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Teaching and Assessing Single-Pilot Human Factors and Threat and Error Management

This publication is advisory but is a CASA preferred method for complying with the Civil Aviation Regulations 1988 (CAR 1988).

It is not the only method, but experience has shown that if you follow this method you will comply with the Civil Aviation Regulations.

Always read this advice in conjunction with the appropriate regulations and Civil Aviation Orders.

Contents

The relevant regulations and other references

- Civil Aviation Safety Regulation (1988) 5.59.
- Australian Transport Safety Bureau Research Report: Limitations of the See-and-Avoid Principle; November 2004.
- Australian Transport Safety Bureau Research Report 2004/0050: Error Management Training, 2004.
- Aviators' Model Code of Conduct (AMCC) I.b Seek excellence in airmanship - available at http://www.secureav.com/Comment-AMCC-I.b-General-Responsibilities.pdf
- Briefings 2000, Edited by R. Amalberti, M. Masson, A. Merritt and J. Paries.
- CASA training resource: Safety Behaviours: Human Factors for Pilots, due for release in October 2008.
- Day VFR Syllabus (Aeroplanes and Helicopters) Issues 4.1 and 3.1 Dated 1 October 2008.
- Defensive Flying for Pilots: An Introduction to TEM by Ashleigh Merritt Ph.D. & James Klinect Ph.D. 12 December 2006.
- Federal Aviation Administration (USA) Advisory Circular 90-48C: Pilots' Role in Collision Avoidance; 18 March 1983.
- 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 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.

Who this CAAP applies to

This Civil Aviation Advisory Publication (CAAP) applies to all pilots, but in particular to Instructors, Approved Testing Officers (ATO) and Flight Operations Inspectors (FOI).

Why this publication was written

This publication is written to provide practical guidance on how to teach and assess single pilot human factors (HF) and threat and error management (TEM) for licenses and ratings, as detailed in the Day VFR Syllabuses.

Status of this CAAP

This is the first CAAP to be written about single pilot human factors and threat and error management.

For further information

Contact Human Factors and Safety Analysis Section Telephone 131 757.

1. Abbreviations

AC	Advisory Circular
AGL	Above Ground Level
AIC	Aeronautical Information Circular
AIP OPS	Aeronautical Information Publication Operations
AOC	Air Operator's Certificate
ATC	Air Traffic Control
ATO	Approved Testing Officer
ATPL	Air Transport Pilot Licence
ATS	Air Traffic Service
ATSB	Australian Transport Safety Bureau
AUW	All Up Weight
CAA	Civil Aviation Authority (of the UK)
CAAP	Civil Aviation Advisory Publication
CAO	Civil Aviation Order
CAR	Civil Aviation Regulations
CASA	Civil Aviation Safety Authority
CASR	Civil Aviation Safety Regulation
CBT	Competency Based Training
CFI	Chief Flying Instructor
CFIT	Controlled flight into terrain
CPL	Commercial Pilot Licence
CRM	Crew Resource Management
EFATO	Engine Failure After Take-off
EGPWS	Enhanced Ground Proximity Warning System
FAA	Federal Aviation Administration (of the USA)
FOI	Flight Operations Inspector
FRMS	Fatigue Risk Management System
FTO	Flying Training Organisation
GA	General Aviation
GAAP	General Aviation Aerodrome Procedures
HF	Human Factors
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
IMC	Instrument Meteorological Conditions
LOSA	Line Operations Safety Audit
NOTAM	Notice to Airman
NTSB	National Transport Safety Board (USA)
OC	Operators Certificate
PIC	Pilot-in-Command
POH	Pilot Operating Handbook
R/T	Radio Telephone
SA	Situation Awareness
SOP	Standard Operating Procedure
SMS	Safety Management System
TAWS	Terrain Awareness and Warning System
TCAD	Traffic Collision Alerting Devices
TCAS	Traffic Alert and Collision Avoidance System
TEM	Threat and Error Management
UFIT	Uncontrolled Flight Into Terrain
USA	United States of America
VFR	Visual Flight Rules

2. Definitions

Airmanship: The consistent use of good judgement and well developed skills to accomplish flight objectives (International Civil Aviation Organization (ICAO) definition**.**

Airspace cleared procedure: Collision avoidance must always be practiced and a procedure followed to ensure a collision does not occur.

This procedure 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: Flight crew actions or inactions that:

- lead to a deviation from crew or organisational intentions or expectations;
- reduce safety margins; and
- increase the probability of adverse operational events on the ground and during flight.

Flight environment: The environment internal and external to the aircraft that may affect the outcome of the flight.

The aircraft’s internal environment may include, but is not limited to, aircraft attitude and performance, instruments, observations, flight controls, equipment, warning and alerting devices, trainee 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: 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, sometimes referred to as 'soft skills', such as lookout, situation awareness, decision making, task 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: Knowing what is going on around you and being able to predict what could happen.

Stakeholder: Any person involved with, or affected by the flying operations to be performed.

Standard Operating Procedure: Any procedure included in the operations manual of an AOC or OC holder.

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** (University of Texas/GAPAN definition for multi-crew/LOSA operations)**:

Events or errors that:

- occur outside the influence of the flight crew;
- increase the operational complexity of the flight; and
- 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 (TEM): The process of detecting and responding to threats and errors to ensure that the ensuing outcome is inconsequential, i.e. the outcome is not an error, further error or undesired state.

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.

3. Introduction

3.1 Why this Civil Aviation Advisory Publication (CAAP) is issued

3.1.1 Most aircraft accidents are linked to deficiencies in human performance. These deficiencies may involve a variety of factors. The factors include poor lookout, situation awareness (SA), decision-making, task organisation, communication, failure to recognise threats to safety and the commission of errors.

3.1.2 Worldwide statistics indicate that about 75% of aircraft accidents are caused by Human Factors (HF) deficiencies. The application of Threat and Error Management (TEM) practices requires the competent use of HF skills. This Civil Aviation Advisory Publication (CAAP) is comprised of two major sections, which are single-pilot HF and TEM.

Each section will provide guidance on teaching and assessing those items. The International Civil Aviation Organization (ICAO) has acknowledged the need for this type of instruction and recommends that HF and TEM should be introduced into all pilot training. A major component of TEM is the application of good HF practices.

3.1.3 On 1 March 2008 the Day Visual Flight Rules (VFR) Syllabuses (Aeroplanes) Issue 4 and (Helicopters) Issue 3 became effective. These documents contained new flight standards for single-pilot HF and TEM. From 1 July 2009, HF and TEM will be assessed on flight tests for the General Flying Progress Test (GFPT), and private and commercial pilot licenses. Additionally, TEM will be examined in all HF aeronautical knowledge examinations for these licences from 1 July 2009. Consequently, instructors will be required to teach HF and TEM skills, and Approved Testing Officers (ATOs) and Flight Operations Inspectors (FOI) will need to assess the standards on licence and rating flight tests.

3.1.4 This CAAP is issued because there is little guidance material available that addresses the subject of teaching and assessing a practical level of HF and TEM. This CAAP will also ensure consistency and standardisation during assessment of these skills.

3.2 What is the intent of this CAAP?

3.2.1 The intent of this CAAP is to provide guidance to instructors about teaching a realistic level of single-pilot HF and TEM. Although these two subjects have a theoretical knowledge component, this document will concentrate on the application of these skills to flying. Up until 1 July 2009, HF will be assessed by written knowledge examinations for each licence level. After that date, these skills will also be assessed during every pilot licence flight test.

4. Single-pilot Human Factors

4.1 What are single-pilot human factors?

4.1.1 The definition used in the Day Visual Flight Rules (VFR) Syllabus for HF is ‘Optimising the relationship within systems between people, activities and equipment’. This is a generic definition that applies to many occupations. So, to contextualise HF for the aviation environment, a clearer explanation is 'Optimising safe flight operations by enhancing the relationships between people, activities and equipment'. This means: achieving the safest outcome for flight operations by the most effective use of people, and what people do when operating in the aviation environment and the equipment they use.

4.1.2 HF are often perceived as 'psychobabble' and the realm of the psychologists, rather than an extension of old-fashioned 'good airmanship'. Also, HF have been associated more with multi-crew and airline operations, rather than general aviation single-pilot activities. The intent of this CAAP is to provide guidance on the incorporation of single-pilot HF into general aviation (GA) flight operations.

4.1.3 The HF Flight Standard C6 in the Day VFR Syllabus titled 'Manage Flight' (Appendix 1 of this CAAP) is comprised of five elements that are:

- maintain effective lookout;
- maintain SA;
- assess situations and make decisions;
- set priorities and manage tasks; and
- maintain effective communications and interpersonal relationships.

4.1.4 Traditionally these items have been associated with airmanship or just plain common sense; and knowledge was gained through experience and a process of 'infusion'. The move by CASA to link airmanship to HF, is in effect, tantamount to bringing science to the often nebulous concept of airmanship**.** In a competency based training (CBT) system a person must be assessed by weighing evidence of an individual's competence against published standards. The evidence must be valid, authentic, sufficient and current. However, before a person can be assessed, **they must be trained**.

4.1.5 This training must be structured and designed to meet competency standards. Therefore, it is essential that flight training organisations develop techniques and material for teaching HF, and those assessors conducting flight tests have methods and tools to assess competency.

4.1.6 Examination of the elements of the 'Manage Flight' standard will show that the standard deals with only a fraction of the content of the Aeronautical Knowledge Syllabus for Human Performance and Limitations in Section 3 of the Day VFR Syllabus. However, when applying these elements, a pilot would be expected to demonstrate knowledge of the physiological, psychological and ergonomic aspects contained therein. For example fatigue, illusion, drug and alcohol management, general health and knowledge of the functions of the eyes and ears are just some areas that would be incorporated into the application of HF practices.

4.2 The link between human factors and airmanship

4.2.1 Previous issues of the Day VFR Syllabus (Aeroplanes) had a section in most of the Assessment Guides called ‘Elements of Airmanship’. Airmanship is not well-defined and means different things to different people. Experience has shown that airmanship was difficult to measure accurately because identifiable performance criteria were not available. By linking airmanship to the five elements of the 'Manage Flight' HF standards it is possible to more accurately determine the competency of a person. For example, it is deemed 'good airmanship' for a pilot on a navigation exercise to continually identify potential forced landing areas along the route.

Thus, as a measure of airmanship, if the pilot is maintaining an adequate lookout, he or she will see potential forced landing areas. By maintaining SA (for example, wind velocity, visibility, aircraft performance) the pilot can apply this information for contingency planning and reinforce the decision-making process if an engine failure occurs. These three aspects of the competency would be observable and assessable.

4.2.2 The purpose of linking HF and airmanship is not to diminish the importance of airmanship, but to make the measurement of it valid and reliable. Later in this CAAP considerable attention will be paid to how the elements of HF and TEM must be assessed to ensure reliable and consistent results.

4.3 Information processing

4.3.1 Pilots are required to continuously process information during flight operations. This function 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 understand how information is processed so that they can apply the principles involved to assist trainees with lookout, SA, decision-making, task management and communications.

4.3.2 Stimuli are collected by the sensors: eyes, ears, nose, taste buds, skin and muscles (feel), and the vestibular senses (balance mechanism), and then this information is passed to the brain. The information is analysed and interpreted (perception or mental model) and is stored in the sensory memory for a short time (one to five seconds) until it is replaced by new information. This is the basis of SA. Failure to receive information or analyse it appropriately, may result in poor SA.

4.3.3 Some factors that may limit the construction of an accurate mental model are:

- **Experience:** lack of experience will lead to the likelihood of not recognising a stimulus;
- **Stress:** may lead to single task fixation;
- **Anomalous perception:** illusions, false signals from other people or the balance mechanism; or
- **Lack of knowledge:** can lead to a false premise.

The acquisition of SA is what all pilots must strive for, and all instructors must teach. The next step to information processing is decision-making.

4.3.4 After the stimuli have been perceived and options developed, a person is in a position to make a decision. A decision is arrived at after the brain determines what to do about the options. This process involves memory to recall stored information that is applicable to the situation. The working or short-term memory holds the 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.

4.3.5 This is a very brief explanation of information processing and the Civil Aviation Safety Authority (CASA) recommends that instructors review the information contained in the references at the beginning of this CAAP and other publications that address the subject in greater depth.

4.3.6 Instructors must be aware of the many limitations that affect information processing and decision-making. Understanding these limitations and applying the information judiciously can assist in the development of a trainee's skills in these disciplines.

Some of the limitations are:

- time limitations;
- mental overload, task mis-management;
- conflicting information;
- expectations and anticipation;
- fatigue;
- insufficient knowledge;
- forgetting;
- emotions; confirmation bias (ignoring information that does not support the decision);
- personality traits;
- failure to seek or apply feedback;
- stress; and
- fixation and destination obsession.

This is not a comprehensive list but it represents some of the factors that an instructor must take into account when dealing with information processing and decision-making.

5. Maintain Effective Lookout

5.1 Teaching an effective lookout

5.1.1 Although the concept that 'you must teach before you assess' is reasonably intuitive, it is often overlooked. One area of concern is how to maintain an effective lookout. Effective lookout means seeing what is 'out there' and assessing the information that is received before making an appropriate decision. Teaching this skill is the domain of the instructor.

5.1.2 Vision is the primary source of information for a pilot. Whether it is aircraft attitude, position, physical hazards or other traffic, what a pilot sees is processed by the brain and used to build up SA. Therefore, it is important for an instructor to effectively train a pilot how to best utilise vision to maintain safety. In this context, lookout must not be thought of as just scanning the skies to locate other traffic; it also involves the internal and external environment of the aircraft. Inside an aircraft vision is used to interpret flight instruments, flight controls and aircraft systems and externally to observe and interpret weather, terrain, aircraft attitude and position.

5.1.3 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, the cleanliness and crazing of windscreens and other physiological and psychological concerns. Failure to address these issues could result in restrictions to visibility.

5.1.4 Workload mis-management can lead to excessive ‘head in the cockpit’ with less time then spent looking outside the aircraft during busy periods. Instructors should warn trainees about all these situations and highlight such incidents when they occur during flight training. For example, instructors should, during flight training, stress the importance of ensuring the windscreen and eyewear is always clean and free of crazing. Trainees must be taught to move their head to see beyond window posts and any other obstructions such as pilots or passengers in the adjacent seat.

5.1.5 **Seeing and interpreting:** 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 and instructors should spend time explaining the logic of observations. 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 before them.

5.1.6 Other examples for consideration are observing and interpreting:

- 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; and
- any other visual cues that contribute to better SA.

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

5.1.8 **Looking for traffic:** A great deal of a pilot's time must be spent looking for and sighting air traffic in order to avoid possible conflict. The concept of see-and-avoid is far from reliable[1]. By employing an effective scanning technique and understanding how to enhance visual detection of other traffic, a pilot is more likely to reduce the likelihood of collision. Size and contrast are the two primary factors that determine the likelihood of detecting other aircraft. Size is the more important parameter in detecting aircraft and as GA aircraft are usually small, the problem of detecting aircraft is exacerbated.

[1] ATSB report Limitations of See-and Avoid Principles – Summary Page vii

Federal Aviation Authority (FAA) Advisory Circular (AC) 90-48C details a scanning technique that involves eye movements in sectors of 10 degrees, of one-second duration per sector. However, scanning a 180 degree horizontal and 30 degree vertical sector would take a minimum of 54 seconds. United States military research found that it takes a pilot 12.5 seconds to avoid a collision after target detection. Therefore, it can be deduced that considerable time gaps exist where traffic may not be detected during a normal scan period. Also, such a structured and disciplined scan technique may be difficult to achieve. Pilots must develop an effective scan that provides maximum opportunity to see traffic.

5.1.9 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. 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.**

5.1.10 In the Day VFR Syllabus at the 'Terminology Used During Assessment' explanation, there is an ‘Airspace Cleared’ procedure that is commonly used. Instructors must ensure that this or a similar practice is always utilised 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.

5.1.11 **Alerted search:** An alerted search is visual scanning when air traffic information has been provided and a pilot is, in effect, told where to look. Air traffic services or other pilots could provide this information. The likelihood of detecting other traffic is eight times greater under these circumstances than during an unalerted scan[2]. Other technologies that provide similar information include transponders, radar (both airborne and ground installations), Traffic Collision Alerting Devices (TCAD) and Traffic Alert and Collision Avoidance Systems (TCAS). In a slightly different circumstance technology such as radar altimeters and Enhanced Ground Proximity Warning System/Terrain Awareness and Warning System (EGPWS/TAWS) can also enhance SA and visual acquisition of hazardous terrain.

[2] ATSC report Limitations of See-and Avoid Principles – Page 12

Although this equipment is not usually fitted to general aviation aircraft it demonstrates how technology can assist lookout and pilots must not disregard the benefits that the engagement of an autopilot can provide to visual scanning. Instructors must demonstrate the benefits of 'alerted searching'; and listening to and interpreting radio transmissions in the circuit area are an ideal opportunity to teach these aspects to a trainee.

5.1.12 CASA strongly recommends reading the Australian Transport Safety Bureau (ATSB) Research Report titled 'Limitations of the See-and-Avoid Principle', which is available at www.atsb.gov.au. This report contains useful information about visual acuity, physiological, psychological and ergonomic factors that affect vision and techniques that may enhance successful pilot lookout.

5.1.13 A summary of maintaining an effective lookout:

- threats are external to the aircraft; so
- the pilot must look outside the aircraft;
- search the available visual field to detect threats that will probably appear in the peripheral vision;
- shift vision directly to the threat and if identified as a collision risk, decide on what effective evasive action to take; and
- manoeuvre the aircraft to mitigate the risk.

5.1.14 Pilots must realise that this process takes time; and HF deficiencies can reduce the chances 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[3]. Nonetheless, effective training can improve the effectiveness of a lookout technique.

[3]ATSB report Limitations of See-and Avoid Principles – Page 3

6. Assessing Effective Lookout

6.1 Assessment in general

6.1.1 Assessment is the process of weighing evidence of an individual's performance against a standard. The evidence used must follow an established set of rules. These are:

- **Validity:** it must cover all the performance criteria for the skills and knowledge of the standard being assessed;
- **Authenticity:** it must be the individual's own work;
- **Sufficiency:** enough evidence must be collected to judge the individual is competent across:
  - all elements and performance criteria;
  - all dimensions of competency; and
- **Currency:** the individual is competent now and meets the current standard.

6.1.2 Only with evidence which follows these rules can an accurate judgment of an individual's competence be made.

6.1.3 The 'dimensions of competency' referred to in the previous paragraph 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 and transfer skills. For example, instead of just assessing a 30° 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).

6.1.4 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.

6.2 Assessing lookout

6.2.1 Instructors and Approved Testing Officers (ATOs) 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, but the ATO must conduct a summative assessment at the conclusion of training to determine if the trainee is competent to be issued a licence. 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'.

6.2.2 There are two main elements to effective lookout. Firstly, to see an ‘object’ and secondly, to react appropriately to what has been seen. An 'object' could range from a speck in the windscreen that is an aircraft at long range, to a large feature like Mount Everest. The next step would be to determine if the object is a threat, and then take mitigating (more commonly known as avoiding action!). These are the processes the assessor is looking for. Just to complicate the process, SA and decision-making are integral to effective lookout.

6.2.3 The three performance criteria relevant to maintaining 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; and
- performs 'airspace cleared' procedure before commencing any manoeuvres.

6.2.4 These three criteria must be achieved for a positive assessment of effective lookout. The application of a systematic scan technique was discussed earlier. The key point is that the trainee covers the field of view from the cockpit, and varies the scan rate to accommodate the threats. Clearly, during periods in congested airspace, extra attention must be paid to other traffic.

6.2.5 Unfortunately 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.

6.2.6 Assessors must 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. Additionally the assessor must monitor the traineee to determine whether any traffic information received by radio transmissions, TCAD or TCAS is reacted to appropriately. Questions such as "Where do you think other traffic will be coming from?" will assist in making this determination.

6.2.7 When operating close to, or in hazardous terrain (mountains, valleys), or periods of reduced visibility, greater effort must be directed outside the aircraft. Again, assessors need to monitor the trainee’s performance and assess any decisions that are made to reduce the chances of collision with terrain or other aircraft. Questioning must be used to determine if the trainee is aware of the current threats, and whether a plan has been made to address them. 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.

6.2.8 The 'airspace cleared' procedure is detailed in the ‘Terminology used during assessment’ section of the Day VFR Syllabuses and in the Definitions section of this CAAP. Importantly, pilots must always clear the airspace around them before manoeuvering the aircraft. This ‘clearing procedure’ must not only be used to locate other aircraft but also any terrain, weather or other hazards that may compromise safety.

6.2.9 Assessors must observe whether the trainee always uses an acceptable procedure and whether when they look, threats are seen and identified.

6.2.10 Given the physiological limitations of see and avoid, at times, other actions (establish vertical separation) may be appropriate in addition to continued lookout. To achieve this, assessors must also closely monitor the airspace and maintain a good lookout so that they can identify any threats that are missed by the trainee. Pilots of slow-flying aircraft must also demonstrate an awareness of the fact that undetected faster aircraft approaching from the rear quarter are a constant risk to flight safety.

6.2.11 Finally, assessors must ensure that trainees are aware of the limitations of vision and take these aspects into account when looking out. These limitations are addressed in the reference material listed at the front of this CAAP, and include such aspects as blind spots, threshold of acuity, accommodation (focusing on an object), empty field myopia, focal traps, visual field narrowing and cockpit workload. However, the bottom line is that pilots must sight any threats to safety or take other appropriate mitigating action.

7. Maintain Situation Awareness

7.1 What is situation awareness?

7.1.1 Simply defined SA is ‘Knowing what is going on around you, and being able to predict what could happen’. A more colloquial term is ‘street smarts’. However, a comprehensive and technical definition proposed by M. R. Endsley in 1988, is: 'The perception of the elements in the environment within a volume of time and space, the comprehension of their meaning and the projection of the status in the near future'. The first definition is generic and applies to life in general, and to most occupations. The second definition is more specific to aviation and is often assigned three levels which are:

- **Level 1:** perception of the current environment;
- **Level 2:** interpretation of the immediate situation; and
- **Level 3:** anticipation of the future environment.

7.1.2 Monitoring and gathering information from both within the cockpit and outside the aircraft achieves perception of the current environment.

7.1.3 This information is collected by the senses; sight, smell, sound, taste, vestibular (balance mechanism in the ear) and somatosensory system (bodily pressure and position nerve receptors -'seat of the pants') (Level 1). Next the process of interpretation (Level 2) leads to making conclusions of what is likely to occur (Level 3). In the context of the Day VFR Syllabus and assessing SA, it is important to understand that this is where SA stops. The next step is situation assessment and decision-making, which will be discussed later in this CAAP.

7.1.4 Historically SA is usually referred to after an event…'the aircraft crashed because the pilot lost SA'. SA is sometimes seen as a cause rather than something that enhances safety.

7.1.5 Some sceptics believe that SA cannot be taught and can only be developed through experience. In a competency based training system, competency must be taught before it is assessed. It is therefore the role of the instructor to teach this skill to trainee pilots.

7.2 Teaching situation awareness

7.2.1 From the moment training begins, a trainee must be made aware of SA, it's importance, and how it will be taught and assessed. In the normal course of flight training, trainees are shown how to monitor flight instruments, aircraft systems and flight attitudes and to manage them appropriately to achieve the desired performance. Instructors need to point out how all this information is applied to develop SA. Additionally, trainees must learn to monitor, gather and interpret appropriate information from both inside and outside the aircraft. This continual monitoring assists perception (mental model) of what is happening and what is likely to happen in the near future, which is the basis of SA. Visual information is the greatest source for building and maintaining SA.

7.2.2 Instructors must also explain to trainees the importance of maintaining a good radio listening watch and, during initial training, explain how interpretation of radio-telephone (R/T) transmissions will enable them to anticipate other traffic and likely air traffic instructions. As training progresses, the instructor must observe the trainee’s performance and if necessary develop scenarios to improve, challenge and assess SA.

7.2.3 In Endsley's definition of SA, the phrase 'within a volume of time and space' is used. Although SA is an ongoing process, it is also bounded by time and space. Instructors need to highlight that there is no value in having SA after the event. Timely information gathering and interpretation is essential to good SA.

For example, if a pilot is in the circuit pattern in a higher speed aircraft and does not realise that the aircraft ahead is slower, it is likely that safe separation between aircraft will be compromised. If the pilot's SA (information gathering and interpretation) was 'behind his or her aircraft's position and performance', the results could be embarrassing, to say the least.

7.2.4 Although the element of competency is titled 'Maintain SA', instructors must also show trainees how to re-establish SA whenever it is lost or degraded. If a trainee is distracted from the task of navigation and becomes uncertain of their position, they must be shown how to regain SA. This process may involve gathering information, reviewing the aircraft heading and airspeed and using this information to find a dead (also deduced) reckoning (DR) position and then fix the aircraft's position.

7.2.5 This procedure is part of navigation training, but it is also a practical demonstration of re-establishing SA. Instructors must monitor a trainee's SA, and if they establish that it is not adequate, must alert the trainee to the fact and give advice on how to correct the problem.

7.2.6 Observation and questioning are the primary means of making a formative assessment of SA. For example, one of the first senses that can degrade during higher workload is hearing. If a trainee (or instructor) is aware they require ATC to readback clearances more often than normal, and/or they are starting to miss radio calls altogether, this could be the first sign of overload and degraded SA. Other obvious signs could be degraded workcyles leading to fixation or tunnel vision in which 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. Alternatively, a late turn onto base leg may indicate that the trainee has realised that the aircraft ahead is slow and that delaying the base turn would mitigate the potential conflict. Questions like "What do you think could happen if….?" or "What would you do if…?" can be used to assess a person's SA. Where SA is determined to be deficient, guidance on how to improve SA should be provided. This type of assessment must be conducted throughout a pilot's training and the results used to modify the training plan when appropriate.

7.2.7 During training, instructors must include SA 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 to verbalise their observations so that the instructor is also informed and able to make assessments. Therefore, they may need to plan how they will conduct SA instruction and possibly create scenarios to enable the learning to occur, it is likely however that, during the normal course of a flight, situations will evolve that present trainees with the opportunity to apply and demonstrate their SA.

7.2.8 A more formal process to ensure SA 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 SA. 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.

7.2.9 It is a duty of care for the instructor to maximise the ability for each trainee to recognise their initial symptoms that may lead to lost SA and to learn how to recover from lost SA. Hence, during the pre-flight brief the instructor could brief the trainee that one of the lesson aims is the for the trainee to formally start to recognise lost SA. One means to try to achieve this is to expose the trainee to a higher workload (initially within the training area) that promotes the loss of SA. As the trainee starts to display signs of degraded performance the instructor should question the trainee on what they are experiencing to assist the trainee to understand what is different about their work cycles, how they are feeling etc in an attempt to make the trainee aware of their indicators of degraded performance. Instructors must give careful consideration to how, when and where they conduct such activities as there is the possibility that workload will be excessivley 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.

8. Assessing Situation Awareness

8.1 Assessment in general

8.1.1 Assessment tools are the resources used by an assessor to gather evidence that a person is competent. A few examples of assessment tools are:

- 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; and
- simulation and scenarios.

8.1.2 These tools must be:

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

8.2 Assessing situation awareness

8.2.1 The most important aspect of assessing SA is to confirm that the pilot’s mental model (or perception) of the environment is accurate. Next, find out what options have been generated and 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. There may be no need to proceed to the next step of making a decision, as SA is an ongoing process and further action only needs to be taken if some of the perceived situations compromise flight safety. For example, if there are thunderstorms in the area but they do not conflict with the intended track, and the adverse effects of the storm will not affect the flight, no action would need to be taken.

However, it would indicate a lack of SA if the pilot did not consider the storms and the associated hazards in his or her planning.

8.2.2 Assessors must determine if SA is being maintained regardless of workload. During periods of high workload it is possible that information may be overlooked. 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 reduction in SA is failure to recall the information received (short-term memory breakdown causing faulty perception) which can lead to failure to take appropriate action.

8.2.3 Equally, assessors must continue to monitor the trainee during periods of low arousal or workload (inactivity) to ensure that an appropriate level of SA 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 SA 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?" or "What is our endurance now?"

8.2.4 In the normal course of a flight test, it is likely that many opportunities to assess SA will occur. Despite this, if an assessor would like to investigate a specific situation, it may be necessary to develop a scenario to test a person's SA. This may require the use of imagination and the practice of good communications skills. For instance, if the assessor wishes to explore the candidate’s ability to maintain SA under a high workload, it may be necessary to create an artificial workload interspersed with distractions. This practice may require some time and thought, but once developed, the scenario could be refined, adapted and used on subsequent flight tests.

8.2.5 Assessors must also observe the appropriate application or otherwise of knowledge, because SA can be adversely affected by a lack of knowledge. For example, unfamiliarity with air traffic separation rules could result in unsatisfactory descent planning when opposing traffic is present. Deficiencies in aircraft systems knowledge could lead to unsatisfactory outcomes; fuel system mis-management would be a typical example. Therefore, if lack of knowledge is a factor causing a pilot's poor SA, then this problem must be recorded and appropriate feedback provided to the trainee. In some cases lack of adequate knowledge and its effect on SA may be enough reason to deem this aspect of a trainee's HF performance as not yet competent.

8.2.6 Finally, assessors may gain an intuitive feeling that a trainee's SA is not up to standard. Feelings cannot be used as a basis for an adverse assessment. Evidence must be obtained to support such claims. If a trainee's SA 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 for assessment. As an aid to diagnosis, the limits of a trainee's SA can be explored through the creation of different scenarios.

9. Assess Situations and Make Decisions

9.1 Teaching situation assessment and decision-making

9.1.1 Although the element is titled 'Assess Situations and Make Decisions' the primary area of interest is the decision-making process. By applying SA, a pilot may arrive at a number of options of 'what could happen', and the next step is to make a decision that achieves the optimum outcome. In daily life people are always making decisions - usually sub-consciously. However, in the aviation environment the decisions that sometimes must be made can have tragic consequences if they are incorrect or inappropriate. 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 correct decisions.

9.1.2 Instructors must mentor trainee pilots through the decision-making process. For example, information sources such as meteorological reports, Notice to Airmen (NOTAMs), radio transmissions, visual observations and knowledge must be highlighted and the trainee encouraged to apply this information to make decisions.

9.1.3 Trainees must be given the opportunity to decide and, if a decision is flawed, the reasons must be clearly explained. 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. 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. By doing this it is possible to assess their progress and then to provide training if it is required.

9.1.4 During flight training there will be many occasions to observe, assess and improve a trainee pilot's decision-making. Instructors must be conscious of when there is a requirement for a trainee to make a decision. They must then determine if it is an acceptable decision that has been made in the time available. If the decisions are defective, it may be necessary to go through the reasoning that was used and point out any faults and 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 had 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.

9.1.5 The timeliness of decisions is another facet of decision-making that instructors must emphasise. During flight training opportunities will arise to gauge and advise a trainee about timely decisions, but there may be a need to create scenarios for the purpose of demonstration. For example, a mishandled landing may require a quick decision to go around to prevent damage to the aircraft. However, the decision to divert because of adverse weather or fuel shortage on a navigation flight may have a 'deadline', by which time a decision must be made. Although the aforementioned decisions must be made in different timeframes, the information process will be the same. That is:

- receive information;
- convert information into reality;
- options are generated;
- options are analysed; and
- a decision is made.

9.1.6 What is also different is that in the second case the situation is dynamic, variable, emotive and subject to bias. These aspects of decision-making make the process more difficult and susceptible to errors.

9.1.7 The result could be an incorrect or 'non' decision. To give a trainee practice at this type of (more complex) decision-making, instructors may have to develop scenarios for different stages of flight training to provide opportunities to practice (and learn) decision-making. Another example to highlight this process is a simulated engine failure versus partial power loss. The first is a relatively clear outcome that requires well rehearsed decisions, checklists and actions to set up a forced landing.

9.1.8 The latter is more subjective, potentially offers more time and provides the trainee with a larger number of options from which to make a final decision. In itself this latter type of scenario is a richer training environment for decision-making as it leaves the trainee with a number of options that can be discussed in the debrief: why the trainee chose a specific course of action, what were their considerations for reaching this conclusion etc.

9.1.9 Furthermore, with increased experience and exposure to known operating conditions and a specific aircraft type, a number of processes become more automated, which is the natural outcome from a positive transfer of learning. For those that have been driving a car for a number of years you probably don’t have to think about what you are doing, your actions are automatic. For others who are learning to drive it is more mechanical and requires much more conscious effort and thought to consider the steps required. This automatic decision-making process will occur within flight training as the trainee becomes more familiar with the local operating environment and the training aircraft. 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 large amounts of spare capacity to deal with any simulated scenarios the instructor may wish to impose, many of which have been previously experienced.

9.1.10 Higher cognitive demands are potentially created any time a trainee experiences something new or unknown,. For example, if the trainee has conducted a large part of their training under conditions of clear weather, even with considerable training experience, the first flight in which they are required to deal with marginal weather in the same training area and aircraft could impose significantly increased workload with the potential to result in degraded performance and higher cognitive demands when making decisions.

9.1.11 Instructors should ensure that training sequences consider trainee familiarity and look for opportunities that expose the trainee to new situations with which they may not be as familiar, in order to consolidate and assess their ability to manage the flight, maintain situational awareness and make sound decisions.

9.1.12 Finally, when teaching decision-making, instructors must remember that individuals have different emotional attitudes, learning rates, thought processes, analytical skills, aspirations and cultural backgrounds which 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 of all experience levels. The bottom line is that pilots must make timely, correct or correctable decisions…if not the consequences could be fatal!

10. Assessing Decision-making

10.1 Assessing decision-making

10.1.1 Normal flight training provides ample opportunities for instructors to conduct formative assessments of decision-making skills, though it may be necessary to create scenarios to analyse a trainee's ability to manage complex decision-making. This process may be more difficult for an ATO to assess on a flight test because of a limited time frame and reduced opportunity. Nevertheless, a pilot's decision-making must be assessed as competent on a General Flying Progress Test (GFPT) or a licence flight test.

10.1.2 A good starting point for assessors is Element Three of Flight Standard Unit C6, Manage Flight. The pilot must recognise that a decision has to be made. The ongoing process of acquiring SA, if working correctly, will provide the pilot with a perspective from which any number of options can be derived and ultimately the best action to follow. Problems must be identified and the assessor will use observation and questioning to determine the facts. Next, the problems must be analysed and solutions (options) proposed. This procedure 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. Using this information a decision can be made. Assessors must ensure the decision is the optimal one and is implemented effectively in the time available. The pilot then must monitor progress against their plan and re-evaluate as circumstances change, even if it is to confirm the desired outcome.

10.1.3 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 a point worth considering would be to ensure the pilot recognised the mishandled landing soon enough and did not delay the recovery action. However, 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, but could be modified at a later time.

10.1.4 It is acceptable 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 (operational requirements, insufficient information available or weather).

10.1.5 An assessor must also observe a pilot to determine if they are able to manage the factors mentioned in paragraph 4.3.3, which 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. ATOs and flight 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 ensure safe flight. While it is a challenge to assess a pilot's decision-making competence on a flight test, if an ATO prepares for the test by creating scenarios to evaluate more complex decisions, the task of assessing a pilot’s decision-making competency will be achievable.

11. Set Priorities and Manage Tasks

11.1 Teaching how to set priorities and manage tasks

11.1.1 The adage 'aviate, navigate and communicate' is probably the basis of prioritisation and task management. Many people have minds that are well organised and logical, but some do not…and these people may need guidance and direction to operate efficiently in a confined and, at times, demanding and busy environment. 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.

11.1.2 The brain is a single-channel processor (linear) and 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. 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. Proficiency in these operations will make workload management easier.

11.1.3 As a further example, 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.

11.1.4 During flight training trainees must be encouraged to prioritise tasks to ensure that the important and safety critical actions are dealt with first. Referring to the adage at the beginning of this section 'aviate' or maintaining control of the aircraft must be a pilot's first concern. One of the cornerstones of managing an undesired aircraft state in TEM (see paragraph 14.3.5 of this CAAP) is timely correction of the undesired state rather than concentrating on why an error may have occurred. This is prioritising correctly. Instructors must alert trainees when they have incorrectly prioritised and offer a more appropriate solution.

11.1.5 A question like "Is there anything else we should/could be doing now?' or "What is more important?" may prompt a pilot to prioritise correctly. Another practice that instructors must stress is good organisation in the cockpit. This is particularly applicable when navigating. Thoughtful selection and storage of charts, flight plans, computers, publications and writing implements should result in more precise and simpler navigation. In addition, achieving an appropriate work rate is critical during this phase of flight. Instructors must remember that rationalising the workload will ensure more efficient task completion which in turn must result in greater safety.

11.1.6 One of the keys to workload management is the ability to recognise factors that adversely affect a pilot's ability to operate efficiently. A non-comprehensive list of factors that can reduce a pilot's work efficiency follows:

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

11.1.7 Although this is not a comprehensive list, instructors must be aware of these types of factors and look for these deficiencies in their trainees. Once the weaknesses have been identified, instructors must advise trainees of methods of developing and applying countermeasures or strategies to manage these inhibiters to efficient workload management.

11.1.8 A final word on prioritising tasks. Whether it is a minor or major problem that is being encountered it must always be remembered that the first priority is survival. To survive requires maintaining control of the aircraft and/or the situation. When dealing with a major system malfunction at the same time as Air Traffic Control (ATC) is requesting information the choice is simple: deal with the malfunction first. Unfortunately, a pilot's response to 'authority' can dominate and time could be wasted with a long communication with ATC. This would be an example of incorrect prioritisation if it happened in a remote area, in bad weather, when uncertain of position, and dealing with a worried or annoyed passenger. This would be an unenviable position - nevertheless the pilot must think 'survival' and prioritise actions accordingly. During flight training an instructor must develop and use appropriate scenarios to provide valuable and potentially lifesaving guidance.

11.2 Assessing prioritisation and task management

11.2.1 An assessor must be able to assemble evidence of competence in setting priorities and managing tasks on a flight test by simply observing a pilot's work pattern and task completion. The danger is that such assessment is prone to subjectivity. Valid evidence must be obtained. For example, if a pilot is told by ATC to "Expedite take-off", and does so before completing pre-take-off checks then the pilot could be reasonably deemed as not competent at prioritising tasks. The pilot will not have met the 'Take-off Aeroplane' standard and could compromise safety. This is valid evidence. The correct action would be to advise ATC that the pilot was not ready to take-off.

11.2.2 When assessing task management the ATO must be looking for competent completion of a task in the time available. In particular, the assessor would be seeking confirmation that the pilot can manage multiple tasks (not an excessive amount) in a logical order. It may be necessary to create scenarios to fulfil this requirement.

11.2.3 Element 6.4 of the Manage Flight standard must be used to make a judgment about a pilot's competence at setting priorities and managing tasks. The assessment process will require detailed observation, information gathering and questioning because there will be a need to determine how a candidate’s mind is functioning while managing tasks. By obtaining this information and combining it with observations it is possible to judge a pilot's ability to competently set priorities and manage tasks.

12. Maintain Effective Communications and Interpersonal Relationships

12.1 Teaching effective communications and interpersonal relationships

12.1.1 Communication is a two-way process; it involves the accurate transmission, receipt, and interpretation of information. Communication is not limited to the radio-telephone; it also involves direct verbal and non-verbal exchanges. ‘Effective interpersonal relationships’ is a topic that may seem to be 'touchy-feely', but involves being able to get a positive or helpful, rather than negative or obstructive, response from individuals or groups that a pilot deals with. A major component of interpersonal relationships is effective communication.

12.1.2 The first requirement for communication is a common language, which in Australia is the English language and 'aviation English'. 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. There may be 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 adequately.

12.1.3 Instructors must monitor and develop a pilot’s communication skills throughout flight training, pointing out when communications are confusing, ambiguous or out of context. The next step would be to suggest a way to modify and improve the communication (“Raise the nose” may result in a backwards head movement rather than increasing the aircraft’s nose attitude/angle of attack). Extra care is required when teaching trainees who do not have English as a first language.

12.1.4 The instructor must be precise with their use of language and be careful with slang and colloquial speech. During flight training there will be many opportunities to observe and judge the effectiveness of a trainee's communication skills.

12.1.5 It is important to make the trainee aware of the consequences of poor communication skills and for them to be self-critical of their own performance. Emphasise the safety issues that can result through mis-communication. Instructors must refer to Unit C1-'English Communication in the Aviation Environment' standard in the Day VFR Syllabus for guidance.

12.1.6 The intent of the 'maintain effective interpersonal relationships' component of the element is to make pilots aware of the need to always foster positive and cooperative relationships with persons involved with or affected by the flying operation to be performed.

12.1.7 Persons affected could be an instructor, refueller, maintenance engineer, an air traffic controller or the farmer who owns the airfield where the aircraft will land; and the pilot must be able to elicit positive reactions from them. This does not mean that instructors must be teaching manners or how to be nice, but they must provide guidance on achieving positive outcomes. The flight instruction will involve observation of the pilot's interaction with others and the results of these activities.

12.1.8 If the instructor detects inadequacies, then the trainee must be advised and given strategies to improve their performance. Some personal characteristics that must be evaluated are:

- tone and phrasing of communications;
- openness;
- reaction to criticism;
- aggressiveness or lack of assertion;
- willingness to listen;
- respect for others;
- arrogance; and
- use of authority.

12.1.9 This is not an all-encompassing list, but it highlights some of the positive and negative characteristics that, if applied inappropriately, could cause an adverse response from others. As an example, an aggressive, brusque or demanding tone of voice during an R/T transmission could garner an adverse response from an air traffic controller, 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.

12.1.10 As a practical example, during a multi-leg navigation flight that involves refuelling, an instructor could watch the interaction between the trainee and fuel agent. The aim of the trainee would be to complete the operation with minimum delay or safety risk. Late arrival of either the aircraft or fuel agent could cause inconvenience (and annoyance), and would present an ideal opportunity to observe how the trainee managed in such a situation. If the operation was completed without any problems, there would be no need to take any action, other than to make a positive comment.

12.1.11 However, if the instructor detected problems with the trainee’s interaction with the fuel agent, guidance must be given to the trainee. This type of interaction could involve communication, personality, cultural (overseas trainee) or even financial issues that must be managed. 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.

12.2 Assessing effective communications and interpersonal relationships

12.2.1 The first performance criteria for the element is: 'Establishes and maintains effective and efficient communications and interpersonal relationships with all stakeholders to ensure a safe outcome of the flight’. 'Establishes' means that the pilot first make the effort to communicate or interact. The behavioural markers that the instructor may look for could include tone of voice, non-aggressive approach, willingness to listen, body language (when applicable) and assertiveness. These markers apply both to communications and interpersonal relationships and must be assessed by observing the reaction of the person receiving the message or attention.

It is important to remember that when making a judgment of a trainee, an instructor must be able to state the evidence used. For example, "You did not communicate competently because the air traffic controller had to ask you twice for clarification of your request", or "You got into a shouting match with the engineer when discussing the aircraft's serviceability". For efficiency an instructor must look for brevity of language, use of standard phraseology or whether the trainee was able to quickly elicit a positive reaction from the person with whom they were dealing.

12.2.2 The second performance criteria for the element is: 'Defines and explains objectives to applicable/involved stakeholders'. This could be observed by 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. These communication and interpersonal skills should not be limited to the cockpit and instructors must make a holistic assessment of this aspect of HF performance.

12.2.3 The third performance criteria for the element is: 'Demonstrates a level of assertiveness that ensures the safe completion of the flight'. This infers that the level of assertiveness is important. At the end of a pilot's flying training she/he must be competent, skilled and knowledgeable enough to perform the task of pilotage at the private or commercial pilot level. To achieve this standard will require assertiveness by the pilot to ensure operational safety is maintained during the completion of a task. Assertiveness or insistence could involve communications or actions. For example, if an air traffic clearance 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.

12.2.4 The fourth performance criteria for the element is: 'Encourages passengers to participate in and contribute to the safe outcome of the flight'. This would be impossible to observe without simulation or questioning, as passengers cannot be carried on a flight test. For example, questions could be asked such as, "What would you include in your passenger briefing to encourage passengers to participate in flight safety?" An assessor must expect the trainee to mention such aspects as sighting hazards or other aircraft or if they see anything they think is wrong with the aircraft, they must advise the pilot. This aspect of the assessment must complement the 'Manage Passengers and Cargo' competency, which must also be assessed.

12.2.5 In summary, the competent application of HF skills should ensure the safety of flight. As noted previously research shows that 75% of accidents are caused by HF inadequacies. Therefore, instructors must recognise and appreciate the importance of HF skills and make them an integral part of training; and assessors must be prepared to incorporate HF into flight tests. This will require diligence in the preparation of training plans by instructors and assessment planning by ATOs. The application of good HF is integral to, and inseparable from, competent TEM which is covered in the next section of the CAAP.

13. Threat and Error Management

13.1 Threat and Error Management

13.1.1 As there is little material published about the principles and application of TEM, this CAAP is intended to provide some background on the subject and explain the concept of TEM in the general aviation environment.

13.1.2 TEM was developed by the University of Texas and derived from observations on flight decks during Line Operations Safety Audits (LOSA). Although some pilots may see TEM as just another fad with a new range of buzz words, TEM is in reality the formalisation of what many would call common sense.

13.1.3 Before discussing TEM specifically, the use of the word 'manage' needs to be clarified. Throughout the Day VFR Syllabus the term ‘manage’ or ‘management’ is used and defined. The same definition 'plan, direct and control an operation or situation' is used in this CAAP.

13.1.4 When assessing competency standards that involve management, evidence must be sought to ensure that a plan is developed, implemented (direction) and re-evaluated (control), throughout the activity.

13.1.5 The application of this skill when managing threats and errors involves a plan for identifying the threat or error and implementing countermeasures 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 the hazards, in accordance with checklist or approved Flight Manual/POH procedures, SOPs or other acceptable means. Control would involve monitoring the progress of events to ensure a safe outcome. The last step may require amendment of plans and actions. Management would also be involved in correcting an undesired aircraft state.

13.1.6 TEM is an operational concept applied to the conduct of a flight that is more than the traditional role of airmanship as it provides for a structured and pro-active approach for pilots to use in identifying and managing threats and errors that may affect the safety of the flight. To achieve this TEM uses many tools, including training, SOPs, checklists, briefings and single-pilot HF principles.

13.1.7 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.

13.1.8 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.

13.1.9 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 concept applied to managing and maintaining the safety of a particular flight. The following sections provide a brief introduction to assist General Aviation (GA) pilots and trainers to apply the principles of TEM to their own operations.

13.2 Threats

13.2.1 The TEM model as originally developed by the University of Texas, and used by the Guild of Air Pilots and Navigators (GAPAN) defines threats as external events or errors that:

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

13.2.2 They may be anticipated, unexpected or they may be latent within the operational system.

13.2.3 Whilst this original definition is based on that obtained from the University of Texas LOSA program, an expanded definition proposed by CASA, which is equally applicable to GA is 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 any influence that promotes opportunity for pilot errors*. Generally, threats are considered to be external (e.g. bad weather) or internal i.e. those the pilot or trainee bring to the operation (e.g. fatigue, complacency). This concept expands on the original definition of threat and considers the psychological state of the pilot and the limitations they may bring with them to the aircraft on any given day. For example, increased levels of fatigue could result from a young child that is not sleeping well.

13.2.4 The threat (in this case fatigue) has the capacity to promote opportunity for increased errors, degraded SA, and poor decision-making due to physiological and/or psychological impairment.

13.2.5 Pilots need good SA 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; or
- the condition of the aircraft.

13.2.6 Some typical internal threats to GA operations might be:

- fatigue;
- complacency;
- over or under confidence;
- lack of flight discipline;
- hazardous behaviour;
    - impulsiveness;
    - machoism;
    - invulnerability;
    - resignation; and
    - anti-authority or
- lack of recency and proficiency;

13.3 Errors

13.3.1 The TEM model accepts that it is unavoidable 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; and
- increase the probability of adverse operational events on the ground and during flight.

They can be classified as handling errors, procedural errors or communications errors. External and internal threats may lead to errors on the part of the pilot.

13.3.2 While errors may be inevitable, safety of flight requires that errors that occur are identified and managed before flight safety margins are compromised. Typical errors in GA flight might include:

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

13.4 Undesired Aircraft State

13.4.1 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.

13.4.2 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, such as loss of control, failure to achieve optimum performance or uncontrolled flight into terrain occurs.

13.4.3 Examples of errors and an associated undesired aircraft states in GA aircraft might be:

- mis-management 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); or
- flying a final approach below appropriate threshold speed (error) resulting in excessive deviations from specified performance (state).

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

- **planning countermeasures:** including flight planning, briefing, and contingency planning;
- **execution countermeasures:** including monitoring, cross-checking, workload and systems management; and

- **review countermeasures:** including evaluating and modifying plans as the flight proceeds, and inquiry and assertiveness to identify and address issues in a timely way.

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

13.5 TEM application

13.5.1 Threats and errors occur during every flight as demonstrated by the considerable database that has been built up in observing threats and errors in flight operations worldwide through the LOSA collaborative. One interesting fact revealed by this programme is that around 45% of flight crew errors go undetected or are not responded to by crew members.

13.5.2 TEM must be integral to every flight, and includes anticipation of potential threats and errors as well as planning of countermeasures. Also included must be the 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, terrain etc).

13.5.3 The following summary is intended to assist pilots to apply TEM in GA operations:

Pre flight:

- just as you perform a number of tasks on a regular basis in preparation for flight (e.g. interpreting NOTAMs and MET information, checking fuel contents), pilots must include TEM as part of routine pre-flight planning and preparation;

- a few minutes (or more) spent on the ground 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 your workload airborne as you may have already partially prepared yourself with how to deal with those threats and errors.

In flight:

- brief (self-brief and passengers) planned procedures before take-off and prior to commencing each significant flight sequence (eg. approach to an unfamiliar aerodrome, low-level operations etc);
- include anticipated threats and countermeasures in briefings;
- continuously monitor and cross-check visual and instrument indications and energy state to maintain situation awareness;
- prioritise tasks and manage workload to avoid being overloaded, and to maintain SA;
- identify and manage threats and errors;
- when confronted by threats and/or errors a priority is to ensure the aircraft is in an appropriate configuration to optimise your 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; and;
- 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 your threats, errors, and/or undesired aircraft states and discuss them with more experienced pilots to assist with the development of improved TEM strategies.

14. Teaching TEM in the GA Environment

14.1 Teaching threat management

14.1.1 In the TEM model, threats can be defined as 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 errors. Instructors must understand that threats (and errors) are a part of everyday aviation operations and must be managed. First, instructors must stress to trainees that threats fall into two main groupings: anticipated and unexpected.

14.1.2 However, there is a third group called latent threats. These threats may not be observable by pilots involved in flight operations and may need to be uncovered by safety analysis.

14.1.3 Some examples of latent threats are optical illusions (approaches to sloping runways), poor manuals, or equipment design faults (landing gear and flap levers located too close to each other) or unnecessary pressure to get a job done. Therefore, it is incumbent upon instructors to show trainees how to detect the three groups of threats, and the steps to take to mitigate these potential hazards.

14.1.4 Detection of anticipated threats relies mainly on knowledge and experience. As pilots learn (and gain experience) they will be able to predict where threats may occur. For example, being able to obtain and interpret a meteorological (MET) report will allow a pilot to prepare for adverse weather. Instructors should monitor and guide trainees through the use of MET reports and the means of avoiding unfavourable conditions. Likewise, experience assists pilots to understand more about their own capabilities and limitations.

14.1.5 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. Prior to each flight, the instructor should discuss the proposed flight and ask the trainee to identify the obvious threats to safety. During the early stages of training the instructor should not necessarily expect a comprehensive list of threats, but as the training progresses, a trainee’s level of knowledge is expected to improve. Much will depend on the instructor’s approach to TEM training.

14.1.6 Some examples of threats that an instructor must be aware of with a new trainee (and which the instructor should inform the trainee about) are:

- conduct in the vicinity of aircraft on the ground;
- performance of competent pre-flight inspections;
- correct adjustment of flight controls and harness restraint;
- a clear handover/takeover procedure;
- ensuring propeller clearance before engine start; and
- listening before transmitting on the radio.

And the aircraft has not even moved yet!

14.1.7 In a very short time, instructors should expect a trainee to manage these identified threats as a matter of course. As the trainee gains knowledge, experience and skills, they will learn to manage all the threats that develop. Remember: a mismanaged threat could lead to an error, which may result in an undesired aircraft state.

14.1.8 Unexpected threats are more likely during flight operations and must be well managed. These threats are generally managed by applying skills and knowledge acquired through training and flight experience. Typically, a practice engine failure or simulated system failure are methods of training a pilot to manage unexpected threats.

14.1.9 Knowledge and repetition prepare a trainee to mitigate these events, but an instructor should link such training activities to the threat management component of TEM. Again, if errors occur during these sequences, they must be highlighted and advice provided to reduce their effects. During flight training the instructor must identify unexpected threats such as incorrect ATC instructions, traffic hazards or adverse weather and point them out to the trainee should they fail to identify them.

14.1.10 Then it is important to question the trainee to see what steps they would take to mitigate the threats, ensuring that the action is completed in the time available. Instructors may have to develop scenarios or 'what if' questions, to further test the trainee.

14.1.11 Threats are also categorised in the TEM model into environmental and organisational threats. Environmental threats occur outside the control of the aircraft operator due to the environment in which the operations take place and have to be managed by the pilot in the available time. Some examples would be:

- **Weather:** turbulence, ice, wind;
- **Aerodromes:** congestion, complex surface navigation, poor signage/markings;
- **ATC:** non-standard phraseology, complex clearances, poor English language; and
- **Terrain:** mountains, valleys, built up areas.

14.1.12 On the other hand, organisational threats (which are often latent) can be controlled by the operator or reduced by aviation organisations putting in place mitigators such as safety management systems (SMS), fatigue risk management systems (FRMS), standard operating procedures, checklists, ground handling measures (marshallers) or operational health and safety procedures. However, the last line of defence will be the pilot.

14.1.13 Some examples or organisational threats in GA are:

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

14.1.14 Threats, whether environmental or organisational, must be managed or an undesired aircraft state, incident or accident may result.

14.2 Teaching error management

14.2.1 The acknowledgement that errors will occur has changed the emphasis in aviation operations to error recognition and management rather than error prevention.

14.2.2 Notwithstanding the fact that under ideal circumstances, errors will not occur, aviation is not an ideal situation and pilots must be trained to manage errors. So once again responsibility falls on the instructor to conduct the training. Rather than just pointing out errors as they occur, instructors must show trainees how to minimise the chances of errors happening, and then if they do happen, recognise the fact and implement strategies to manage them. Error management could be something as simple as "Oops, I should not have done **that**, I will do **this** now". If the subsequent actions are appropriate then the error has been mitigated.

14.2.3 The important point is that the error was recognised by the pilot, acknowledged and corrective action was taken. Instructors must afford the trainee the opportunity to recognise a committed error rather than intervening as soon as they see an error committed, they must wait (if time allows) to see if the error is identified by the trainee. If it is not, this is a deficiency on the part of the trainee, and the instructor should then analyse why the error happened, why it was not recognised and how to prevent future occurrences.

14.2.4 In the TEM model, errors must be observable and are classified as aircraft handling, procedural or communications errors. The point of reference that defines these classifications is the 'primary interactions'.

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

14.2.5 A question that instructors may also ask themselves is "Is it a communications error if I fail to get the message across to a trainee during training?" Instructors must be familiar with these classifications so they can identify a trainee’s weakness and provide guidance to address the deficiencies.

14.2.6 When teaching TEM, instructors must emphasise the application of HF skills (discussed earlier in this CAAP). The elements of the 'Manage Flight' standard are integral to, and inseparable from, TEM practices. If deficiencies are identified in any of the HF skills, they must be rectified or general flying and TEM competency will be compromised. The LOSA archive shows that 45% of observed errors that occur in airline operations are not detected. Considering that these statistics represent multi-crew operations, single-pilot GA operations are probably more susceptible to errors. Therefore, the mitigators that are in place such as checklists, SOPs and aviation regulations must be applied and complied with. Whether a checklist is used from memory or read, instructors must accept no deviations to its application and terminology. The same principles apply to following SOPs, regulations and other authoritative documentation such as flight manuals. All of those publications are provided to enhance safety (by helping reduce errors) and instructors must continually stress their importance.

14.3 Teaching undesired aircraft state management

14.3.1 Unmanaged or mismanaged threats or errors may result in an undesired aircraft state. Ideally, pilots must be taught to manage threats and errors before an undesired aircraft state develops. During flight training, instructors will be dealing with many undesired aircraft states as trainees develop their flying skills.

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

14.3.3 Some typical examples would be:

- taxiing too fast;
- too fast or slow on final approach; or
- inability to maintain altitude or heading during straight and level flight.

14.3.4 Although such examples would normally be classified as undesired aircraft states when committed by a qualified pilot, 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.

14.3.5 A critical aspect that instructors must teach is the switch 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 old adage 'aviate, navigate and communicate (first)'. It is essential for a pilot to recognise when an undesired state must be managed, and then to 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. Instructors must be on the alert for trainees becoming engrossed with error management to the detriment of control of the aircraft or situation (undesired aircraft state). For example, a trainee's lookout could be degraded due to distraction when fault finding a simulated aircraft system malfunction. 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.

14.3.6 Finally, an effective tool for both teaching TEM and debriefing after a flight is to use a simple timeline with the following formulas:

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.

UAS (U) - Pilot response (R) - Outcome (O):

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

15. Assessing TEM in the GA Environment

15.1 Assessing TEM

15.1.1 The starting point for assessing TEM is the flight standard at Appendix 1 of this CAAP. The basic concept for TEM is simple:

- identify the threat, error or undesired aircraft state; and
- manage the threat, error or undesired aircraft state.

Although this sounds uncomplicated, assessors must obtain evidence (remember the rules of evidence) to ensure that TEM is being practiced. Assessors cannot assume that just because a pilot completed a faultless trip, competent TEM was used.

15.1.2 Trainees must be questioned and their actions observed to ensure the evidence is valid, authentic, sufficient and current. On a flight test it is likely that scenarios will need to be created to allow proper assessment of TEM. A competent pilot on a flight test is less likely to get into an undesired aircraft state or would quickly correct an undesired aircraft state (eg low approach speed) and it could 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 entering a General Aviation Aerodrome Procedures (GAAP), VFR approach point or control zone;
- simulate precautionary search or forced landing;
- simulation of instrument or display failure;
- the use of distraction during high workloads; and
- many other innovative scenarios.

Of course, all the conditions specified in the standard for TEM must be met before the candidate can be assessed as competent.

15.1.3 Instructors are required to conduct formative assessments throughout flight training. Additionally, instructors will have many more opportunities than an assessor to observe the progress of a pilot's HF and TEM skills. Because they conduct ab initio training instructors will observe the improvement of these skills and must have a good idea of the trainee's expected rate of learning. The results of these formative assessments may require that changes to the training plan are developed to ensure that competence is achieved. Ultimately it is the instructor who ensures the trainee meets the final competency standards.

15.1.4 The task is more difficult for the assessor in that the HF and TEM assessment will be made on a test generally involving only one flight. Remember that at this stage of the training the candidate must be able to manage threats and errors, so scenarios will have to be developed to ensure adequate assessment. The assessment must be holistic with TEM being assessed from the very beginning of the test.

15.1.5 During the pre-flight planning stages, observation and questioning will give the assessor insight into the countermeasures that a pilot applies to anticipated threats. Scrutiny of flight planning activities will also allow the assessor to monitor some aspects of error management.

15.1.6 Throughout the 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. Hand-in-hand with TEM assessment, HF competencies will also be open to appraisal. In fact it would be impossible to assess TEM without looking at the HF components. Although a flight test involves the 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.

15.1.7 As a practical example, it would be possible to assess a number of elements from the HF and TEM standards 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;
- **SA:** 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.

It can be seen from any one activity that it is possible to assess a number of competencies. In addition, task-management, role and transfer skills can also be observed and assessed if relevant.

15.1.8 Single-pilot HF and TEM are arguably a pilot’s most important skills. By applying them judiciously it is more that likely that a pilot will have a long and safe flying career. Accordingly, assessors must take on the ‘new’ notion of assessing these competencies and prepare themselves to do the job well.

APPENDIX 1 to CAAP 5.59-1(0)

Table 1: Generic Range of Variables

Range of Variables

- Performance standards are to be demonstrated in flight in an aircraft of the appropriate category equipped with dual flight controls and electronic intercommunication between the trainee and the instructor or examiner.
- Consistency of performance is achieved when competency is demonstrated on more than one flight.
- Flight accuracy tolerances specified in the standards apply under flight conditions from smooth air up to, and including light turbulence.
- Where flight conditions exceed light turbulence appropriate allowances as determined by the assessor may be applied to the tolerances specified.
- When minimum descent altitudes (MDA) and not below or above heights are specified, the tolerance for straight and level height must be adjusted to (+100 –0 ft) or (+0 –100 ft) as applicable.
- Infrequent temporary divergence from specified tolerances is acceptable if the pilot applies controlled corrective action[1].
- Units and elements may be assessed separately or in combination with other units and elements that form part of the job function.
- Assessment of an aircraft operating standard also includes assessment of the threat and error management and HF standards applicable to the unit or element.
- Standards are to be demonstrated while complying with approved checklists, placards, aircraft flight manuals, operations manuals, standard operating procedures and applicable aviation regulations.
- Performance of emergency procedures is demonstrated in flight following simulation of the emergency by the instructor or examiner, except where simulation of the emergency cannot be conducted safely or is impractical.
- Assessment must not involve simulation of more than one emergency at a time.
- Private pilots must demonstrate that control of the aircraft or procedure is maintained at all times but if the successful outcome is in doubt, corrective action is taken promptly to recover to safe[2] flight.
- Commercial and air transport pilots must demonstrate that control of the aircraft or procedure is maintained at all times so that a successful outcome is assured.
- The following evidence is used to make the assessment:
  - The trainee's licence and medical certificate as evidence of identity and authorisation to pilot the aircraft.
  - For all standards, the essential evidence for assessment of a standard is direct observation by an instructor or examiner of the trainee's performance in the specified units and elements, including aircraft operation and threat and error management.
  - Oral and written questioning of underpinning knowledge standards.
  - Completed flight plan, aircraft airworthiness documentation, appropriate maps and charts and aeronautical information.
  - Aircraft operator's completed flight records to support records of direct observation.
  - Completed achievement records for evidence of consistent achievement of all specified units and elements of competency.
  - The trainee's flight training records, including details of training flights and instructors comments, to support assessment of consistent achievement.
  - The trainee's log book for evidence of flight training completed.
- For licence and rating issue:
  - Completed application form, including, licence or rating sought, aeronautical experience, Chief Flying Instructor (CFI) recommendation and the result of the flight test.
  - Completed flight test report indicating units and elements completed.
  - Examination results and completed knowledge deficiency reports.

[1] Timely and coordinated use of controls, without abrupt manoeuvring is made to achieve specified performance.
[2] Means that a manoeuvre or flight is completed without injury to persons, damage to aircraft or breach of aviation safety regulations, while meeting the requirements of the Manual of Standards Part 61

Unit C6: Manage Flight – Flight Standard

Unit Description: Skills, knowledge and behaviour to plan, direct and control all aspects of a flight.

Element	Performance Criteria
C6.1 Maintain effective lookout	• 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 of traffic. • Performs airspace-cleared procedure before commencing any manoeuvres.
C6.2 Maintain situation awareness	• Monitors all aircraft systems using a systematic scan technique. • Collects information to facilitate ongoing system management. • Monitors flight environment for deviations from planned operations. • Collects flight environment information to update planned operations.
C6.3 Assess situations and make decisions	• Identifies problems. • Analyses problems. • Identifies solutions. • Assesses solutions and risks. • Decides on a course of action. • Communicates plans of action - if appropriate. • Allocates tasks for action – if appropriate. • Takes actions to achieve optimum outcomes for the operation. • Monitors progress against plan. • Re-evaluates plan to achieve optimum outcomes.
C6.4 Set priorities and manage tasks	• Organises workload and priorities to ensure completion of all tasks relevant to the safety of the flight. • Puts the safe and effective operation of the aircraft ahead of competing priorities and demands. • Plans events and tasks to occur sequentially. • Anticipates critical events and tasks to ensure completion. • Uses technology to reduce workload and improve cognitive and manipulative activities. • Avoids fixation on single actions, tasks or functions.
C 6.5 Maintain effective communications and interpersonal relationships	• Establishes and maintains effective and efficient communications and interpersonal relationships with all stakeholders to ensure the safe outcome of the flight. • Defines and explains objectives to applicable/involved stakeholders. • Demonstrates a level of assertiveness that ensures the safe completion of the flight. • Encourages passengers to participate in and contribute to the safe outcome of the flight.

Range of Variables
• All flight and ground operations • Interactivity with stakeholders • Single- or multi-engine aircraft.

Underpinning Knowledge
N/A

Unit C7: Threat and Error Management – Flight Standard

Unit Description: Skills, knowledge and behaviour to recognise and plan, direct and control threats and errors.

Element	Performance Criteria
C7.1 Recognise and manage threats	• Identifies relevant environmental or operational threats that are likely to affect the safety of the flight. • Develops and implements countermeasures to manage threats • Monitors and assesses flight progress to ensure a safe outcome; or modifies actions when a safe outcome is not assured.
C7.2 Recognise and manage errors	• Applies checklists and standard operating procedures to prevent aircraft handling, procedural or communication errors and identifies committed errors before safety is affected or aircraft enters an undesired aircraft state. • Monitors aircraft systems, flight environment and crewmembers, collects and analyses information to identify potential or actual errors. • Implements countermeasures to prevent errors or takes action in the time available to correct errors before the aircraft enters an undesired aircraft state.
C7.3 Recognise and manage undesired aircraft state	• Recognises undesired aircraft state. • Prioritises tasks to ensure management of undesired aircraft state. • Manipulates aircraft controls or systems, or modifies actions or procedures to maintain control of the aircraft and return to normal flight operations, in the time available.

Range of Variables

- All flight and ground operations.

Underpinning Knowledge

- Explain the principles of threat and error management detailing a process to follow to identify and mitigate or control threats and errors during multi-crew operations.
- Give an example of how an undesired aircraft state can develop from an unmanaged threat or error.
- What aspects of multi-crew operations can prevent an undesired aircraft state?
- Explain how the use of checklists and standard procedures prevents errors.
- Give an example of a committed error and how action could be taken to ensure safety of flight.
- Explain how prioritising and managing workload can reduce the commission of errors.
- Explain how establishing and maintaining interpersonal relationships can ensure safe flight.
- Explain how checklists and standard operating procedures can help to recognise, prevent and/or correct errors.