives (International Civil Aviation Organization definition).
Airspace cleared procedure	A procedure that is performed before all turns and manoeuvres. A commonly used technique for this procedure is: when turning left, 'clear right, clear ahead, clear left-turning left'; or when turning right, 'clear left, clear ahead, clear right-turning right' If an object is closing and remains on a line of constant bearing (stays at the same point on the windscreen), a collision will occur if avoiding action is not taken.
Behavioural markers	A short, precise statement describing a single non-technical skill or competency. They are observable behaviours that contribute to competent or not yet competent performance within a work environment.
Error	‘Actions or inactions by the pilot that lead to deviations from organisational or pilot intentions or expectations’ (Maurino, 2005). When undetected, unmanaged or mismanaged, errors may lead to undesired aircraft states
Flight environment	The environment internal and external to the aircraft that may affect the outcome of the flight. The aircraft’s internal environment can include, but is not limited to, aircraft attitude and performance, instruments, observations, flight controls, equipment, warning and alerting devices, cockpit physical and interpersonal climate and conditions, crew members, aircraft position, procedures, publications, checklists and automation. The external environment may include, but is not limited to, airspace, meteorological conditions, terrain, obstacles, the regulatory framework, other stakeholders and operating culture.
Formative assessment	Formative evaluation monitors learning progress during instruction and provides continuous feedback to both trainee and instructor concerning learning success and failures.
Human factors	The minimisation of human error and its consequences by optimising the relationship within systems between people, activities and equipment.
Judgement	An opinion formed after analysis of relevant information.
Leadership	The ability of the pilot in command to induce the trainee member(s) to use their skills and knowledge to pursue a defined objective.
Manage(ment)	To plan, direct and control an operation or situation.
Non-technical skills	Specific human factors competencies, such as lookout, situation awareness, decision making, workload management and communications.
Safe(ly)	Means that a manoeuvre or flight is completed without injury to persons, damage to aircraft or breach of aviation safety regulations, while meeting the standards specified by the Civil Aviation Safety Authority.
Safest outcome	Means that the manoeuvre or flight is completed with minimum damage or injury under the prevailing circumstances.
Situation awareness	The accurate perception of available information about yourself, the aircraft and the environment in which it is being flown, the comprehension of their meaning, and the projection of their status in the near future; or more simply, knowing what is going on around you and being able to predict what could will happen.

Term	Definition
Stakeholder	Any person involved with, or affected by the flying operations to be performed.
Standard operating procedure	Any procedure included in the operator's operations manual.
Stress(ors)	Disturbing physiological or psychological influences on human performance that may impact adversely on the safe conduct of a flight or situation.
Summative assessment	A summative evaluation is conducted at the end of a course of training and determines if the instructional objectives (competency standards) have been achieved.
Technical skills	The manipulative and knowledge skills a pilot employs when operating an aircraft.
Threat[1]	Events or errors that: • occur outside the influence of the flight crew • increase the operational complexity of the flight require crew attention and management if safety margins are to be maintained.
Threat (CASA modified definition for single pilot operations)	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). (See paragraph 13.2.3)
Threat and Error Management	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.
Undesired aircraft state	Pilot-induced aircraft position or speed deviations, misapplication of flight controls, or incorrect systems configuration associated with a reduced margin of safety.
Violation	Intentional deviation from rules, regulations, operating procedures or standards.

1.3 References

Legislation

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

Document	Title
Part 61	Flight crew licensing.
Part 141	Recreational, private and commercial pilot flight training other than integrated training.
Part 142	Integrated and multi-crew pilot flight training and contracted recurrent training and checking.
CASR Dictionary	

[1] Definition developed by the University of Texas and the Honourable Company of Air Pilots, Australia for multi-crew LOSA operations.

Document	Title
Part 61 Manual of Standards Instrument 2014	Part 61 Manual of Standards (MOS)

Advisory material

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

Document	Title
CAAP SMS-2	Integration of Human Factors (HF) into Safety Management Systems (SMS)
CAAP SMS-3	Non-Technical Skills Training and Assessment for Regular Public Transport Operations

General references

Document
Safety Behaviours: Human Factors for Pilots, CASA training resource, available on the CASA website.
Limitations of the See-and-Avoid Principle, Australian Transport Safety Bureau Research, November 2004.
Threat and Error Management, Attitudes towards training and applicability of TEM to general aviation and low capacity air transport operations, ATSB Transport Safety Report AR-2006-156(1), Australian Transport Safety Bureau, 2009
Briefings 2000, Edited by R. Amalberti, M. Masson, A. Merritt and J. Paries.
Defensive Flying for Pilots: An Introduction to TEM, by Ashleigh Merritt Ph.D. & James Klinect Ph.D. 12 December 2006.
Federal Aviation Administration (FAA) Advisory Circular 90-48D: Pilots' Role in Collision Avoidance, Federal Aviation Administration (USA), 19 April 2016.
Flight Discipline by Tony Kern, McGraw-Hill 1998.
Human Factors for Pilots by Roger C Green *et al*.
Procedures and Air Navigation Services-Training. International Civil Aviation Organization PANS-OPS), Document 9868-2006.
Redefining Airmanship by Tony Kern, McGraw-Hill 1997.
Threat and Error Management Training-Facilitator Guide, published by the Guild of Air Pilots and Navigators

2 Introduction

Effective threat and error management (TEM) is reliant on the application of good human factors (HF) knowledge. Worldwide statistics indicate that about 75% of aircraft accidents are caused by HF deficiencies. These deficiencies may involve a variety of factors, including:

- poor lookout
- poor situation awareness
- poor decision-making
- lack of task organisation
- insufficient communication
- failure to recognise threats to safety
- commission of errors.

The International Civil Aviation Organization (ICAO) has acknowledged the need for guidance related to the teaching and assessment of HF and TEM, and recommends that these subjects should be introduced into all pilot training.

2.1 Link between human factors and airmanship

2.1.1 Human factors is concerned with 'optimising safe flight operations by enhancing the relationships between people, activities and equipment'. This means achieving the safest outcome for flight operations through the most effective use of people, and the procedures and equipment they use in the aviation environment.

2.1.2 Traditionally, such skills as the consistent use of good judgement and flight discipline, as well as a high state of situation awareness, have been associated with airmanship—knowledge was gained through experience and a process of 'infusion'. Experience has shown that airmanship was difficult to measure accurately because identifiable performance criteria were not available. Linking airmanship to HF and non-technical skills (NTS) is, in effect, bringing science to the often nebulous concept of airmanship. By linking airmanship to the performance criteria in the NTS units[2] and HF units[3] of the Part 61 MOS schedules, it is possible to more accurately evaluate a person's competency.

> This AC provides guidance on the NTS units of competency specified in Schedule 2 of the Part 61 Manual of Standards (MOS). It does not address the HF units prescribed in Schedule 3 of the Part 61 MOS.

2.1.3 For example, it is deemed good airmanship for a pilot on a navigation exercise to continually identify potential forced landing areas along the route. But how can this be objectively measured? If an assessor observed the pilot maintaining an adequate lookout, identifying potential forced landing areas along the route, demonstrating that they are maintaining situation awareness by keeping track of, for example, surface wind direction and velocity, visibility, aircraft performance, and applying this information for

[2] Schedule 2 (Flight Crew Licensing Competency Standards) to the Part 61 MOS.
[3] Schedule 3 (Aeronautical Knowledge Standards) to the Part 61 MOS.

realistic contingency planning that then underpinned effective decision-making in a simulated engine failure, then the assessor could assess the pilot on their competency in these observable skills.

2.1.4 The purpose of linking HF and NTS to airmanship is not to diminish the importance of airmanship, but to make the measurement of it valid and reliable.

2.2 Competency-based training

2.2.1 In a competency-based training system, a person must be assessed by weighing evidence of their competence against published standards. The evidence must be valid, authentic, sufficient and current. However, before a person can be assessed, they must be trained. Therefore, it is essential that flight training organisations develop techniques and material for teaching HF and NTS, and ensure that their assessors have methods and tools to assess competency during flight tests.

2.2.2 Instructors must recognise and appreciate the importance of HF knowledge and NTS and make them an integral part of training; and assessors must be prepared to incorporate HF principles into flight tests. This requires diligence in the preparation of training plans by instructors and assessment plans by flight examiners.

2.2.3 The requirement for NTS training and assessment is addressed through elements and performance criteria in Schedule 2 of the Part 61 MOS[4]:

- NTS1.1 – Maintain effective lookout (Chapter 4 of this AC)
- NTS1.2 – Maintain situation awareness (Chapter 5 of this AC)
- NTS1.3 – Assess situations and make decisions (Chapter 6 of this AC)
- NTS1.4 – Set priorities and manage tasks (Chapter 7 of this AC)
- NTS1.5 – Maintain effective communications and interpersonal relationships (Chapter 8 of this AC)
- NTS2 – Threat and error management (Chapter 9 of this AC).

2.2.4 A pilot would be expected to demonstrate knowledge of human performance limitations in these units, including physiological, psychological and ergonomic aspects. For example, some knowledge aspects that underpin the application of NTS include:

- fatigue
- illusion
- drug and alcohol management
- general health
- knowledge of the functions of the eyes and ears.

2.3 Assessment

2.3.1 Assessment is the process of weighing evidence of an individual’s performance against established standards of:

- **validity**: it must cover all the performance criteria for the skills and knowledge of the standard being assessed

[4] Section 2 – Common Standards.

- **authenticity**: it must be the individual's own work
- **sufficiency**: enough evidence must be collected to judge the individual is competent across:
  - o all elements and performance criteria
  - o all dimensions of competency
- **currency**: the individual is competent now and meets the current standard.

2.3.2 An assessment against 'all dimensions of competency' means that the assessment is not narrowly based on a task, but embraces all aspects of performance and represents an integrated and holistic approach to the assessment. The assessment process must take into account:

- task skills
- management and contingency skills
- role skills
- transfer skills.

> For example, instead of just assessing a 30º banked turn against the specified standard, it may be more realistic to observe the candidate performing the manoeuvre during a precautionary search (a contingency) where the turn is used to position the aircraft to observe and assess the landing surface (a role).

2.3.3 By assessing all dimensions of competency, the skill is being applied to a new circumstance (transfer of skill), while managing a somewhat complex undertaking. This approach combines knowledge, understanding, problem solving, technical skills and application into the assessment.

2.3.4 Assessment tools are used by an assessor to gather evidence that a person is competent. Examples of assessment tools include:

- CASA flight test forms
- pilot's logbooks
- examination results
- training and achievement records
- instructions for assessors and candidates
- evidence and observation checklists
- specific questions or activities
- simulation and scenarios.

2.3.5 These tools (and their application) must be:

- **valid:** assess what you claim to assess using an approved standard in a realistic environment
- **reliable:** a qualified assessor gathering consistent evidence gained from observation, questioning, simulation and training records, using clearly stated criteria and instructions
- **flexible:** assessment is conducted in an operational environment using an aircraft in realistic flight circumstances with adjustments for different situations
- **fair:** the candidate's needs are identified and accommodated, any allowable adjustments catered for and any applicable appeal procedure explained.

2.3.6 Single-pilot HF and TEM are arguably a pilot's most important skills. By applying them judiciously it is more than likely that a pilot will have a long and safe flying career. Accordingly, assessors must adopt the concept of assessing these competencies and prepare themselves by learning a structured and evidence-based approach to assessment.

3 Information processing

3.1 Introduction

3.1.1 Pilots are required to continuously process information during flight operations. This processing occurs during all phases of flight from the moment planning begins until the pilot signs the maintenance release or flight technical log after a flight. It is necessary for instructors to apply the principles of information processing to assist trainees with lookout, situation awareness, decision-making, task management and communications.

3.1.2 Stimuli are collected by the body—eyes (sight)[5], ears (hearing), nose (smell), taste buds (taste), skin and muscles (feel), and the vestibular and somatosensory systems (balance and proprioception)—and the information is passed to the brain. The information is analysed and interpreted (perception) and stored in the sensory memory for a short time (one to five seconds) until it is replaced by new information. This sensory memory forms the basis of perception—failure to receive information or analyse it appropriately may result in poor situation awareness.

3.1.3 Some factors that may impair accurate perception are:

- **lack of experience**: likelihood of not recognising a stimulus
- **stress:** may lead to single task fixation
- **anomalous perception**: illusions, false signals from other people or the proprioceptive sense
- **lack of knowledge**: can lead to a false premise.

3.1.4 After stimuli have been perceived and the person has interpreted and comprehended its meaning and developed options to respond, they are in a position to make a decision. The decision making process involves memory to recall stored information that is applicable to the situation. The working (or short-term memory) holds information being used at the time and may call on the long-term memory to evaluate new information. The brain is a 'single channel processor' and can only deal with one decision at a time. Therefore, if the decisions are not prioritised correctly (the most critical decision first), the outcome could be unfavourable.

3.1.5 Instructors must be aware of the many limitations that affect information processing and decision-making so as to assist in the development of a trainee's skills in these disciplines. Some of the limitations are:

- time constraints
- mental overload
- task mismanagement
- conflicting information
- expectations and anticipation
- fatigue
- insufficient knowledge
- forgetting requirements or information

[5] Visual information is the greatest source of information for building and maintaining situation awareness.

- emotional state
- confirmation bias (ignoring information that does not support the decision)
- personality traits
- failure to seek or apply feedback
- stress
- fixation and destination obsession.

3.2 Further information

3.2.1 For further material on information processing, CASA recommends that instructors review the references provided in Chapter 1 of this AC and other publications that address the subject in greater depth.

4 Maintain effective lookout

4.1 Introduction

4.1.1 Effective lookout means seeing what is 'out there' and assessing the information that is received before making an appropriate decision.

4.1.2 Vision is the primary source of information for a pilot. The aircraft attitude, position, physical hazards and other traffic seen by the pilot are processed by the brain and used to build up situation awareness. Therefore, it is important for an instructor to effectively train a pilot how to best use vision to maintain safety.

4.1.3 In this context, lookout must not be thought of as just ‘scanning the skies’ to locate other traffic; it also involves looking at the internal and external environment of the aircraft. Inside an aircraft, vision is used to interpret flight instruments, flight controls and aircraft systems. Externally, vision is used to observe and interpret weather, terrain, aircraft attitude and position.

4.2 Teaching effective lookout

4.2.1 Instructors should guide trainees through the multitude of factors that can adversely affect vision and lookout, such as:

- the amount of ambient light
- window posts
- cleanliness and crazing of windscreens
- other physiological and psychological concerns.

4.2.2 Workload mismanagement during busy periods can lead to excessive ‘head in the cockpit’ with less time spent looking outside the aircraft. Instructors should warn trainees about such situations during theoretical training and highlight such incidents when they occur during flight training.

> During flight, training instructors should stress the importance of ensuring the windscreen and eyewear are clean and free of crazing. Trainees should be taught to move their head to see beyond window posts and any other obstructions e.g. pilots or passengers in the adjacent seat.

4.2.3 To maintain an effective lookout, the pilot should be taught to:

- understand that collision threats are external to the aircraft
- take time to look outside the aircraft
- recognise that threats will probably appear in the peripheral vision and search the available visual field with emphasis on 60º left/right of centre and 20º above/below the horizon
- shift vision 10º–15º at a time, pausing between each movement
- focus directly on a threat and, if it appears static in the windscreen, identify it as a collision risk and decide on effective evasive action

– manoeuvre the aircraft to mitigate the risk of collision.

4.2.4 Pilots must realise that maintaining an effective lookout takes time and that HF deficiencies can reduce the chance of a threat being detected and avoided. The factors affecting lookout are not errors or poor airmanship, but are limitations of the human visual and information processing systems, which are present to various degrees in all humans. Nonetheless, effective training can improve the effectiveness of a pilot's lookout technique.

Looking for traffic

4.2.5 A great deal of a pilot's time must be spent looking for and sighting air traffic in order to avoid possible conflict. 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. The instructor should teach the pilot an effective scanning technique that provides the maximum opportunity to see traffic.

4.2.6 Size and contrast are the two primary factors that determine the likelihood of detecting other aircraft. Size is the more important parameter and as general aviation aircraft are usually small, the problem of detecting aircraft is exacerbated.

4.2.7 FAA AC 90-48C details a scanning technique that involves moving the eyes in sectors of 10º at a speed of one second per sector. Using this approach, scanning a 180º horizontal / 30º vertical sector would take a minimum of 54 seconds. United States military research has 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. Also, such a structured and disciplined scanning technique may be difficult to achieve. Pilots must develop an effective scan that provides maximum opportunity to see traffic.

4.2.8 Passengers may also be used to help improve lookout. Trainees should be taught to ask their passengers to advise them if they sight anything that may be a threat or could compromise safety.

4.2.9 An instructor must provide and demonstrate an acceptable lookout technique, and ensure that trainees practice and apply the technique and, most importantly, **see all other traffic that is a threat to flight safety**. For example, an 'airspace cleared' procedure (or equivalent expression) should be used at all times when an aircraft manoeuvres in flight under the visual flight rules (VFR).

4.2.10 Instructors must ensure that this or a similar practice is always used before turning an aircraft. Instructors must religiously employ the procedure themselves and then monitor trainees to confirm that they are not only looking for, but also seeing, any traffic or other hazards that may compromise flight safety.

Alerted search

4.2.11 An alerted search involves visual scanning when air traffic information has been provided and a pilot is, in effect, told where to look. The likelihood of detecting other traffic is eight times greater under these circumstances than during an un-alerted scan.

4.2.12 Alerted search information may be provided by air traffic services (ATS) or other pilots. Other technologies that provide similar information include:

- transponders
- automatic dependent surveillance broadcast (ADS-B)
- radar (both airborne and ground installations)
- traffic collision alerting devices (TCAD)
- traffic alert and collision avoidance systems (TCAS).

4.2.13 Technology such as radar altimeters and enhanced ground proximity warning systems (EGPWS)/terrain awareness and warning systems (TAWS) can also enhance situation awareness and alerted awareness of hazardous terrain.

4.2.14 Instructors must demonstrate the benefits of alerted searching—listening to and interpreting radio transmissions in the circuit area provides an ideal opportunity for an instructor to teach these aspects to a trainee. Pilots should be instructed on the benefits of using autopilot to permit greater visual scanning.

4.2.15 CASA strongly recommends that pilots read the Australian Transport Safety Bureau (ATSB) Research Report, which contains useful information about visual acuity, physiological, psychological and ergonomic factors that affect vision and techniques that may enhance successful pilot lookout.

Seeing and interpreting

4.2.16 Throughout training, instructors must teach and then assess a trainee's ability to observe what is happening around them and to apply that knowledge to ensure safety.

4.2.17 Not only is seeing important, but accurately interpreting what is seen is equally vital. Instructors may assume that a trainee interprets what they see in the same way as the instructor, but this may not always be the case. Instructors should spend time explaining the logic of their interpretation.

> For example, on a navigation flight, instructors should ensure that trainees choose potential forced landing areas along a route. The trainee must be shown how to select suitable areas, ensure adequate length and surface conditions and be guided about how to avoid unsuitable terrain. Then on future trips, the trainee should be questioned to see if they are correctly interpreting and applying the information.

4.2.18 Other factors that the instructor should consider teaching the trainee are to see and interpret:

- aircraft attitude
- indications of adverse weather
- wind strength and direction from clouds, blowing dust, smoke, trees and wind lanes in water
- terrain and wind effects
- other air traffic
- reduced visibility
- smoke, shadows and dust

- any other visual cues that contribute to better situation awareness.

4.3 Assessing effective lookout

4.3.1 Instructors and flight examiners have the task of assessing the ability of trainees to maintain an effective lookout. Their roles are slightly different:

- an instructor is required to conduct formative assessments during training to determine how well a trainee is learning
- the flight examiners must conduct a summative assessment at the conclusion of training to determine if the trainee is competent to be granted a licence, rating or endorsement.

4.3.2 Lookout is a critical facet of safe flight operations, and assessment of this skill will be ongoing throughout a pilot's flying career. Therefore, it is important for the assessor to 'get it right'.

4.3.3 The assessor should be looking for competency in two main elements of effective lookout—the first is to see an object[6] and the second is to react appropriately to what has been seen. In reacting appropriately, the pilot should be able to determine if the object is a threat and take mitigating action (more commonly known as 'avoiding').

4.3.4 The three performance criteria relevant to demonstrating an effective lookout are:

- maintains lookout and traffic separation using a systematic scan technique at a rate determined by traffic density, visibility and terrain
- maintains radio listening watch and interprets transmissions to determine traffic location and intentions
- performs an 'airspace cleared' procedure before commencing any manoeuvres.

4.3.5 The assessor should ensure that the trainee covers the field of view from the cockpit, and varies the scan rate to accommodate the threats.

Congested airspace

4.3.6 Airspace congestion is usually encountered during busy stages of a flight, such as departure and approach. These high workload periods often focus a trainee's attention inside the cockpit.

4.3.7 The pilot should pay extra attention to other traffic when operating in congested airspace. Assessors should watch the trainee during these phases of flight to ensure that tasks are prioritised and managed to ensure a good lookout is maintained.

> This can be achieved by monitoring head and eye movement when possible, and questioning the trainee about what they see. Ask the trainee to verbalise their lookout.

[6] An 'object' could range from a speck in the windscreen to something large, depending on its size and distance.

4.3.8 Additionally, the assessor must monitor the trainee for an appropriate reaction to any traffic information received by radio transmissions, TCAD or TCAS.

> Questions such as "where do you think other traffic will be coming from?" will assist in making this determination.

Hazardous terrain

4.3.9 When operating close to, or in, hazardous terrain (e.g. mountains and valleys), or during periods of reduced visibility, greater effort must be directed outside the aircraft. Assessors should monitor the trainee's performance and assess any decisions they make to reduce the chances of collision with terrain or other aircraft.

4.3.10 Questioning should be used to determine if the trainee is aware of the current threats and whether a plan has been made to address them. The assessor should ask the trainee what they are seeing and whether they have recognised the possible associated hazards. These assessments must occur throughout the flight, regardless of workload.

Clearing procedure

4.3.11 Pilots must always clear the airspace around them before manoeuvring the aircraft. This 'clearing procedure' must be used to locate other aircraft as well as any terrain, weather or other hazards that may compromise safety.

4.3.12 Assessors should observe whether the trainee always uses an acceptable procedure and whether threats are seen and identified.

4.3.13 Given the physiological limitations of 'see and avoid', it may be appropriate to supplement continued lookout with other actions (e.g. establish vertical separation). To achieve this, assessors must closely monitor the airspace and maintain a good lookout so that they can identify any threats that are missed by the trainee.

4.3.14 Pilots of slow-flying aircraft must also demonstrate awareness of the possibility of undetected faster aircraft approaching from the rear quarter and how that poses a constant risk to flight safety.

Limitations of vision

4.3.15 Assessors should ensure that trainees are aware of, and take into account, the limitations of vision.[7] These limitations include aspects such as blind spots, threshold of acuity, accommodation (focusing on an object), empty field myopia, focal traps, night vision acclimatisation, visual field narrowing and cockpit workload. Notwithstanding the trainee's awareness of vision limitations, the assessor should determine that the pilot sights threats to safety and takes appropriate mitigating action.

[7] These limitations are discussed in the reference materials listed in Chapter 1 of this AC.

5 Maintain situation awareness

5.1 Introduction

5.1.1 Historically, situation awareness has usually been referred to after an event, as in 'the aircraft crashed because the pilot lost situation awareness'. Situation awareness is sometimes seen as a cause rather than a set of behaviours that enhance safety.

5.1.2 As it applies to aviation, situation awareness is defined as

> 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[8]

5.1.3 This definition 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.

5.1.4 Level 1 situation awareness is achieved through monitoring and gathering information from both within and outside the cockpit. Level 2 situation awareness requires the pilot to process the information (refer to Chapter 2.3.2), which leads the pilot to make conclusions of what is likely to occur (level 3).

> In the context of the Part 61 MOS and assessment of situation awareness, it is important to understand that this is the scope of situation awareness. Situation awareness and decision-making are assessed separately.

5.2 Teaching situation awareness

5.2.1 In the normal course of flight training, trainees are shown how to monitor flight instruments, aircraft systems, aircraft attitude and performance, along with location and the environment. Instructors need to explain how this information is applied by the pilot to develop accurate situation awareness.

5.2.2 Trainees must be taught to monitor, gather and interpret appropriate information from both inside and outside the aircraft. This continual monitoring helps the pilot to develop an accurate perception (mental model) of what is happening and what is likely to happen in the near future, which is the basis of situation awareness.

5.2.3 Instructors should explain to trainees the importance of maintaining a good radio listening watch and, during initial training, explain how correct interpretation of radio-telephony transmissions will enable the trainee to anticipate other traffic and likely air traffic instructions.

5.2.4 During training, instructors must include situation awareness as part of every flight. This could be achieved by stressing the importance of continually monitoring the total environment and updating options as situations change. Trainees must be encouraged

[8] M. R. Endsley, 1988.

to verbalise their observations so that the instructor is also informed and able to make assessments.

5.2.5 The instructor may need to plan how they will conduct situation awareness instruction and possibly create scenarios to enable the learning to occur; however, it is likely that during the normal course of a flight, situations will evolve that present trainees with the opportunity to apply and demonstrate their situation awareness.

5.2.6 As training progresses, the instructor must observe the trainee’s performance and, if necessary, develop scenarios to improve, challenge and assess situation awareness.

5.2.7 A more formal process to ensure situation awareness becomes a core part of the training plan may be to include the aim of lesson(s) to primarily focus on the non-technical skills required to achieve situation awareness. This can only be performed once the trainee has demonstrated competence to manage aircraft systems and to handle the aircraft to an acceptable standard so that they have sufficient additional capacity to take on further responsibilities and a higher workload.

Timing of situation awareness

5.2.8 Although situation awareness is an ongoing process, it is also bound by time and space. Instructors need to highlight to trainees that there is no value in gaining situation awareness after the event. Timely information gathering and interpretation is essential to establishing and maintaining accurate situation awareness.

> For example, if a pilot is in the circuit pattern and does not realise that the aircraft ahead is slower, it is likely that safe aircraft separation will be compromised. If the pilot's situation awareness (information gathering and interpretation) lags the aircraft’s position and performance, the consequences could range from simply embarrassing to catastrophic.

Re-establishing situation awareness

5.2.9 Although the NTS1.2 element of competency is titled 'Maintain situation awareness', instructors must also teach trainees how to re-establish situation awareness whenever it is lost or degraded. If a trainee is distracted from the task of navigation and becomes uncertain of their position, they must know how to regain situation awareness.

5.2.10 This process may involve gathering information, reviewing the aircraft heading and airspeed, and using this information to find a dead (also deduced) reckoning position and then fix the aircraft’s position. This procedure is part of navigation training, but it is also a practical demonstration of re-establishing situation awareness. Instructors must monitor a trainee’s situation awareness. If they establish that it is not adequate, they must alert the trainee to the fact and give advice on how to re-establish sufficient situation awareness.

5.2.11 It is the instructor’s responsibility to maximise a trainee’s ability to recognise the indications that they have lost situation awareness and no longer have an accurate awareness of the current situation and environmental circumstances.

Examples of degraded situation awareness include:

- if a trainee (or instructor) becomes aware that they require air traffic control (ATC) to read back clearances more often than normal, or they are starting to miss radio calls altogether
- degraded work cycles leading to fixation or tunnel vision where the trainee spends too much time on one part of a work cycle (e.g. extended focus on a checklist item to the detriment of radio calls and lookout).

An example of re-establishing degraded situation awareness is when a trainee makes a late turn onto base leg after realising that the aircraft ahead is slow and that delaying the base turn would mitigate the potential conflict.

5.2.12 It is also the instructor's role to maximise the trainee's ability to recover from lost or degraded situation awareness.

For example, during the pre-flight brief the instructor could brief the trainee that one of the lesson's aims is for the trainee to start to recognise lost situation awareness.

One means to teach this is to expose the trainee to a higher workload—initially within the training area—to prompt the loss of situation awareness. As the trainee starts to display signs of degraded performance, the instructor should alert the trainee by referring to the indicators of degraded performance. This can be achieved by questioning the trainee about what they are experiencing to elucidate an understanding of what is different about their work cycles and how they are feeling.

5.2.13 **CAUTION:** Instructors must give careful consideration to how, when and where they conduct such activities as there is the possibility that workload will be excessively increased for both trainee and instructor. It would not be appropriate to artificially increase workload at any time there is a real time moderate-to-high workload, as the trainee could be exposed to increased error(s) and unnecessary risk.

5.3 Assessing situation awareness

5.3.1 The most important aspect of assessing situation awareness is to confirm that the pilot's mental model (or perception) of the environment is accurate. The next step is to find out what options the pilot has identified and assess whether they are realistic. In other words, the assessor must see if the 'what ifs' complement the mental model and provide a basis for an accurate and timely decision (if one is required).

5.3.2 Depending on the pilot's perception and options, there may be no need to proceed to the next step of making a decision, as situation awareness is a dynamic process—further action only needs to be taken if a perceived situation compromises flight safety.

For example, if there are thunderstorms in the area but they do not conflict with the intended track and the effects of the storm will not affect the flight, no decision or action would be needed.

However, it would indicate a lack of situation awareness if the pilot did not consider the storms and the associated hazards in their planning.

Objective and responsive assessment

5.3.3 Observation and questioning are the primary means used by an assessor to make a formative assessment of situation awareness. Questions such as “what do you think could happen if….?” or “what would you do if…?” can be used to assess a trainee’s situation awareness.

5.3.4 If the assessor determines that a trainee’s situation awareness is deficient, they should provide guidance on how to improve situation awareness.

5.3.5 Assessment must be conducted throughout a pilot’s training. The assessor should use the results to modify the training plan as appropriate.

5.3.6 Assessors may gain an intuitive feeling that a trainee’s situation awareness does not meet the required competency standard; however, feelings cannot be used as a basis for an adverse assessment. Evidence must be obtained to support such an assessment—if a trainee’s situation awareness is below the required standard, there will be a cause and it is up to the assessor to discover and record this deficiency as evidence.

5.3.7 As an aid to diagnosis, the limits of a trainee’s situation awareness can be explored through the creation of different scenarios.

Assumed level of knowledge

5.3.8 As situation awareness can be adversely affected by a lack of knowledge, assessors must observe the pilot applying appropriate knowledge for any given situation.

For example:

- unfamiliarity with air traffic separation rules could result in unsatisfactory descent planning when opposing traffic is present
- deficiencies in aircraft systems knowledge (e.g. fuel system mismanagement) could lead to unsatisfactory outcomes.

5.3.9 If a pilot’s lack of knowledge contributes to poor situation awareness, the assessor should record the problem and provide appropriate feedback to the trainee. In some cases, lack of adequate knowledge (and its potential effect on situation awareness) may be enough reason for an assessor to deem that a trainee has not achieved competency in non-technical skills.

High workload

5.3.10 During periods of high workload it is possible that information may be overlooked. Assessors must determine if situation awareness is being maintained, regardless of workload.

For example, if the trainee is busy during an approach into a very active terminal area, radio transmissions may be missed or instructions forgotten. A possible cause for this reduced situation awareness is failure to recall the information received (i.e. short-term memory breakdown causing faulty perception), which can lead to failure to take appropriate action.

Low workload

5.3.11 Assessors must also monitor the trainee during periods of low arousal or workload (inactivity) to ensure that an appropriate level of situation awareness is maintained. During a long navigation leg that is proceeding according to plan, a trainee may relax and stop thinking about what is happening and what could happen.

It would be appropriate to confirm that situation awareness is being maintained by the use of questions such as:

- "where would you divert to now if a passenger became seriously ill?"
- "if you suffered an engine failure where would you land?"
- "what is our endurance now?"

Specific scenarios

5.3.12 In the normal course of a flight test, it is likely that many opportunities to assess situation awareness will occur. Despite this, if an assessor wants to investigate a specific situation they may need to develop a scenario to test the trainee's situation awareness. This may require the assessor and pilot to use imagination and practice good communications skills.

For example, if the assessor wants to explore the trainee's ability to maintain situation awareness under a high workload, they could create an artificial workload interspersed with distractions. Such a scenario may require some time and thought but, once developed, the scenario could be refined, adapted and used for other flight tests.

6 Assess situations and make decisions

6.1 Introduction

6.1.1 Although the NTS1.3 unit is titled 'Assess situations and make decisions', the primary area of interest is the decision-making process. By applying situation awareness, a pilot may arrive at a number of options of 'what could happen' and the next step is to make a decision that leads to actions that achieve the optimum outcome.

6.1.2 In daily life people are always making decisions—usually sub-consciously. However, in the aviation environment, incorrect or inappropriate decisions can have tragic consequences. Therefore, it is important for pilots to understand and be able to apply the decision-making process, and to be aware of the need to make timely and optimum decisions.

6.2 Teaching decision-making

6.2.1 Trainees must be given the opportunity to make decisions. The trainee should be encouraged to refer to information sources (such as meteorological reports, notices to airmen (NOTAMs), radio transmissions and visual observations) as the basis for decision-making.

6.2.2 It is quite normal for an instructor to make decisions during flight, but it may be of more benefit to ask the trainee for their opinions. This will help the assessor to monitor progress and target the flight training.

> For example, if the weather is marginal before a flight, rather than cancelling the sortie, the instructor should ask the trainee (who probably is very eager to fly) whether or not it would be prudent to undertake the flight.

6.2.3 During flight training there will be opportunities to observe, assess and improve a trainee's decision-making. Instructors must be conscious of the times when a trainee is required to make a decision. They must then determine if the trainee has made an acceptable decision in the time available.

6.2.4 If a trainee makes a defective decision, the assessor should:

- point out any faults
- explain the reasoning that was used to reach such a determination
- explain how considerations and logic should be applied to reach an acceptable decision.

Although this may seem to be a laborious procedure, it is an improvement on the traditional method of simply revealing to a person that they made a wrong judgment and telling them what they should have done, without analysing why the mistake was made and offering guidance to help them improve their decision-making skills.

6.2.5 When teaching decision-making, instructors must remember that individuals have different emotional attitudes, learning rates, thought processes, analytical skills, aspirations and cultural backgrounds that may influence how this skill is taught. Therefore, instructors must be flexible, imaginative and innovative in developing ways of passing on decision-making skills to pilots.

Timeliness of decision-making

6.2.6 The primary goal of teaching decision-making skills is for pilots to be able to make correct or correctable decisions in a timely manner.

For example:

- a mishandled landing may require a quick decision to go around to prevent damage to the aircraft
- the decision to divert because of adverse weather or fuel shortage on a navigation flight may have a 'deadline' for when a decision needs to be made.

6.2.7 The timeframe for making decisions may vary, but the information process will be the same. That is:

- receive information
- convert information into reality
- generate options
- analyse options
- make a decision.

6.2.8 In the second example provided above, the situation is dynamic, variable, emotive and subject to bias. Such aspects of decision-making make the process more difficult and susceptible to errors, the result of which could be an incorrect or 'non-decision'.

6.2.9 To give a trainee practice at this type of complex decision-making, instructors may have to develop scenarios for different stages of flight training.

For example, the instructor may develop a scenario for a simulated engine failure or partial power loss in a single-engine aircraft:

- The decision-making related to a simulated engine failure is a relatively clear outcome that requires well-rehearsed decisions, checklists and actions to set up a forced landing.
- The decision-making for a partial power loss is more subjective, potentially offering more time and providing the trainee with more options.

The latter scenario provides a richer training environment for decision-making as it offers the trainee a number of options, and opportunities for unrehearsed decision-making, both of which can be discussed in the debrief (e.g. why the trainee chose a specific course of action and what were their considerations for reaching this conclusion).

Automatic decision-making

6.2.10 With increased experience and exposure to known operating conditions and a specific aircraft type, the familiarity with various situations increases and the pilot’s information processing will become more automated—this is the natural outcome of a positive transfer of learning.

6.2.11 This familiarity also translates to an environment in which decision-making may not be fully tested in the latter stages of training as the local operating conditions are so well known and rehearsed that the trainee continues to have spare capacity to deal with any simulated scenarios the instructor may wish to impose, many of which have been previously experienced.

6.2.12 Higher cognitive demands are potentially created any time a trainee experiences something new or unknown. Instructors should ensure that they consider trainee familiarity with existing situations and look for opportunities to expose the trainee to new situations, in order to assess their ability to manage the flight, maintain situation awareness and make sound decisions.

> For example, if the trainee has conducted a large part of their training under conditions of clear weather, the first flight in which they are required to deal with marginal weather—even with considerable training experience in the same area and aircraft—could impose significantly increased workload with the potential for degraded performance and higher cognitive demands when making decisions.

6.3 Assessing decision-making

6.3.1 Normal flight training provides ample opportunities for instructors to conduct formative assessments of decision-making skills; however, it may be necessary to create scenarios to analyse a trainee's ability to manage complex decision-making.

6.3.2 Complex decision-making may be more difficult for a flight examiner to assess on a flight test because of the limited timeframe and reduced opportunity. Nevertheless, a pilot's competence to make complex decisions must be assessed on a flight crew licensing flight test.

Decision-making process

6.3.3 The ongoing process of acquiring situation awareness, if working correctly, will provide the pilot with a perspective from which to derive any number of options and ultimately determine the best action to follow. The pilot must recognise that a decision has to be made. Problems must be identified and the assessor will use observation and questioning to determine the facts.

6.3.4 The pilot must analyse problems and propose solutions (options). This will require the pilot to gather and process information. The pilot’s actions must be observable, but some questioning may be required to obtain an accurate assessment.

6.3.5 On the basis of the options identified and evaluated, the pilot must make a decision. Assessors must ensure the decision is the optimal one and is implemented effectively in the time available.

6.3.6 The pilot then must monitor progress against their plan and re-evaluate as circumstances change, even if it is to confirm the desired outcome.

For an obvious decision such as a 'go around' after a mishandled landing, the action and results will be very evident. In such a case, the assessor should ensure that the pilot recognised the mishandled landing soon enough and did not delay the recovery action.

More complicated decisions may require greater analysis by both the pilot and the assessors. A complex problem may require a decision that does not lead to the optimum result immediately, but could be modified at a later time.

6.3.7 It is acceptable for the pilot to make a decision on the basis that it may require revision if the safety of the flight is not compromised and the trainee continues to re-evaluate and update that initial decision. This situation could occur where a decision is made during flight planning, which may have to be modified after the pilot becomes airborne (e.g. operational requirements, insufficient information available or changed weather conditions).

Management of factors affecting information processing

6.3.8 An assessor must observe a pilot's ability to manage factors that can adversely affect information processing and decision-making. An example would be a pilot who is prepared to press on in bad weather or other adverse circumstances, in an attempt to reach a destination.

6.3.9 Flight examiners and instructors should consider developing scenarios where bad weather, operational requirements or fuel shortage would make it impossible to safely proceed to the destination. In such a case the trainee would be obliged to make a decision not to proceed; and to take appropriate action that ensures safe flight.

6.3.10 While it is a challenge to assess a pilot's decision-making competence on a flight test, if the examiner prepares for the test by creating complex scenarios, the task of evaluating a pilot's decision-making competency will be achievable.

7 Set priorities and manage tasks

7.1 Introduction

7.1.1 Task management means completing a job or operation competently in the time available. If the workload is high and many tasks have to be completed, they must be prioritised in a logical and efficient sequence.

7.1.2 The adage *aviate, navigate, communicate* forms a sound basis for prioritisation and task management. Many people are able to process information in a well organised and logical manner, but some are not able to operate efficiently in a confined and, at times, demanding and busy environment without additional guidance and direction.

7.2 Teaching how to set priorities and manage tasks

7.2.1 The brain is a single-channel (linear) processor—humans can normally only manage one activity at a time. Instruction to ensure competent task management must begin at the commencement of a pilot's flight training. Many things that experienced pilots take for granted must be pointed out and explained to the novice as proficiency in ‘simple’ tasks will allow for more efficient workload management.

For example:

- When a pilot is first introduced to the cockpit they must be shown how to adjust their harness and seat, and reach and touch controls and switches.
- If rudder pedals are not correctly adjusted, a pilot could have trouble using the brakes effectively, which could make taxiing and aircraft control on the ground more difficult and could potentially divert a pilot's attention from other tasks.

Prioritisation

7.2.2 During flight training, trainees must be encouraged to prioritise tasks to ensure that the important and safety-critical actions are dealt with first. The requirement to *aviate*—to maintain control of the aircraft—must be the pilot's first concern.

7.2.3 Correct prioritisation requires that timely correction of an undesired aircraft state takes precedence over concentrating on why an error may have occurred. Instructors must alert trainees to instances of incorrect prioritisation and offer a more appropriate solution.

Questions such as "is there anything else we should or could be doing now?" or "what is more important?" may prompt a pilot to prioritise correctly.

7.2.4 Instructors must stress the importance of good organisation in the cockpit—this is particularly applicable to the requirement to *navigate*. Judicious selection and storage of charts, flight plans, computers, publications and writing implements should streamline navigation tasks.

7.2.5 When dealing with a major system malfunction at the same time as ATS is requesting information, the choice is simple: deal with the malfunction first. Unfortunately there is a tendency—especially for inexperienced pilots—to prioritise ATS communications over dealing with the malfunction, as if it were a response to 'authority'. Irrespective of whether a minor or major problem arises, the pilot must be taught that their first priority is survival, which requires maintaining control of the aircraft and the situation. During flight training an instructor must develop and use appropriate scenarios to provide valuable and potentially lifesaving guidance.

Workload management

7.2.6 Instructors should explain how rationalising workloads helps to complete tasks more efficiently, which in turn results in greater safety. The pilot should be taught to recognise factors that may adversely affect their ability to operate efficiently, including:

- **lack of preparation**: confusion, disorganisation
- **fatigue**: poor decision making, errors
- **discomfort**: distraction, fatigue
- **stress**: inefficiency, distraction
- **arousal**: increased or decreased work cycles
- **distraction**: diverted attention, lack of concentration
- **non-use of automation**: increased work
- **destination or task obsession**: poor decision making, desire to ‘press on'
- **bad health**: decreased physical and psychological performance
- **overload**: fixation, tunnel vision, broken work cycles.

7.3 Assessing prioritisation and task management

7.3.1 Assessment of a pilot's competence to set priorities and manage tasks should be made with reference to the non-technical skills standards in the Part 61 MOS. The assessment process will require close observation, information gathering and questioning by the assessor, because they will need to determine how a candidate’s mind is functioning while managing tasks. By obtaining this information and combining it with other observations, the assessor will be able to judge a pilot's ability to competently set priorities and manage tasks.

7.3.2 An assessor should observe a pilot's work pattern and task completion to evaluate the pilot’s competence to set priorities and manage tasks on a flight test. Valid evidence must be obtained to substantiate the assessment.

> For example, if a pilot is told by ATS to ‘expedite take-off’ and does so before completing pre-take-off checks, then the assessor could reasonably deem the pilot to be not competent at prioritising tasks. The pilot would not have met the 'take-off aeroplane' standard and could compromise safety. The correct action would have been for the pilot to advise ATS that they were not ready for take-off.

7.3.3 When assessing task management, the assessor must look for competent completion of a task in the time available. In particular, the assessor should seek confirmation that the pilot can manage multiple tasks (although not an excessive workload) in a logical order. It may be necessary for the assessor to create scenarios to support this evaluation.

7.3.4 Instructors must be aware of factors affecting workload management and look for evidence of such factors impairing the trainee's performance. Once identified, instructors must advise trainees on methods for developing and applying countermeasures or strategies to manage these inhibiters to efficient workload management.

8 Maintain effective communications and interpersonal relationships

8.1 Introduction

8.1.1 Communication is a two-way process; it involves the accurate transmission, receipt and interpretation of information. Communication includes using aircraft radio communication systems, as well as direct verbal and non-verbal exchanges.

8.1.2 A major component of interpersonal relationships is effective communication. It involves the pilot being able to get a positive and helpful, rather than negative and obstructive, response from individuals or groups they deal with. This ensures the effective transfer of information that may be crucial to maintaining situation awareness and safety of flight.

8.1.3 The intent of the NTS1.5 competency element is to make sure pilots always foster positive and cooperative relationships with people involved with, or affected by, their flying operations. Affected people may include:

- an instructor
- other pilots
- a refueller
- a maintenance engineer
- an air traffic controller
- a farmer who owns the airfield where the aircraft will land.

This does not mean that instructors must teach manners or ‘how to be nice’, but they must provide guidance on achieving positive outcomes.

8.2 Teaching effective communications and interpersonal relationships

8.2.1 In Australia, English is the common language and 'aviation English' is the use of standardised, abbreviated, precise and agreed terminology and phraseology. Pilots are expected to use aviation English and will gain knowledge and experience in its use as their flight training progresses. Instructors should refer to the aviation English language proficiency standard in Schedule 2 to the Part 61 MOS. Unit C1 (Communicating in the aviation environment) is also applied to flight crew training and testing.

8.2.2 There is a tendency for instructors to take the communication process for granted, without considering some of the deeper implications of not communicating clearly, or failing to consciously train novice pilots to communicate effectively. Instructors should be precise with their use of language and take care to not use slang or colloquial speech.

8.2.3 Instructors should make their trainees aware of the consequences of poor communication skills and emphasise the safety issues that can result from miscommunication.

8.2.4 During flight training there will be many opportunities to observe and judge the effectiveness of a trainee's communication skills. Instructors should monitor and develop a pilot's communication skills throughout flight training, pointing out when communications are confusing, ambiguous or out of context. They should suggest ways to modify and improve the communication. Instructors should take extra care when teaching trainees for whom English is not the first language.

For example, saying "raise the nose" may result in a backwards head movement rather than increasing the aircraft's nose attitude/angle of attack.

8.2.5 The instructor should observe the pilot's interaction with others and the results of these activities. If the instructor detects inadequacies, they should advise the trainee and suggest strategies to improve performance. Potential deficiencies in communication style include:

- poor tone or phrasing of communications
- lack of openness
- poor reaction to criticism
- aggressiveness or lack of assertion
- unwillingness to listen
- disrespect for others
- arrogance
- incorrect use of authority.

For example, an aggressive, brusque or demanding tone of voice during a radio transmission could encourage an adverse response from another airspace user, and instructors must identify these issues when they occur. Failure to discuss and rectify this sort of problem could have a negative influence on a pilot's future performance.

As another example, during a multi-leg navigation flight that involves refuelling, an instructor could watch the interaction between the trainee and fuel agent. The trainee should aim to complete the operation with minimum delay and safety risk.

Late arrival of either the aircraft or fuel agent may cause inconvenience (and annoyance), and would present an ideal opportunity for the instructor to observe how the trainee manages such a situation. If the operation was completed without any problems, there would be no need to take any remedial action.

However, if the instructor detected problems with the trainee's interaction with the fuel agent, they should provide guidance to the trainee. When appropriate, the trainee must be guided on any action that could have been handled in a way that avoided conflict or other negative responses.

8.3 Assessing effective communications and interpersonal relationships

8.3.1 The first performance criterion for NTS1.5 is to

establish and maintain effective and efficient communications and interpersonal relationships with involved stakeholders to ensure the optimum safe outcome of the flight

8.3.2 The instructor should evaluate the pilot's ability to 'establish communication'; that is, to make the effort to communicate or interact. The instructor should assess the pilot's:

- tone of voice
- ability to use a non-aggressive approach
- willingness to listen
- body language (when applicable)
- assertiveness.

These traits apply both to communications and interpersonal relationships and should be assessed by observing the reaction of the other person(s) involved.

8.3.3 The instructor must use evidence-based assessment. They should look for brevity of language, use of standard phraseology and whether the trainee was able to quickly elicit a positive reaction from the person with whom they were dealing.

> Examples of feedback on negative communication include:
>
> - "you did not communicate effectively because the air traffic controller asked you twice to clarify your request"
> - "you got into an argument with the engineer when discussing the aircraft's serviceability".

8.3.4 The second performance criterion for NTS1.5 is to

define and explain objectives to involved stakeholders

8.3.5 The instructor can assess performance against this criterion by observing a pilot's cockpit communications and interaction with the instructor. A trainee who states their intention and explains how they will achieve the desired objectives could be assessed as communicating and interacting well with the instructor.

8.3.6 Assessment of communication and interpersonal skills should not be limited to the cockpit—instructors must make a holistic assessment of this aspect of a trainee's performance.

8.3.7 The third performance criteria for NTS1.5 is to

demonstrate required level of assertiveness that ensures the optimum completion of the flight.

8.3.8 To achieve the required standard of competence, skill and knowledge by the end of flight training, the pilot should have been able to demonstrate sufficient assertiveness to ensure that operational safety was maintained during the completion of a task.

For example, if the pilot of another aircraft reports intentions inbound to an aerodrome that is inappropriate or unsafe, an instructor must expect a competent pilot to negotiate or suggest alternatives. When faced with a more time critical situation there may be a need to change the normal tone of voice and style of the transmission to maximise the priority and gain the attention necessary to deal with the situation. Accepting the status quo could result in an unsafe outcome, which would be unacceptable.

9 Threat and error management

9.1 Introduction

9.1.1 TEM was developed by the University of Texas and derived from observations on flight decks during line operations safety audits (LOSA). TEM is an operational concept applied to the conduct of a flight; it is broader than the traditional concept of airmanship as it provides pilots with a structured and pro-active approach to identifying and managing threats and errors that may affect the safety of the flight.

9.1.2 TEM has been generally accepted in the airline industry as an effective method of improving flight safety, and is now required by ICAO as an integral part of pilot training at all licence levels through to air transport pilot. TEM has been incorporated into the Australian licensing system at all levels and in all operational areas.

9.1.3 TEM uses many tools, including training, standard operating procedures (SOPs), checklists, briefings and single-pilot HF principles.

9.1.4 There is some overlap between risk management, TEM and HF, particularly at the stage of developing and implementing plans to mitigate risks and in reviewing the conduct of a flight.

9.1.5 Generally, risk management is the process of deciding whether or not operations can be conducted to an acceptable 'level' of risk ('go' or 'no go') safely, whereas TEM is the process applied to managing and maintaining the safety of a particular flight.

9.1.6 Throughout the Part 61 MOS, the terms ‘manage’ and ‘management’ are used and defined. The same definition—*plan, direct and control an operation or situation*—is used in this AC.

9.1.7 When assessing competency standards that involve management, evidence must be sought that a plan—however small—has been developed, implemented (direct) and re-evaluated (control) throughout the activity.

9.1.8 Managing threats and errors involves developing a plan to identify the threat or error, and implementing counter-measures to reduce or eliminate them. Direction may, in the case of a single-pilot aircraft, require self-direction to ensure action is taken to mitigate hazards in accordance with a checklist, approved flight manual/pilot operating handbook procedures, SOP or other acceptable means. Control would involve monitoring the progress of events to ensure a safe outcome. This may require plans and actions to be amended.

9.1.9 Management also applies to correcting an undesired aircraft state.

9.1.10 The following sections provide a brief introduction to assist general aviation pilots and trainers to apply the principles of TEM to their own operations.

9.1.11 Threats

9.1.11.1 The TEM model, as originally developed by the University of Texas, defines threats as external events or errors that:

- occur outside the influence of the flight crew

- increase the operational complexity of the flight
- require crew attention and management if safety margins are to be maintained.

9.1.11.2 The threats may be anticipated, unexpected or latent within the operational system.

9.1.11.3 CASA proposes an expanded definition that is equally applicable to general aviation: that a threat can be defined as a situation or event that has the potential to impact negatively on the safety of a flight, or as any influence that promotes opportunity for pilot errors. Generally, threats are considered to be external (e.g. bad weather) or internal, such as those the pilot or trainee brings to the operation (e.g. fatigue or complacency).

9.1.11.4 This concept expands on the original definition of threat and considers the psychological state of the pilot and the limitations they may bring to the aircraft operation on any given day.

> For example, increased levels of fatigue could result from having a young child that is not sleeping well. The threat (in this case fatigue) has the potential to cause an increase in errors, degrade situation awareness and contribute to poor decision-making due to physiological and/or psychological impairment.

9.1.11.5 Pilots need good situation awareness to anticipate and recognise threats as they occur. Threats must be managed to maintain normal flight safety margins. Some typical external threats to operations might be:

- adverse weather
- weight and balance
- density altitude
- runway length
- other traffic
- high terrain or obstacles
- the condition of the aircraft.

9.1.11.6 Some typical internal threats to general aviation operations include:

- fatigue
- complacency
- over- or under-confidence
- lack of flight discipline
- lack of recency and proficiency
- hazardous behaviour, such as impulsiveness, machismo, invulnerability, resignation or anti-authority.

9.1.12 Errors

9.1.12.1 The TEM model accepts that it is inevitable that pilots, as human beings, will make errors. Errors are defined as flight crew actions or inactions that:

- lead to a deviation from crew or organisational intentions or expectations
- reduce safety margins

- increase the probability of adverse operational events on the ground and during flight.

9.1.12.2 Threats can be classified as handling errors, procedural errors or communications errors.

9.1.12.3 While errors may be inevitable, the requirement to maintain safety of flight means that errors must be identified and managed before flight safety margins are compromised. Typical errors in general aviation flight might include:

- incorrect performance calculations
- inaccurate flight planning
- non-standard communications
- aircraft mishandling
- incorrect systems operation or management
- checklist errors
- failure to meet flight standards (e.g. poor airspeed control).

9.1.13 Undesired aircraft state

9.1.13.1 Threats and errors that are not detected and managed correctly can lead to an undesired aircraft state, which could be a deviation from flight path or aircraft configuration that reduces normal safety margins. The definition of undesired aircraft state is:

> pilot-induced aircraft position or speed deviations, misapplication of flight controls or incorrect systems configuration associated with a reduced margin of safety.

9.1.13.2 An undesired aircraft state can still be recovered to normal flight but, if not managed appropriately, may lead to an outcome such as an accident or incident. Safe flight in an aircraft requires recognition and recovery from an undesired aircraft state in a very short timeframe before an outcome eventuates (e.g. loss of control, failure to achieve optimum performance or uncontrolled flight into terrain).

Examples of errors and an associated undesired aircraft states in general aviation aircraft might be:

- mismanagement of aircraft systems (error) resulting in aircraft anti-ice settings not turned on during icing conditions (state)
- loss of directional control during a stall (error) resulting in an unusual aircraft attitude (state)
- inappropriate scan of aircraft instruments (error) resulting in flight below V_{YSE} (best single-engine rate of climb speed [blue line speed]) or V_{XSE} (best single-engine angle of climb speed) (state)
- flying a final approach below appropriate threshold speed (error) resulting in excessive deviations from specified performance (state).

9.1.13.3 Good TEM requires the pilot to plan and use appropriate countermeasures to prevent threats and errors from progressing to an undesired aircraft state. Countermeasures used in TEM include many standard aviation practices and may be categorised as follows:

- **planning countermeasures:** flight planning, briefing and contingency planning
- **execution countermeasures**: monitoring, cross-checking, workload and systems management
- **review countermeasures**: evaluating and modifying plans as the flight proceeds, and inquiry and assertiveness to identify and address issues in a timely way.

9.1.13.4 Once an undesired aircraft state is recognised, it is important to manage the undesired state through correct remedial action and prioritise aircraft control for return to normal flight, rather than to fixate on the error that may have initiated the event.

9.1.14 TEM application

9.1.14.1 Threats and errors occur during every flight, as evidenced in the considerable database (through the LOSA collaboration) built up from threats and errors in flight operations worldwide. One interesting fact revealed by this database is that around 45% of flight crew errors go undetected or are not responded to by crew members.

9.1.14.2 TEM must be integral to every flight and include anticipation of potential threats and errors as well as planning of countermeasures. It must include identification of potential threats, errors and countermeasures in the self-briefing process at each stage of flight, and avoiding becoming complacent about threats that are commonly encountered (e.g. weather, traffic and terrain).

9.1.14.3 Table 1 provides considerations that should assist pilots to apply TEM in general aviation operations.

Table 1: Considerations to assist pilots in applying TEM in general aviation operations

Stage	Considerations
Pre-flight	• Just as pilots perform a number of tasks on a regular basis in preparation for flight (e.g. interpreting NOTAMs and MET information, checking fuel contents), they must include TEM as part of routine pre-flight planning and preparation. • A few minutes (or more) on the ground spent anticipating possible threats and errors associated with each flight will provide the opportunity to plan and develop countermeasures (e.g. action in the event of unpredicted weather changes). • A good starting point is to ask what actions, conditions or events are likely to promote errors, leading to the identification of internal and/or external threats applicable to that flight. This can reduce airborne workload as the pilot may then be partially prepared to deal with those threats and errors.
Flight	• Brief (self-brief and passengers) planned procedures before take-off and prior to commencing each significant flight sequence (e.g. approach to an unfamiliar aerodrome, low-level operations). • Include anticipated threats and countermeasures in briefings. • Continuously monitor and cross-check visual and instrument indications and energy state to maintain situational awareness. • Prioritise tasks and manage workload to avoid being overloaded, and to maintain situation awareness. • Identify and manage threats and errors.

Stage	Considerations
	• When confronted by threats and errors, the priority is to ensure the aircraft is in an appropriate configuration to optimise the ability to maintain control of the aircraft and flight path. • Monitor the progress of every sequence and abort if necessary. • Do not fixate on threat or error management to the detriment of aircraft control. • Identify and manage any undesired aircraft state. • Recover to planned flight and normal safety margins before dealing with other problems.
Post-flight	• Take a few minutes at the end of each flight to reconsider what threats, errors and/or undesired aircraft states were encountered during the flight. Ask yourself how well they were managed and what you would do differently to improve management of those threats and errors. • Record threats, errors and/or undesired aircraft states and discuss them with more experienced pilots to assist with the development of improved TEM strategies.

9.2 Teaching threat management

9.2.1 In the TEM model, threats can be defined as:

– situations or events that have the potential to impact negatively on the safety of a flight

or

– any influence that promotes opportunity for pilot errors.

9.2.2 Instructors should teach trainees that threats (and errors) are a part of everyday aviation operations and must be proactively managed.

9.2.3 Instructors should stress to trainees that threats can be categorised as either *anticipated* or *unexpected*. However, there is a third category, *latent* threats, that may not be observable by pilots involved in flight operations and may need to be uncovered through safety analysis.

9.2.4 Threats may also be categorised as either *environmental* or *organisational*.

9.2.5 It is incumbent upon instructors to show trainees how to detect all types of threats and explain the steps necessary to mitigate potential hazards.

Anticipated threats

9.2.6 Detection of anticipated threats relies mainly on the trainee’s knowledge and experience. The instructor should inform new trainees about:

– use of MET reports and means of avoiding unfavourable conditions
– conduct in the vicinity of aircraft on the ground
– perform pre-flight inspections
– correct adjustment of flight controls and harness restraint
– a clear handover/takeover procedure
– ensuring propeller clearance before engine start
– listening before transmitting on the radio.

9.2.7 During flight training, instructors should point out meteorological observations and effects, and question the trainee to determine his or her application of the information that is available.

9.2.8 As pilots learn (and gain experience) they will be able to predict when and where threats may occur. Similarly, as pilots gain experience they should be expected to understand more about their own capabilities and limitations.

9.2.9 Prior to each flight, the instructor should discuss the proposed flight with the trainee and ask them to identify obvious threats to safety. During the early stages of training the instructor should not necessarily expect the pilot to identify a comprehensive set of threats but, as training progresses, the trainee's level of knowledge should improve.

9.2.10 In a very short time, instructors should expect a trainee to manage anticipated threats as a matter of course. As the trainee gains knowledge, experience and skills, they will learn to manage all threats that develop.

Unexpected threats

9.2.11 Unexpected threats are most likely to occur during flight operations.

9.2.12 During flight training, the instructor should expect the trainee to identify unexpected threats such as incorrect ATC instructions, traffic hazards or adverse weather. The instructor should point these out if the trainee fails to identify them.

9.2.13 As unexpected threats are identified, the instructor should question the trainee to understand what action they would take to mitigate threats and ensure the action is completed in the time available. Again, if the trainee makes errors during threat mitigation, the instructor should identify the error and provide advice to the pilot to minimise the effects.

9.2.14 Instructors may have to develop scenarios or 'what if' questions to further test the trainee. Typical scenarios include practice engine failure or simulated system failure.

Latent threats

9.2.15 The instructor should inform the trainee about latent threats, such as:

- optical illusions (e.g. approaches to sloping runways)
- poor manuals
- equipment design faults (e.g. landing gear and flap levers located too close to each other)
- unnecessary pressure to get a job done.

Environmental threats

9.2.16 Environmental threats occur outside the control of the aircraft operator. Such threats include:

- **weather:** turbulence, ice, wind
- **aerodromes:** congestion, complex surface navigation, poor signage/markings
- **ATC:** non-standard phraseology, complex clearances, poor English language
- **terrain:** mountains, valleys, built up areas.

Organisational threats

9.2.17 Organisational threats, which are often latent, include:

- **operational pressure:** tight scheduling of training flights
- **aircraft**: poor serviceability
- **maintenance:** maintenance error or event
- **documentation error:** incorrect or expired charts, incomplete or erroneous maintenance release.

9.2.18 Organisational threats can be controlled by the operator or mitigated by aviation organisations. Mitigating strategies include:

- safety management systems
- fatigue risk management systems
- standard operating procedures
- checklists
- ground handling measures (marshallers)
- operational health and safety procedures.

9.3 Teaching error management

9.3.1 Industry's acknowledgement that errors will occur has changed the emphasis in aviation operations from error prevention to error recognition and management. Rather than simply pointing out errors as they occur, instructors should show trainees how to reduce the risk of errors occurring and then, if they do happen, recognise the fact and implement strategies to manage the error.

9.3.2 The trainee should be taught the importance of ensuring that errors are recognised, acknowledged and corrective action taken. Error management could be something as simple as recognising a forgotten task and completing it.

9.3.3 If time and safety permit, instructors must afford the trainee the opportunity to recognise a committed error, rather than intervening as soon as they see an error committed. If an error is not recognised, the instructor should then analyse why the error occurred, why the pilot did not recognise it and what steps should be taken to prevent future occurrences.

Errors

9.3.4 In the TEM model, errors must be observable. They are classified on the basis of 'primary interactions' as:

- **aircraft handling error:** occurs when a pilot is interacting with an aircraft's controls, automation or systems
- **procedural error:** when a pilot is using procedures such as checklists, SOPs or emergency actions
- **communication error:** occurs when pilots are interacting with other people such as ATC, ground assistants or other crew members.

9.3.5 Instructors must be familiar with these classifications so they can identify a trainee's weaknesses and provide guidance to address the deficiencies.

9.3.6 Additionally, instructors should be mindful of their own role in introducing errors.

> For example, instructors should ask themselves "is it a communications error if I fail to clearly communicate my message to a trainee during training?"

Mitigations

9.3.7 When teaching TEM, instructors must emphasise the application of HF skills. If the instructor identifies that the trainee is deficient in any of the HF skills, the deficiency must be rectified or general flying and TEM competency will be compromised.

9.3.8 The LOSA archive shows that 45% of observed errors that occur in multi-crew operations are not detected. CASA considers that single-pilot general aviation operations are probably more susceptible to errors. Therefore, the trainee should be instructed that mitigations such as checklists, SOPs and aviation regulations must be complied with.

9.3.9 Aviation regulations, SOPs, checklists and other authoritative documentation (e.g. flight manuals) are provided to enhance safety by helping reduce errors—instructors must continually stress the importance of using and adhering to the requirements and guidance provided. Instructors should not permit the trainee to deviate from the application and terminology of such a document, whether it is used from memory or read each time.

9.4 Teaching undesired aircraft state management

9.4.1 During flight training, instructors will be dealing with many undesired aircraft states as trainees develop their flying skills. Ideally, pilots should be taught to manage threats and errors before an undesired aircraft state develops. In this context, instructors have the dual role of practicing TEM by ensuring that undesired aircraft states are managed and then teaching trainees how to do the same.

9.4.2 Because trainees may not have the manipulative and cognitive skills of a qualified pilot, they will often not meet specified flight tolerances or procedures.

> Some typical examples of undesired aircraft state during training are:
>
> - taxiing too fast
> - too fast or slow on final approach
>
>   or
> - inability to maintain altitude or heading during straight and level flight.

9.4.3 Such examples would normally be classified as undesired aircraft states when committed by a qualified pilot; however, they are not unusual events during flight training. The difference is that the instructor should be aware of the threats and errors and should not let an undesired aircraft state develop into an undesired outcome (accident or incident). Highlighting undesired aircraft states as they occur, and providing guidance and advice on their prevention will enrich the trainee’s learning experience.

9.4.4 Instructors should teach trainees the critical aspect of switching from error management to undesired aircraft state management. During the error management phase, a pilot can become fixated on determining the cause of an error and forget the requirement to *aviate, navigate and communicate*. It is essential that pilots recognise when an undesired state must be managed and take appropriate action.

> For example, if a pilot becomes uncertain of his or her position on a navigation flight, a timely decision would need to be made to perform a 'lost procedure'. The pilot may be tempted to ascertain why they became lost and blunder on regardless (undesired aircraft state), rather than initiating a logical procedure to re-establish their position, seek assistance from other aircraft or ATC, or plan a precautionary landing.

9.4.5 Instructors should be on the alert for trainees becoming engrossed with error management to the detriment of control of the aircraft or situation (undesired aircraft state). During training, it is likely that most trainees will experience this problem; instructors must identify these situations and guide and direct the trainee when and how to switch to undesired aircraft state management.

> For example, a trainee’s lookout could be degraded due to distraction when fault-finding a simulated aircraft system malfunction.

9.4.6 Instructors may find the following formulae to be an effective tool for teaching TEM and debriefing after a flight:

Threat (T) – Pilot response (R) = Outcome (O)

Either inconsequential or consequential. Inconsequential means that there was no adverse outcome, i.e. there was not an error.

Error (E) – Pilot response (R) = Outcome (O)

Either inconsequential or consequential. This time a consequential outcome may be a further error, or an undesired state.

Undesired aircraft state (U) – Pilot response (R) = Outcome (O)

Either inconsequential or consequential. Once again a consequential outcome may be a further error, or an undesired state.

9.5 Assessing threat and error management

9.5.1 The practical flight standards prescribed in NTS2 of the Part 61 MOS form the starting point for assessing TEM. The basic concept for TEM is simple:

a. identify the threat, error or undesired aircraft state

b. manage the threat, error or undesired aircraft state.

9.5.2 All elements and performance criteria specified in the standard for NTS2 must be met before the candidate can be assessed as competent.

Evidence-based assessment

9.5.3 Assessors must obtain evidence to ensure that TEM is being practiced. Assessors cannot assume that just because a pilot completed a faultless trip, competent TEM was used. The assessor should question the trainee and observe their actions to ensure the evidence is valid, authentic, sufficient and current.

9.5.4 It is likely that an assessor will need to create scenarios on a flight test to allow proper assessment of TEM. A competent pilot is less likely to get into an undesired aircraft state, or would quickly correct an undesired aircraft state (e.g. low approach speed), and it may be necessary for the assessor to artificially create such a circumstance.

For example:

- when approaching a destination aerodrome, simulate a thunderstorm over the airfield to duplicate both a threat and an undesired aircraft state
- simulate a radio failure approaching a non-controlled aerodrome with a CTAF), a VFR approach point or control zone
- simulate precautionary search or forced landing
- simulate instrument or display failure
- use distraction during high workloads.

Formative assessment during flight training

9.5.5 Instructors are required to conduct formative assessments throughout flight training. Instructors will have many more opportunities than an assessor to observe the progress of a pilot's HF and TEM skills. Through the conduct of ab initio training, instructors will observe the trainee’s skills improvement and would develop an understanding of the trainee’s expected rate of learning.

9.5.6 On the basis of formative assessments, the instructor may need to modify the training plan to ensure that the trainee achieves competence. Ultimately, it is the instructor who ensures the trainee meets the final competency standards.

Flight test assessment

9.5.7 Evaluation of competence is more difficult for an assessor as the HF and TEM assessment must typically be determined on the basis of a single test flight. By the time the candidate performs a test flight, they should be able to manage threats and errors—the assessor will need to develop scenarios to ensure adequate assessment.

9.5.8 TEM must be assessed throughout the flight test.

9.5.9 During pre-flight planning, the assessor should observe and question the pilot to gain insight into the countermeasures that the pilot applies to anticipated threats. Scrutiny of flight planning activities will also allow the assessor to monitor some aspects of error management.

9.5.10 Throughout general flying and navigation phases of the test, simulation of systems malfunctions and emergencies will afford the opportunity to evaluate threat, error and undesired state management competencies.

9.5.11 The assessor will evaluate HF competencies at the same time as appraising TEM competencies. Although a flight test involves assessment of a multitude of competencies, with proper planning and some thought, assessors will be able to successfully assess HF and TEM on licence and rating tests. In addition, task-management, role and transfer skills can also be observed and assessed if relevant.

As a practical example, it would be possible to assess a number of elements from the HF and TEM standards in NTS1 and NTS2 if an assessor sets a scenario during the navigation phase that requires a precautionary search. Consider the list below.

- **Lookout**: selection of suitable landing area, weather and terrain avoidance
- **Situation awareness**: perception of present situation and options, action plan, potential hazard awareness, aircraft configuration and performance
- **Decision-making**: decision to conduct precautionary search, assessment of landing area and decision to land
- **Task prioritisation**: work management and prioritisation
- **Communications**: communications with ATC, other aircraft
- **Threat management**: weather, low-level operations, aircraft handling
- **Error management**: recognition of any errors, countermeasures, checklist use
- **Undesired aircraft state**: taking appropriate action to prioritise management of an undesired aircraft state.