Australian Government
Civil Aviation Safety Authority

Civil Aviation Advisory Publication

January 2007

AEROBATICS

This publication is only advisory but it gives a CASA preferred method for complying with the **Civil Aviation Regulations 1988 (CARs)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.

Contents

The relevant regulations and other references

- Civil Aviation Regulation (CAR) 155
- Civil Aviation Order (CAO) 40.0. Subsection 2
- Civil Aviation Order (CAO) 40.1.7 Subsection 9 Paragraph 9.5 and Appendix III
- United States Federal Aviation Regulation (US FAR) Part 91
- Federal Aviation Administration (FAA) of the United States Advisory Circular (AC) 91-61
- Federal Aviation Regulations (FAR) Advisory Circular (AC) 91-48
- Bureau of Air Safety Investigation (BASI) (now Australian Transport Safety Bureau) Air Safety Research Report 872-1017 (1988)
- G-Awareness for United States Air Force (USAF) Pamphlet 11-419

Acknowledgment: Sections of this CAAP are reproduced from FAA AC 91-61 – with thanks.

Who this CAAP applies to

This CAAP applies to pilots in aerobatic operations.

Why this publication was written

Fatal accidents associated with aerobatics have been occurring, on average, about once every two years in Australia. While such accidents are not frequent, the rate is significant given the relatively limited amount of aerobatic flying that occurs in this country. Five of the fatal accidents that occurred were due to loss of control while performing aerobatic manoeuvres and one was due to an in-flight airframe failure.

One possible significant factor in aerobatic accidents is that the high G forces experienced in aerobatic manoeuvres can result in loss of consciousness (GLOC), with or without prior warning symptoms, and this condition may not be widely understood by pilots.

This CAAP has been written:

- To provide information and guidance on safety issues related to aerobatic flight
- To clarify the rules relating to aerobatic flight
- To provide information on the regulatory requirements for the issue of aerobatic qualifications and low-level aerobatic permissions
- To provide information on risk management and Threat and Error Management (TEM) principles that may be applied to aerobatics.
- To provide information on future competency standards for the issue of aerobatics qualifications and permissions.

This CAAP does not attempt to provide tuition in how to fly aerobatic manoeuvres. Pilots should undertake training with an appropriately qualified flight instructor for this purpose.

Status of this CAAP

This is the first CAAP written on this subject.

For further information

For further information, telephone your local CASA Office on 131 757.

1. Abbreviations

ABAA	Amateur Built Aircraft Acceptance
AC	Advisory Circular
AGL	Above Ground Level
AOC	Air Operator's Certificate
ARN	Aviation Reference Number
ATSB	Australian Transport Safety Bureau
BASI	Bureau of Air Safety Investigation (now ATSB)
CAAP	Civil Aviation Advisory Publication
CAO	Civil Aviation Order
CAR	Civil Aviation Regulation
CASA	Civil Aviation Safety Authority
CASR	Civil Aviation Safety Regulation
CFI	Chief Flying Instructor
$\mathbf{C_{LMAX}}$	Maximum Co-efficient Of Lift
COA	Certificate of Airworthiness
CRM	Crew Resource Management
DAME	Designated Aviation Medical Examiner
FAA	Federal Aviation Administration of the USA
FOI	Flying Operations Inspector
G	Gravity
GIVD	G-induced Vestibular Dysfunction
GLOC	G-induced Loss Of Consciousness
HP	Horse Power
IAS	Indicated Air Speed
ICAO	International Civil Aviation Organization
LAME	Licensed Aircraft Maintenance Engineer
LSA	Light Sport Aircraft
POH	Pilot's Operating Handbook
RPM	Revolutions Per Minute
SOPS	Standard Operating Procedures
TEM	Threat and Error Management
US FAR	United States Federal Aviation Regulations
VFR	Visual Flight Rules
$\mathbf{V_{A}}$	Manoeuvre Speed
$\mathbf{V_{NE}}$	Never Exceed Speed
$\mathbf{V_{MAN}}$	Visual Manoeuvre Speed
VMC	Visual Meteorological Conditions
$\mathbf{V_{NO}}$	Maximum Structural Cruising Speed

2. Definitions and Terminology

2.1 Definitions and Terminology

2.1.1 Current regulations refer to 'acrobatic flight', however 'aerobatics' is a more specific term which is in widespread use and will be used in the proposed new CASRs Parts 91 (General Operating and Flight Rules) and 61 (Flight Crew Licensing). Therefore this CAAP will use the term 'aerobatics' in relation to 'acrobatic flight'. Aerobatic flight is currently defined in CAR 1988 as:

"… manoeuvres intentionally performed by an aircraft involving an abrupt change in its attitude, an abnormal attitude, or an abnormal variation in speed."

2.1.2 A more detailed definition based in the United States Federal Aviation Regulations (US FAR) Part 91 is:

"Aerobatic flight means manoeuvres intentionally performed by the pilot that involve:

(a) bank angles in excess of 60^{o}; or

(b) pitch angles in excess of 30^{o}, or otherwise abnormal to the aircraft type; or

(c) abnormal accelerations involving abrupt changes of direction, angles of bank, angles of pitch, or speed."

2.2 Acrobatic category means an aeroplane is certified for aerobatic manoeuvres in accordance with relevant design rules. Limitations for aerobatic flight are shown in the aircraft's flight manual.

2.3 Utility category means an aeroplane is certified for limited aerobatic manoeuvres in accordance with relevant design rules. Permitted manoeuvres and limitations are shown in the aircraft's flight manual**.**

2.4 Basic aerobatic manoeuvres means the types and combinations of aerobatic manoeuvres are virtually unlimited, but the basic aerobatic manoeuvres specified in CAO Section 40.0 for the issue of an aerobatic endorsement are:

(a) Barrel roll;

(b) Loop;

(c) Slow roll;

(d) Roll off the top;

(e) Stall turn;

(f) Spinning–which is listed as a separate endorsement in CAO 40.0 but is a pre-requisite for the issue of an aerobatic endorsement and can also be considered as a basic aerobatic manoeuvre.

2.5 Gravity (G) Force

One G is an accelerative force equivalent to the force of gravity at the earth's surface.

2.6 Flick Manoeuvres

Flick manoeuvres are rapid rolling motions induced by a stalled condition of flight and tend to be abrupt manoeuvres which place additional stress on the aircraft and pilot. Some aerobatic aircraft may have limitations prohibiting flick manoeuvres.

3. Aircraft Airworthiness for Aerobatics

3.1 Airworthiness Categories

An Australian aircraft can be authorised to fly under a standard certificate of airworthiness, a special certificate of airworthiness, or an experimental certificate. Before performing aerobatics in any aircraft, the pilot needs to establish that it is suitable and authorised for that purpose.

3.2 Standard Certificate Of Airworthiness

Each certificate of airworthiness is issued in one or more airworthiness categories. The airworthiness category determines whether or not the aircraft can be used for aerobatics and is specified in the aircraft's flight manual. The relevant categories are:

- Normal category–not designed for, and should not be used to, perform aerobatic manoeuvres.
- Utility category–only suitable for limited aerobatic manoeuvres under conditions specified in the aircraft's flight manual.
- Acrobatic category–suitable for aerobatic manoeuvres, subject to limitations specified in the aircraft's flight manual.

3.2.1 Older aircraft without flight manuals should have placards in the aircraft cockpit if they are suitable for aerobatics and specifying associated limitations.

3.3 Special Certificates Of Airworthiness

Aircraft that have not been issued with a standard certificate of airworthiness may be authorised to fly under a special certificate of airworthiness in one of the following categories:

- Primary;
- Intermediate;
- Restricted;
- Limited;
- Amateur built under an ABAA;
- Light Sport Aircraft (LSA).

3.3.1 There is no specific aerobatics approval for aircraft in these categories and the pilot needs to check the aircraft flight manual, placards or other documentation, to establish suitability.

3.4 Limited Category

3.4.1 Little documentation may exist for some ex-military aircraft in the limited category in relation to aerobatics, and the pilot will need to research the operating history of the type, for information in regard to types of manoeuvres that can be performed, and any unusual handling characteristics.

3.4.2 Consideration of the current state of airworthiness, in relation to possible deterioration in the aircraft structure and systems, is important before performing aerobatic manoeuvres. Structural fatigue and other deterioration are known to have caused a number of fatal accidents in ex-military aircraft during aerobatic performance.

Note: CASA does not take responsibility for the airworthiness of limited category aircraft as this is entirely the responsibility of the aircraft operator and the pilot-in-command.

3.5 Experimental Certificates

3.5.1 Experimental aircraft do not have to comply with specific airworthiness standards and are not issued with certificates of airworthiness. Aircraft with experimental certificates are required to undergo a flight test programme showing controllability throughout the normal range of speeds and manoeuvres. Specific aerobatic manouevres will have to be demonstrated as part of the flight test programme and documented in the aircraft logbook.

Note: As for the limited category, CASA does not take responsibility for the airworthiness of experimental category aircraft as this is entirely the responsibility of the aircraft operator and the pilot- in-command.

3.6 Gravity (G) Load Factors And Aerobatics

3.6.1 A major consideration in determining an aircraft's suitability for aerobatics is its structural strength as specified by the G loading that the structure is designed to withstand. Pilots need to be aware of and observe these G loading limitations when performing aerobatic manoeuvres.

3.7 What Is 'G' Loading?

3.7.1 G loading is a measure of the forces acting on the aircraft structure to produce the accelerations involved in changing speed and direction in flight. One G is the loading on the aircraft structure in un-accelerated straight and level flight produced by the lift force needed to balance the gravitational force, or the weight of the aircraft.

3.7.2 A 60^{o} banked level turn requires twice as much lift as in level flight and results in a 2 G loading, which effectively doubles the weight of the aircraft and occupants. An aerobatic manoeuvre such as a loop typically requires 4 G loading or more.

3.7.3 G loading can be measured by an accelerometer instrument fitted in the aircraft.

3.8 Positive And Negative G

3.8.1 Positive aerobatic manoeuvres are those involving backward movement of the control column (pull up) to induce a pitching up motion where the G force pushes the pilot into the seat. Note that the terms 'pitching up' and 'pitching down' as used here are relative to the airframe and not necessarily to the ground. G loads act in the same direction relative to the aircraft as lift.

3.8.2 Negative manoeuvres involve a forward movement of the control column (or push over) and a pitching down motion which results in a negative G (-G) loading which tends to lift the pilot off the seat.

3.8.3 Forces less than zero G are termed -G and impose forces on the airframe in the opposite direction to positive G (+G) forces.

3.8.4 -G loadings have significantly different physiological effects on the pilot than +G.

3.9 G Limitations For Aerobatic Aircraft

3.9.1 Aeroplanes may be certificated for aerobatics in either the acrobatic category or the utility category. The main difference between the two categories is the structural strength of the aircraft expressed in terms of the load factors, or 'G loadings', the structure is designed to withstand. The table below shows the minimum structural requirements for each category.

	Normal	Utility	Aerobatic
Positive	+3.8 G	+4.4 G	+6.0 G
Negative	-1.9 G	-2.2 G	-3.0 G

3.9.2 It can be seen from the table that aircraft certificated in the 'aerobatic' category must be designed to be significantly stronger than 'utility' category or 'normal' category aeroplanes.

3.9.3 Many aerobatic aircraft are fitted with 'G' meters which indicate the maximum 'G' loadings experienced during manoeuvres. If the aircraft's limitations are exceeded at any time, an inspection of the airframe should be conducted by a qualified maintenance engineer.

3.9.4 Extending flaps and/or landing gear generally reduces the capacity of the aircraft structure to absorb G loadings and aerobatics should normally not be performed with such devices extended.

3.10 Rolling G Limitations

3.10.1 The G limitations for an aircraft are specified in the flight manual for the symmetrical case, that is, where both wings are producing an equal amount of lift. Rolling motion is normally imparted by increasing the lift on one wing relative to the other. This asymmetrical lift results in an asymmetrical G loading which is termed 'rolling G'.

3.10.2 The effect of rolling G is cumulative with the normal G forces and if rapid rolling motion is imparted during a manoeuvre already involving a high G, then aircraft structural limitations could be exceeded. Caution needs to be exercised in rolling manoeuvres because the accelerometer does not indicate rolling G.

3.11.3 Some aircraft flight manuals will specify both symmetrical and rolling G limitations, but if a rolling G limitation is not given, a good rule of thumb is to use 2/3 of the symmetrical G limitation as the limit for rolling manoeuvres.

3.11 Flight Manual Manoeuvre Limitations

3.11.1 In utility category aeroplanes, the manoeuvres that can be performed safely are listed in the approved aircraft flight manual and/or on placards located in the cockpit.

3.11.2 Acrobatic category aeroplanes are normally suitable for most standard aerobatic manoeuvres but some types may have certain restrictions. The aircraft's flight manual or cockpit placards will normally specify any manoeuvres that are not permitted or any other restrictions on aerobatic flight.

3.12 Airspeed Limitations

3.12.1 The aircraft flight manual will specify airspeed limitations for the aircraft. Limitations that are particularly relevant in aerobatics are:

- V_{NE} – never exceed speed;
- V_{NO} – normal operating limit speed;
- V_A – maximum manoeuvring indicated air speed (IAS);
- Entry speeds for manoeuvres;
- Maximum flick manoeuvre IAS.

3.13 Manoeuvring Speed

3.13.1 Manoeuvring speed (V_A) is the speed above which full deflection of the elevator control will exceed aircraft structural limitations. Below V_A the aircraft will stall before structural limits can be exceeded. V_A will be specified in the aircraft's flight manual and placarded on the instrument panel. Full control deflection of any flight control should be avoided above this speed.

3.13.2 It is important to note that V_A is established at the aircraft’s maximum all-up weight or maximum aerobatic weight, and that at lighter weights it is possible to exceed G limitations at speeds less than the specified V_A.

3.13.3 It could be argued that exceeding G limitations at a lighter weight may not necessarily overstress the wing structure because the lift forces imposed at the lighter weight for the same G are proportionately less, and therefore the wing structure should be strong enough to withstand the load. However, other airframe components such as engine mountings, attachments and other equipment still experience the full G loading and these structural components could fail even though the wing does not.

3.13.4 Thus, to stay within a safe operating envelope, the pilot should manoeuvre near V_A with caution, monitor the accelerometer rather than rely solely on airspeed limitations, respect rolling G and flick roll limits, and be cautious in the use of abrupt control inputs.

3.14 Stick Position And The Stall

3.14.1 An important aspect of both normal and aerobatic flight is the relationship of the stick position to the angle of attack of a wing for a specific flap setting or centre of gravity, in particular at the stall. The fore and aft position of the control column determines the angle of the aircraft's wings to the airflow. For example, the stick positions for cruise, glide and the stall move progressively aft. Once the stick position for the stall has been determined (and remembered), it can be used as a measure of whether an aircraft's wing is stalled or not. If the stick is forward of the 'stalled stick position', the aircraft will always be in unstalled flight, regardless of aircraft attitude or airspeed.

3.14.2 Appreciation of this concept, and the ability to recognise and apply stick position to achieve C_{LMAX} (that is the point just before a wing stalls) can increase awareness and enhance a pilot's confidence and aircraft handling at this critical phase of flight.

3.15 Airframe Fatigue And High G Loadings

3.15.1 While G limitations are established to ensure the aircraft structure is able to withstand the maximum specified loading, the cumulative effect of deliberately imposing maximum or greater loads on numerous occasions can have an adverse effect on the fatigue life of an aircraft by weakening the aircraft structure.

3.15.2 In recent years a number of aircraft, particularly those that have been used in simulated air combat operations, have suffered structural failure attributable to this cause. Frequent rapid application of maximum G loadings should be avoided unless the aircraft has been specifically designed for this purpose. Particular attention should be paid to the structural integrity of aircraft known to have been subjected to such regimes.

3.16 Older Aircraft

3.16.1 Many aircraft still flying were designed to older, less demanding standards or to military standards. In the absence of flight manuals or placards, pilots will need to seek information regarding the aerobatic capabilities of these aircraft from reliable sources.

3.16.2 Owners and pilots must also be aware of possible effects on structural strength generally related to aircraft age, such as corrosion, material quality, delamination of glued structures, metal fatigue, and other factors which may degrade an aircraft's structural integrity.

3.16.3 There are various regulatory and other systems for advising pilots and operators about how to deal with the airworthiness issues related to aging aircraft. Owners and pilots of old and ex-military aircraft should consult airworthiness engineers and authorities and respect their advice.

3.16.4 Material stress is cumulative – a manoeuvre that could be safely performed in a particular aircraft some years ago could be fatal in the same aircraft today.

3.17 Occupant Restraint

3.17.1 Proper aerobatic harnesses in good condition are essential to securely restrain the occupants under the higher stresses imposed by aerobatics. At least a five-point attachment harness (consisting of lap-strap, shoulder harness and crotch strap) is required if significant -G is intended.

3.17.2 Many aerobatic aircraft incorporate an additional lap-strap to separate attachment points (seven-point harness), with separate buckles latching in the opposite direction to minimise the risk of accidental release.

3.17.3 Harnesses and attachments should not be worn if damaged, and latching mechanisms should fasten securely and not be susceptible to inadvertent release. Harnesses should always be secured as tightly as possible so the body cannot be thrown around during manoeuvres.

3.18 Engines And Systems

3.18.1 Aerobatic aircraft generally need to have special systems designed to cope with -G loadings to ensure continued fuel supply and lubrication for the engine, although brief periods of -G are still possible in aircraft without such systems. Pilots should consult the aircraft flight manual to establish the -G limitations for the particular aircraft, to guard against engine failure due to fuel starvation or excessive wear and tear on the engine due to inadequate lubrication.

3.18.2 Care also needs to be taken during aerobatic manoeuvres not to exceed engine and propeller revolutions per minute (rpm) limitations.

3.18.3 Batteries need to be sealed or otherwise designed to prevent the escape of corrosive substances.

4. Human Factors in Aerobatics

4.1 Physiological Effects Of G Forces

4.1.1 Aerobatic manoeuvres involve rapid changes in speed and direction which impose significant accelerative forces on the aircraft and pilot. The physiological effects of these G forces can range from minor discomfort to loss of consciousness.

4.1.2 Pilots beginning aerobatics may be adversely affected by airsickness, disorientation and discomfort but continued practice, and the use of appropriate methods of mitigating the physiological effects, will allow most pilots to adapt fairly quickly to standard aerobatic manoeuvres.

4.1.3 However, advanced aerobatics require the pilot to endure high G loadings, and rapid changes in G over extended periods, which can result in hazardous physiological effects such as loss of consciousness. Even experienced aerobatic pilots must keep in practice and be aware of their physical limitations in respect of G to safely perform advanced aerobatics.

4.2 Positive G (+G)

4.2.1 Pull-up manoeuvres (Figure 1) produce a +G loading, causing the body and limbs to feel heavier and more difficult to move. Blood is forced towards the lower part of the body and the extremities, resulting in reduced blood pressure and therefore oxygen to the brain and eyes. When the blood circulation to the brain and eyes decreases as a result of +G forces, a pilot may experience grey-out, tunnel vision, black-out, and finally loss of consciousness (GLOC). If +G is increased steadily, the eyes are generally affected by a reduction of blood pressure before the brain, providing some visual warning that incapacitation is imminent. The progressive effects of increasing +G may be described as follows.

Figure 1: G's Acting on Pilot in Pullup from Dive

4.3 Grey-out

4.3.1 The first visual indication of high +G may be a loss of colour perception and clarity known as 'grey-out ', probably accompanied by a loss of peripheral vision. The grey-out phase is a warning to reduce +G forces.

4.4 Tunnel Vision

4.4.2 Grey-out may be followed by a concentric narrowing of the field of vision that is termed 'tunnel vision'.

4.5 Black-out

4.4.1 If +G is maintained or increased, the field of vision narrows completely so that that vision is lost and 'black-out' occurs. The pilot is still conscious but cannot see. Loss of consciousness is likely to follow quickly if +G is not reduced.

4.6 Rapid Onset +G

4.6.1 If high G forces are applied rapidly enough, for a period of around five seconds or more, then loss of consciousness can occur without any of the visual warning signs of low-level tunnel vision or black-out.

4.7 Negative G (-G)

4.7.1 Push-over manoeuvres (Figure 2) produce -G loading and force blood and body organs towards the head. The pilot initially feels weightless and is pushed out of the seat against the safety harness. Under mild conditions of -G forces, the pilot will experience the sort of face and head congestion felt when standing or hanging inverted, but at higher levels of -G discomfort can be acute and possibly be accompanied by haemorrhaging of small blood vessels in the eyes, nosebleed or headache. Due to the discomfort, it may take longer to adapt to -G.

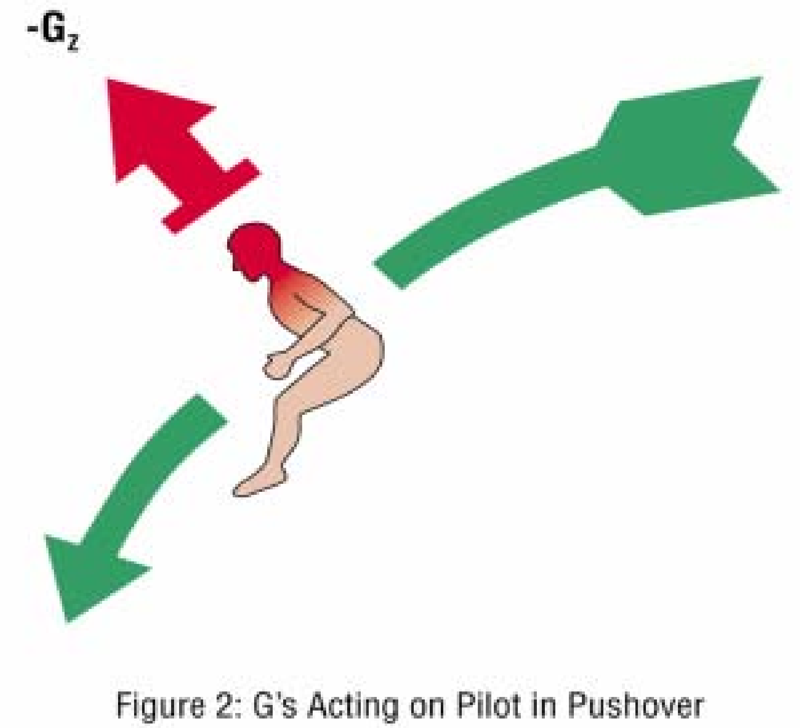


Figure 2: G's Acting on Pilot in Pushover

4.8 Red-out

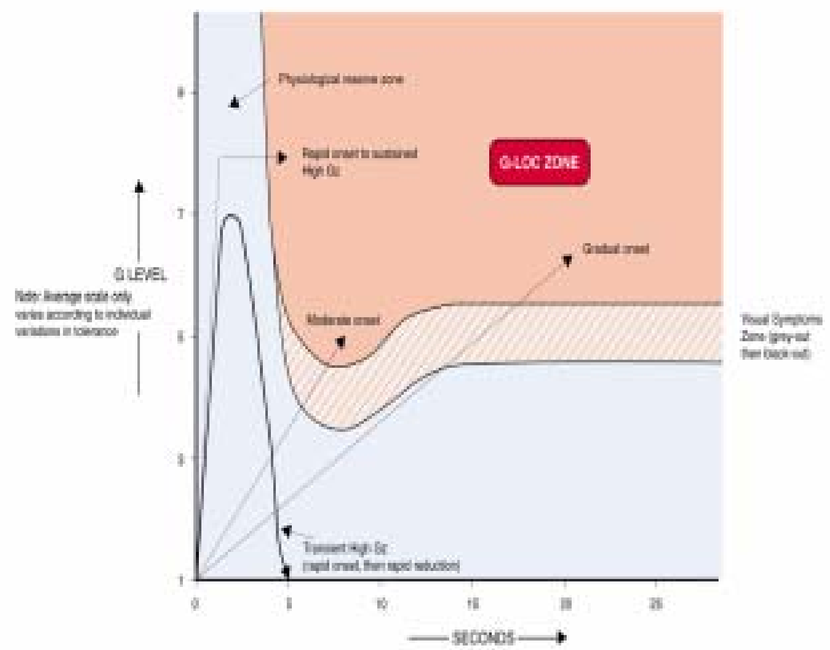
It was once thought that the lower eyelids rise to cover the pilot's pupils during high -G, causing the pilot to see only a red field, the opposite of a black-out. This condition was called 'red-out', but has not been well documented and a number of pilots question its existence.

4.9 G Induced Loss Of Consciousness (GLOC)

4.9.1 Loss of consciousness will occur if the blood flow to the brain, and therefore the supply of oxygen, is sufficiently reduced by the +G forces being experienced. High -G for a significant period may also have a similar effect.

4.9.2 High +G for short periods may not be sufficient to cause GLOC, because without blood flow, the brain and eyes can continue to function on oxygen reserve for about four to seven seconds. However, longer than this period at +5 G or more is generally sufficient to bring on GLOC as illustrated by the graph below.

Figure 6: Gz onset rate and Gz tolerance



4.10 G Incapacitation

4.10.1 In a GLOC event, there will be a short period of total incapacitation where the pilot is completely unconscious, followed by a recovery period of relative incapacitation where the pilot has regained consciousness but is in a confused state and unable to control the aircraft. However, after recovering sufficiently to regain control, there is likely to be a longer period before full normal functioning and situational awareness returns.

4.10.2 GLOC in flight normally results in the pilot relaxing the control forces and therefore reducing the G force, so that the actual duration of loss of consciousness may only last, on average, for about 15 seconds. The following period of relative incapacitation may last another 15 seconds but could be up to 50 seconds.

4.10.3 Full recovery may take several minutes, during which time the pilot will be functioning below normal ability and may be more susceptible to another GLOC episode.

4.10.4 A particularly insidious aspect of GLOC is that it can often occur without the pilot subsequently being aware of it. Centrifuge studies have shown that 50% of pilots do not recall a GLOC event. Warning signs that this may have happened could be an unexplained loss of altitude or an unusual aircraft attitude, either of which may be good reason for discontinuing aerobatic manoeuvres on that flight.

4.10.5 Obviously, the period of time during which control of the aircraft is lost following GLOC is extremely hazardous, particularly if aerobatics are being conducted at low-level.

4.10.6 Visual symptoms, such as grey-out and black-out, are a warning that oxygen reserves are seriously depleted, that GLOC is imminent, and that G forces should be immediately reduced. However, they should not be relied on to provide a warning, because GLOC can often occur without prior visual symptoms.

4.11 Change From -G To +G

4.11.1 A rapid change from -G to +G also presents a potential hazard. When a pilot is subjected to -G, blood pressure receptors in the neck and chest respond to the increased blood pressure in the upper body by slowing the heart rate. If the -G is followed by a rapid change to +G, there is a rapid reduction in blood pressure in the upper body and the heart rate cannot respond rapidly enough to maintain adequate blood pressure to the brain. Maintaining -G for three to four seconds is enough to significantly reduce a pilot's normal tolerance to +G, and may lead to loss of consciousness well before the pilot would normally expect it, (as low as +3G). Figure 5 shows an aerobatic sequence, a vertical 8 with an outside loop on top (-G) and an inside loop on the bottom (+G) as an example of a manoeuvre which could easily constitute a GLOC risk.

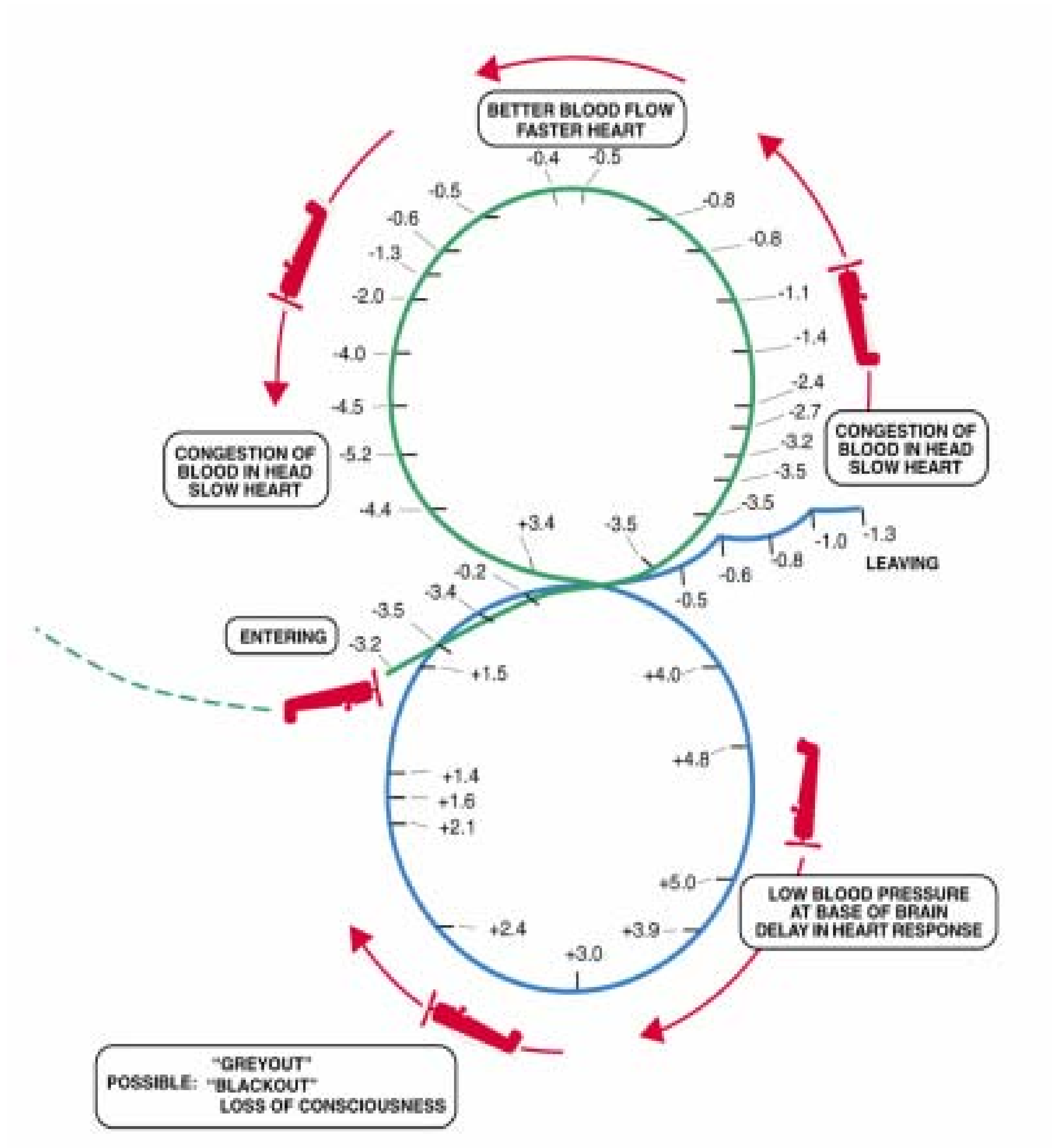


Figure 5: Negative and positive G'z recorded second-by-second during the outside (upper loop)—inside (lower loop) vertical 8 manoeuvre. The major psysiological consequences are indicated at their respective positions in the manoeuvre. The rapid change from negative to positive is particularly stressful.

4.12 Other G Forces

4.12.1 G forces in aerobatics are usually positive or negative and forces acting sideways or fore and aft are generally minor by comparison, other than in some advanced aerobatic manoeuvres where the pilot may be flung about if not properly restrained.

4.13 G Tolerance

4.13.1 The average pilot can probably tolerate about +5G for extended periods without losing consciousness, but this figure can vary significantly for different individuals, and an individual's tolerance can also vary from day to day.

4.13.2 The following table gives some idea of normal levels of G tolerance.

Table 1. Thresholds In Relation To +G Tolerance

Symptom	Average Threshold	Deviation	Standard Range
'Grey-out'	4.1 G	± 0.7 G	2.2 to 7.1 G
'Black-out'	4.7 G	± 0.8 G	2.7 to 7.8 G
Unconsciousness	5.4 G	± 0.9 G	3.0 to 8.4 G

4.14 Establishing Individual G Tolerance.

4.14.1 Some pilots can tolerate more G than others, but all have a limit which can vary considerably from day to day for the same individual. Not all pilots may be capable of competing in advanced aerobatic competitions because of the extreme G forces associated with the required manoeuvres.

4.14.2 Aerobatic pilots need to realise the potential hazards of high G and establish personal limits based on their own experience and taking into account their current state of health, fitness, and recent aerobatic experience.

4.14.3 A warm up manoeuvre of three to five G for ten seconds will confirm adequate G tolerance on the day and raise the G tolerance level slightly by increasing blood pressure.

4.15 G Resistance Straining

4.15.1 G resistance straining can significantly increase +G tolerance, but needs to be initiated prior to the application of G forces to be fully effective. Effective straining is intended to prevent pooling of blood in the extremities, particularly the legs and lower body, thus maintaining sufficient blood pressure to the brain. Properly done, the straining manoeuvre can increase normal +G tolerance by three G or more.

4.15.2 Straining consists of tensing the lower body muscle groups, abdominals, buttocks and upper leg muscles. Straining should be commenced as +G is applied and maintained until +G is released. Relaxing the straining while still pulling +G could result in immediate GLOC.

4.15.3 Frequent aerobatic practice and physical conditioning can increase the effectiveness of the straining manoeuvre. Conditioning exercises should aim at increasing the strength of the abdominal and upper leg muscles. Aerobic exercise and fitness is beneficial in increasing endurance and assisting recovery from high G but will not of itself raise the G tolerance level.

4.16 'Hook' manoeuvre

4.16.1 The 'hook' or modified valsalva manoeuvre is used by military pilots in addition to the muscle straining technique to further increase +G tolerance, but if not done correctly it could be hazardous by actually bringing on GLOC. It should only be done in conjunction with the G straining manoeuvre. The term 'valsalva', is more commonly understood by pilots as the process of clearing ears by pinching the nose, closing the mouth and exhaling.

4.16.2 The technique is not easy to do correctly and requires considerable practice to be safe, effective and automatic:

- Take a deep breath and exhale against a closed glotis (airway) to increase and maintain pressure in the chest;
- About every three to five seconds make a short forced exhalation and take a quick breath.

4.16.3 This is also known as the 'hook' manoeuvre because sounding and holding the initial 'hoo' sound for three to five seconds closes the glotis, and the final 'k' sound achieves the short exhalation and intake of breath. The 'hook' sequence is repeated continuously while straining under +G.

4.16.4 The technique is intended to increase blood pressure and assist the heart to maintain circulation to the brain by increasing and maintaining a higher pressure in the chest cavity.

4.16.5 However, the correct timing is vital. If the time interval between exhalations is too short the manoeuvre is ineffective, but if it is too long the increased pressure in the chest impedes blood return to the heart, resulting in a loss of circulation and probable GLOC.

4.16.6 The hook or modified valsalva is used by military pilots to allow extended periods at very high +G, but is not necessarily essential for sport aerobatics, given the shorter duration of G forces involved. Before using the hook or valsalva under high +G, pilots should be well practised and should carefully consider the hazards.

4.17 Head Elevation

4.17.1 Reducing the distance of the head above the heart, or elevating the legs, will reduce the pressure required to maintain blood circulation to the brain during +G. Some aircraft may incorporate a semi-reclining position for this purpose.

4.18 Resistance Strategies For -G

4.18.1 There is no known method to counter the effects of -G, other than to continue to breathe normally and relax the abdominal and leg muscles, although it has been suggested that practising hanging or standing inverted may possibly assist adaptation.

4.19 Physiological Factors Adversely Affecting G Tolerance

4.19.1 Pilots can build up their tolerance to G with practice, but need to be aware that tolerance levels that have been established can be significantly reduced by various factors affecting their physical condition. For example, studies have shown that dehydration can reduce G tolerance by up to 50%. Factors that can reduce G tolerance include:

- Dehydration;
- Low blood sugar level;
- Eating a large meal before flying;
- Fatigue;
- Prolonged standing or sitting;
- Hypoxia;
- Illness;
- Smoking;
- Alcohol;
- Drugs;
- Medications;
- Low blood pressure;
- Cardiovascular fitness level;
- Recent weight gain or loss.

4.19.2 Pilots with any medical condition listed would be advised to consult a DAME before undertaking aerobatics.

4.19.3 Lack of recent aerobatic practice will also reduce a pilot's G tolerance and pilots returning to aerobatics after some time away will need to check and then gradually re-establish their tolerance level.

4.20 Disorientation

4.20.1 The human balance mechanism was not designed for the forces experienced during normal flight, let alone aerobatics. Balance therefore cannot be relied on for orientation, and maintaining visual reference to the horizon and prominent ground features is the best method of minimising feelings of disorientation.

4.20.2 Rapid head movements or turning the head while performing high G manoeuvres is known to cause severe disorientation and should be avoided. There is also the risk of neck injury by moving the head about under high G.

4.20.3 The best practice is to hold the head still during high G manoeuvres, which requires the pilot to anticipate the direction in which he or she needs to be looking during the manoeuvre so that only minimal head movements are necessary.

4.20.4 Sustained rapid rotation, such as in flick manoeuvres or spins, can also lead to disorientation because visual reference is made difficult due to the rapid rotation and there is no visual correction to the confused signals from the balance mechanism.

4.20.5 Recent ear, nose, throat infections may cause injury or pain, as well as disorientation, during aerobatics.

4.21 G Induced Vestibular Dysfunction

4.21.1 Sometimes known as 'the wobblies', this is a condition that is not well understood, but which has affected a number of advanced aerobatic pilots, both in Australia and overseas. It seems to occur when pilots are subjected to high G loadings, particularly –G, and turn their head from one side to the other.

4.21.2 Symptoms consist of loss of balance and nausea experienced subsequent to the aerobatic performance and can sometimes be long lasting for days or even months. A number of pilots have been forced to abandon aerobatic flying because of this condition.

4.21.3 Pilots experiencing symptoms should seek medical advice, preferably from a Designated Medical examiner (DAME), and refrain from aerobatics while symptoms persist. They may also need to consider whether they continue to meet the aviation medical standard for other types of flying.

4.22 Airsickness

4.22.1 Airsickness is probably due to the disruption to the balance mechanism brought about by the unusual and changing forces acting on the body, and particularly on the abdominal organs, during flight. Some degree of airsickness can be expected when commencing aerobatics but should settle or reduce with practice and when the trainee begins flying the manoeuvres. Leaving spinning manoeuvres until the end of an aerobatics session is good practice for beginning pilots.

4.22.2 Aerobatics sessions may need to be cut short if airsickness is experienced, although fresh air and a short break from manoeuvring may help. Tensing the abdominal muscles and holding the internal organs firmly in place during manoeuvres and maintaining visual reference will help. A number of aerobatic pilots have overcome initial severe airsickness problems by perseverance.

4.22.3 Readily accessible airsick bags should be a pre-flight checklist item for aerobatic training flights.

4.23 Medical Fitness

4.23.1 If you experience incapacitation or have any lingering symptoms as a result of aerobatics, you should consult a DAME before resuming flying.

5. Rules for the Conduct of Aerobatics

5.1 Civil Aviation Regulation (CAR) 155

5.1.1 CAR 155 specifies rules limiting the conduct of aerobatic flight. Aerobatics pilots should be familiar with all the provisions of CAR 155 and the following provides a summary of the main elements of the regulation:

(1) Aerobatics must only be conducted in visual meteorological conditions (VMC) by day.

(2) A pilot must not perform aerobatics in aircraft unless the Certificate of Airworthiness (COA) or flight manual for the aircraft specifies that the aircraft can perform aerobatics.

(3) Straight and steady stalls or turns with not more than 60^{o} bank, are not classified as aerobatics.

(4) Aerobatics must not be conducted below 3000' above terrain or objects on the ground without the written permission of CASA.

(5) Aerobatics are not permitted over populous areas or public gatherings without the written permission of CASA.

(6) Before conducting aerobatics, pilots must ensure that:

- There are no loose articles in the aircraft;
- All locker and compartment doors are fastened;
- Safety harnesses on vacant seats are secured so as not to foul controls;
- Dual controls are removed or passengers are briefed not to interfere with the controls and there is adequate communication with the pilot. (See Civil Aviation Regulation (CAR) 226 and Civil Aviation Order (CAO) Section 20.16.3);
- All occupants are secured with correctly adjusted safety harnesses.

6. Aerobatic Endorsements and Permissions

6.1 Conditions On Pilot Licences Relating To Aerobatics

6.1.1 Civil Aviation Order (CAO) 40.0, Subsection 2, includes the condition on aeroplane pilot licences that pilots must not conduct spinning or aerobatic flight as pilot-in-command unless they are authorised to conduct the particular spinning or aerobatic manoeuvres to be performed. The Order also includes the manoeuvres to be endorsed and how instructors are authorised to conduct the training and issue the endorsements.

6.2 Spin Endorsements

6.2.1 The training and the issue of a spinning endorsement may only be conducted by a flight instructor who holds a spin training endorsement. When entered in a pilot's logbook, the spinning endorsement specifies the type of aeroplane in which competency was demonstrated, but is valid for any other aeroplane approved for spinning.

6.2.2 Separate endorsements are required for upright and inverted spins.

6.3 Aerobatics Endorsements

6.3.1 To be authorised to conduct aerobatics as pilot-in-command, a pilot must hold a logbook endorsement for upright spins and a logbook endorsement for the aerobatic manoeuvres to be performed.

6.3.2 An aerobatic endorsement must be made in the pilot's logbook by either a flight instructor or an approved person and must include the manoeuvres that the pilot is authorised to perform. The following manoeuvres are specified in CAO Section 40.0, as needing specific authorisation:

- Barrel roll;
- Loop;
- Slow roll;
- Roll off-the-top;
- Stall turn.

6.3.3 A pilot may perform any combinations of the manoeuvres endorsed and needs no further endorsement to perform other manoeuvres not listed in the Order.

6.3.4 Aerobatic endorsements entitle a pilot to conduct aerobatics in accordance with CAR 155, not below 3000' above ground level (AGL). To perform aerobatics at lower levels, a separate low-level aerobatics permission issued by CASA under CAR 155 is required.

6.4 Competency Standards

6.4.1 Competency standards applicable to the issue of spinning and aerobatic endorsements are provided in Appendix A of this CAAP for the guidance of pilots and instructors. Achievement of the standards should be sufficient evidence that a pilot is able to safely perform the manoeuvres demonstrated and is qualified for the issue of the appropriate endorsement.

Note: No minimum training or experience requirements are specified for the issue of aerobatic endorsements, however, a pilot should be able to consistently demonstrate competency (that is, on more than one flight) to be assessed as meeting the standard.

6.4.2 Appendix B of this CAAP also includes an achievement record form for use as a checklist to ensure that all the applicable units and elements of competency for aerobatics have been achieved. It may also be used to advise CASA that an endorsement has been issued.

6.5 Aerobatic Training Endorsements

6.5.1 Flight instructors must be certified as competent to give instruction in spins and in aerobatics and have the logbook endorsements specified in CAO Section 40.1.7 to that effect. An instructor must hold a spin training endorsement and a training endorsement for each the aerobatic manoeuvres which require endorsement under CAO Section 40.0 and for which he or she gives instruction. Aerobatics training endorsements must be entered in the instructor's logbook by either a chief flying instructor (CFI) or a Grade 1 instructor who also must hold the training endorsement.

6.5.2 Assessment of competence for the issue of an aerobatic training endorsement should be on the basis of the instructor's ability to give ground and flight instruction and assess competence in each of the units and elements listed in the aerobatics competency standards in Appendix A of this CAAP. Sample Achievement records for issuing instructor training endorsements are included in Appendix B of this CAAP.

6.5.3 The forms of log-book endorsement for spinning, aerobatic manoeuvres and aerobatic instruction are specified in CAO Section 40.1.7, Appendix III.

6.6 Approved Persons

6.6.1 Persons other than flight instructors may also be approved by CASA under CAO Section 40.0 to give aerobatic flight instruction and issue aerobatic endorsements. However, CAO Section 40.0 only allows for flight instructors to be approved to give spin training.

6.7 Low Level Aerobatic Training

6.7.1 Instructors or approved persons authorised to give aerobatics instruction, who also hold a low-level aerobatics permission, may give aerobatics instruction down to the limit specified in the permission.

6.8 Requirement for Air Operator's Certificate (AOC)

6.8.1 Aerobatic flight instruction is given for the purpose of increasing a pilot's skill and is therefore classed as flying training. Aerobatic training for the issue of an endorsement or permission must be conducted under an Air Operator's Certificate (AOC) and be specified in the holder's Operations Manual.

Note: This does not prevent a person who already holds an aerobatic endorsement or permission from practising aerobatics as a private operation to maintain or improve their own skills.

6.8.2 Therefore, an initial aerobatics endorsement can only be given by a suitably qualified flight instructor or approved person operating under a flying school AOC. Subsequent aerobatics activities such as advanced aerobatics and low-level aerobatic permissions may be given by pilots approved by CASA.

6.9 Low-level Aerobatics Permissions

6.9.1 CAR 155 normally limits aerobatic flight to not below 3000' AGL but allows CASA to issue permissions to pilots to conduct aerobatics at a lower level. CASA may also delegate persons under CAR 155 to issue low-level aerobatic permissions on behalf of CASA.

6.9.2 Appendix A of this CAAP provides recommended competency standards for low-level aerobatics to assist delegates in making the assessment for the issue of the permission. However, the issuing delegate is ultimately responsible for the final decision and should only issue a permission if satisfied that the applicant will be able to exercise it safely. Use of the assessment form provided at Appendix C of this CAAP will assist the delegate in making a comprehensive and accurate assessment.

6.9.3 Aerobatics at low-level obviously entail a higher degree of risk because of the reduced safety margins for recovery from manoeuvres. A low-level aerobatics permission should be issued not just because the holder has appropriate aerobatic skills, but because he or she has the ability to assess and manage the risks involved in low-level aerobatics, particularly the risks to third parties.

6.9.4 Therefore, it is recommended that the competency assessment should address not just performance skills but the ability to apply threat and error management principles.

6.9.5 Specific requirements for recent experience for low-level permission holders have not been described in this CAAP, on the basis that keeping current is ultimately the pilot's own responsibility and CAAPs are only advisory documents. Advice on recent experience for low-level aerobatics is provided at section 9.5 of this CAAP, but low-level permission holders need to be able to self assess their currency and whether it is sufficient to conduct a particular flight safely.

6.9.6 It is important to note that a CAR 155 permission is NOT a permission to fly over, or to perform aerobatics at, public gatherings or airshows. This requires a separate permission under CAR 156.

6.9.7 Nor is a CAR 155 permission an authorisation to conduct low flying. CAR 157 specifies minimum heights for flight and a low-level aerobatic permission does not absolve a pilot from compliance with CAR 157.

6.10 Issuing Low-level Aerobatics Permissions

6.10.1 A permission for pilots to conduct aerobatics below 3000' AGL is issued by CASA under CAR 155(6). A delegate who issues a permission on behalf of CASA must exercise his/her own judgement in deciding whether to issue the permission and the conditions under which it is issued, but must always be satisfied that the permission can be exercised safely.

6.10.2 The following section provides guidance to delegates about issuing low-level aerobatics permissions.

6.11 Training

6.11.1 Appendix A of this CAAP includes recommended competency standards for low-level aerobatics, and Appendix B includes an achievement record. The achievement record, signed by the instructor and the applicant, certifies that the applicant has received training and achieved competence in each element listed.

6.12 Assessment

6.12.1 Appendix C of this CAAP includes a sample application and assessment form to assist the delegate. The assessment form includes the essential items of underpinning knowledge and aerobatic elements that would enable the delegate to assess the applicant's ability to undertake low-level aerobatics safely.

6.12.2 The assessment may be conducted by the delegate either by airborne observation or from the ground.

- If the applicant is seeking a low level permission down to 1500' AGL, airborne observation by the delegate in the aircraft would be the normal method.
- If the applicant is seeking a permission below 1500' or in a single-seat aircraft, then observation from the ground would be appropriate.

6.13 One-off Low-level Permission For The Purpose Of Assessment

6.13.1 If an applicant for a low-level permission is to be observed from the ground, then the delegate <u>must issue</u> a one-off CAR 155 permission for that purpose and must have a reasonable basis for believing that the flight can be conducted safely by the applicant. A recommendation from the instructor who provided training to the applicant, and the delegate's own assessment of the applicant performing at a higher level, would provide a basis for issuing the permission.

6.14 Issuing The Permission

6.14.1 If the delegate is satisfied that the applicant is competent to conduct low-level aerobatics safely, then he or she should issue a written permission under CAR 155 to the pilot. Appendix D includes a sample form of a CAR 155 permission.

6.14.2 Once issued by the delegate, the permission, including any conditions on the permission, is effective and may be exercised by the pilot.

6.14.3 It will be a condition of the delegation that the delegate must forward a copy of the application and the assessment, including details of the permission issued and the conditions on the permission, to CASA within seven days to enable CASA to maintain a record of low-level aerobatic permissions issued.

6.15 Conditions On Permissions

6.15.1 A delegate cannot cancel a permission once it is issued. Therefore a delegate needs to carefully consider whether there is a need to issue the permission with conditions. Delegates may issue a low-level aerobatics permission with any conditions they believe necessary in the interests of safety. For the guidance of delegates, it is considered that the following conditions are applicable to all low-level permissions to provide an acceptable level of safety:

(1) Other than one-off permissions, the permission can be issued for an indefinite period, but a delegate may include an expiry date if he or she considers this necessary in the interests of safety.

(2) A limitation to single-engine aeroplanes up to 800 hp or to a particular aircraft type or types.

(3) A height limitation specifying a minimum level for the conduct of aerobatics. Delegates may specify any height limitation they believe necessary in the interests of safety, but the following height limitations would probably cover most circumstances:

- Not below 1500' AGL;
- Not below 1000' AGL;
- Not below 500' AGL; or
- Unlimited.

Note: There is no requirement for pilots to hold a permission at each higher level before being issued one at a lower level, although some form of progression would be the normal expectation. The delegate may issue a permission with any height limitation that is based on safety considerations.

Note: A low-level aerobatic permission with an unlimited height is still limited by the provisions of CAR 157 relating to low-flying.

6.15.2 A sample form of low-level permission is included at Appendix D.

6.16 Civil Aviation Regulation (CAR) 155 Delegations

6.16.1 Issuing CAR 155 delegations to industry enables industry experts to issue the low-level aerobatics permission without direct involvement of CASA staff. Delegating this function to industry personnel is in line with CASA's main priority of concentrating resources on protecting the travelling public and persons not in a position to assess the relevant risk and mitigate it.

6.16.2 Normal procedures for the issue of delegations will be applicable and delegates must be familiar with and comply with the conditions of their delegations. A suggested condition of the delegation will be a requirement for the delegate to have undergone the peer review of his or her low-level aerobatics competency specified in Section 7.28 of this CAAP within the 15 months preceding the use of the delegation.

6.16.3 A sample instrument of delegation with typical conditions is given at Appendix E.

6.17 Low-level Testing Approvals

6.17.1 CASA has previously issued low-level testing approvals to individuals and has accepted recommendations from the holders of these approvals for the issue of CAR 155 permissions. These approvals will remain valid for the duration of the approval, but are not delegations and do not entitle the holders to issue permissions.

6.17.2 However, it is a matter for the issuing delegate within CASA as to whether or not a recommendation from an approved testing officer is accepted. Compliance by the testing officer with the provisions applicable to delegates would provide a sound basis for delegates within CASA to accept a recommendation made by the testing officer.

6.17.3 Industry CAR 155 delegates should issue permissions based only on their direct observation and assessment of the applicant and will not be able to issue a permission based on the recommendation of the holder of a low-level testing approval.

6.17.4 Holders of a low-level testing approval who wish to issue low-level aerobatic permissions should apply to the nearest CASA Field Office for a CAR 155 delegation.

6.18 Issue Of CAR 155 Delegation

6.18.1 Interested persons should apply to the nearest CASA Field Office for the issue of a CAR 155 delegation.

6.18.2 In assessing applicants for the issue of a CAR 155 delegation, CASA takes the following into account:

- The need for the delegation;
- The level of CASA oversight needed for the delegation;
- The applicant's experience in performing and/or instructing in low-level aerobatics; and

- The applicant's demonstrated ability to assess applicants for low-level aerobatic permissions in accordance with the standards included in this CAAP.

6.18.3 Depending on the applicant's experience, this may or may not involve a demonstration of the applicant's ability to assess low-level aerobatics competency. Generally, persons who have held low-level testing approvals issued by CASA should be eligible for the issue of a delegation without further assessment.

6.18.4 Delegations will include the requirement to assess applicants in accordance with the standards specified in this CAAP and to only issue permissions based on the delegate's own direct observation and assessment.

6.18.5 Delegates will also be required to maintain recent experience and to undertake regular peer review.

6.18.6 Delegates will be expected to follow administrative procedures for the issue of low-level aerobatics permissions as specified in the Flight Crew Licensing (FCL) procedures manual.

6.18.7 A sample form of delegation is provided at Appendix E.

6.19 Airshows

6.19.1 A low-level aerobatics permission is not, by itself, a permission to conduct aerobatics over a public gathering, e.g. at an airshow. This requires a separate permission under CAR 156 and is described (not dealt with) in this CAAP.

6.20 Summary:

- Spinning training can only be conducted, and the endorsement issued, by an authorised flight instructor;
- Aerobatics (other than spinning) training may be conducted by an authorised flight instructor or approved person;
- A person may be approved to conduct the testing for the issue of a low-level aerobatics permission on behalf of CASA;
- Low-level aerobatics permissions may only be issued by CASA or a CASA delegate.

7. Risk Management and TEM

7.1 Risk Management

7.1.1 Risk management is a process that can be applied before deciding to undertake a proposed flight, to determine whether or not it should be conducted or modified, based on the assessment of the risk involved. The basic question that risk management addresses is whether the level of risk for a proposed flight is acceptable or, if not, can it be managed to make it acceptable?

7.2 Identify The Hazards Or 'Threat' Risks (see Section 7.7)

7.2.1 Before deciding to conduct an activity, try to identify the main risks applicable to the type of operation as well as those that might affect the particular flight. For example, does the flight involve:

- Lower than normal operating levels?
- Particularly difficult manoeuvres?
- Unsuitable environmental conditions?
- Aircraft airworthiness issues?
- Issues of pilot fitness, level of training and recent experience? OR
- Extraneous pressures?

7.3 Categorise the Likelihood and Consequence of Adverse Events Stemming from the Hazard or Threat (Risk)

7.3.1 How likely is it that the hazard (risk) identified may have an adverse consequence?

7.3.2 Who will be affected and what is the likely severity of the consequence? It is highly probable that the consequence of an error or failure during low-level aerobatics will be fatal to the participants. Categorising the risk suggests the level of effort that needs to be applied to manage or mitigate the risk.

7.3.3 Must include assessment of risks to third parties (other airspace users and people and property on the ground).

7.4 Plan To Manage/Mitigate Risk

7.4 What strategies can be applied to mitigate risk (reduce the likelihood or severity of consequences, or both)? For example, cancel flight, operate at a higher level, leave out a manoeuvre? Be sure of the entry parameters required for successful completion of all manoeuvres and emergency recovery procedures. Warm up at a higher level.

7.5 Implement Risk Management Plan

7.5.1 Stick to the plan and the risk mitigation strategy. Modify the plan if necessary, but do not include unplanned spontaneous manoeuvres. Know and do not exceed aircraft and personal limitations.

7.6 Review performance

- Did the flight go as planned?
- Was the plan adequate?
- Were there any unexpected occurrences?
- How can the risk management plan or strategies be improved for future flights?

7.7 Threat and Error Management (TEM)

7.7.1 Threat and error management (TEM) is an operational concept applied to the conduct of a flight that includes the traditional role of airmanship, but provides for a structured and proactive approach for pilots to use in identifying and managing threats and errors (hazards) that may affect the safety of the flight.

7.7.2 TEM uses many tools, including training, Standard Operating Procedures (SOPS), checklists, briefings and crew resource management (CRM) principles to assist pilots to manage flight safely. It has been widely accepted in the airline industry as an effective method of improving flight safety, and is now required by the International Civil Aviation Organization (ICAO) as an integral part of pilot training at all licence levels from student to airline transport pilot. It is also a useful concept for aerobatic pilots to apply to their operations.

7.7.3 There is some overlap between risk management and Threat and Error Management (TEM), particularly at the stage of developing and implementing plans to mitigate risks and in reviewing the conduct of a flight, but 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.

7.7.4 The following sections provide a brief introduction to TEM to assist aerobatic pilots who may wish to apply the principles to their own operations.

7.8 Threats

7.8.1 In the TEM model, threats are events or hazards (e.g. meteorological conditions) whose occurrence is outside the control of the pilot(s) and which may threaten the safety of the flight. They may be anticipated or they may be unexpected, or they may be latent in the operational system. Pilots need good situational awareness to anticipate and to recognise threats as they occur. Threats must be managed to maintain normal flight safety margins. Some typical threats/hazards to aerobatic operations might be:

- Strong winds and/or turbulence;
- High density altitude;
- Other traffic;
- High terrain or obstacles;
- Pre-existing structural damage;
- Third parties on the ground.

7.9 Errors

7.9.1 The TEM model accepts that it is unavoidable that pilots, as human beings, will make errors. Errors may be intended or unintended actions or inactions on the part of the pilot(s) and can be classified as handling errors, procedural errors or communications errors. External threats can also lead to errors on the part of the pilot(s).

7.9.2 While errors may be inevitable, safety of flight demands that errors that do occur are identified and managed before flight safety margins are compromised. Some typical errors in aerobatics flight might be:

- Setting altimeter subscale incorrectly;
- Aircraft handling errors;
- Failure to use or achieve manoeuvre entry parameters;
- Impulsive deviation from intended routine; or
- Not observing G or other limitations.

7.10 Undesired Aircraft State

7.10.1 Threats and errors that are not detected and managed correctly can lead to an undesired aircraft state, which is a deviation from flight path or aircraft configuration that reduces normal safety margins. 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 an incident. Aerobatic flight requires recognition and recovery from undesired aircraft state in a very short timeframe before an outcome, such as unintended spin, descent below minimum height or GLOC occurs. Examples of an undesired aircraft states in aerobatics might be:

- Pre-stall (buffet) during manoeuvre;
- Manoeuvre commenced with insufficient energy state (height and/or speed);
- Approaching G or other airframe limitation;
- Incorrect attitude recognised during manoeuvre; or
- Grey-out and/or tunnel vision.

7.10.2 Good TEM requires the pilot to plan and use appropriate countermeasures to prevent threats and errors from 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 automation 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.

7.10.3 Once an undesired aircraft state is recognised, it is important to manage the undesired state and prioritise aircraft control for return to normal flight, rather than to fixate on the error which may have initiated the event.

7.11 TEM Application

7.11.1 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. One interesting fact revealed by this programme is that around 50% of crew errors go undetected.

7.11.2 TEM should be integral to every flight, including anticipation of potential threats and errors, and planning of countermeasures. Include potential threats, errors and countermeasures in the self-briefing process at each stage of flight, and avoid becoming complacent about threats that are commonly encountered.

7.11.3 Error management requires an acceptance that errors are unavoidable and the use of standard operating procedures, checklists, monitoring and cross checking procedures to both minimise the risk of errors and to detect and manage those that occur. Good situational awareness at all times is essential to TEM.

7.11.4 The following summary is intended to assist pilots to apply TEM to aerobatic operations:

- Try to anticipate possible threats and errors associated with each flight, and plan countermeasures;
- Brief (self-brief) planned procedures before take-off and prior to commencing each aerobatic sequence;
- Include anticipated threats and countermeasures in briefings;
- Continuously monitor and cross check visual and instrument indications and energy state to maintain situational awareness;
- Prioritise tasks and manage workload so as not to be overloaded and to maintain situational awareness;
- Identify and manage threats and errors;
- Identify the threat/error;
- Maintain control of the aircraft and flight path;
- Manage the threat or error, and
- Monitor the progress of the sequence and abort if necessary;
- Identify and manage undesired aircraft state;
- Identify undesired aircraft state;
- Aircraft control and flightpath and abort if necessary are the first priority;
- Do not fixate on error management;
- Manage the undesired aircraft state;

- Recover to planned flight and normal safety margins as the first priority.

7.12 Situation Awareness

7.12.1 Situation awareness is the awareness of all the elements in the environment, how they affect your flight, and how they could affect it in the future. Situation awareness requires good anticipation and asking 'what if'? Considering all possibilities and planning operations to proactively identify and manage the potential threats and errors for each flight will aid in enhancing situational awareness. Typical issues to consider for aerobatics activities are:

- Pilot fitness;
- Pilot G awareness and readiness;
- Aircraft airworthiness;
- Aircraft G loading and manoeuvre limitations;
- Aircraft airspeed and engine limitations;
- Manoeuvre entry parameters;
- Unusual attitude/ spin recognition and recovery;
- Density altitude effect on performance;
- Area/ terrain/ ground features;
- Height limitations;
- Cloud base and visibility;
- Airspace requirements and other traffic;
- Use of clearing manoeuvres;
- Extraneous pressures;
- Possible effects on persons, animals and property on the ground.

7.13 Decision Making

7.13.1 The ability to assess a situation, identify the need to make a decision and then to implement the decision in the time available is an essential element of aircraft operation and successful TEM.

7.13.2 Emotions often play a significant role in decision-making with the decision being an emotional reaction to a situation rather than the result of a logical and structured process. The use of a logical and structured decision making process will reduce the likelihood of emotions clouding or confusing the result. Decisions can be proactive (anticipating a problem), or reactive (dealing with an unexpected problem) but the decision-making process always involves:

- Identifying a problem;
- Collecting relevant information;
- Generating and analysing options;
- Deciding on the most appropriate option;

- Implementing the decision;
- Monitoring progress against intended outcomes and modifying actions as required.

7.13.3 Good decision-making relies on good situation awareness and the ability to identify problems and available options promptly so as to decide on the best course of action without being influenced by extraneous pressures. However, studies show that pilots mostly base decisions on previous experience and learned rules and procedures, particularly in situations where time is limited, such as in aerobatics.

7.13.4 Aerobatic decision-making therefore needs to concentrate on a proactive approach, because there is unlikely to be much time to fully consider all aspects of a problem when something goes wrong. Proactive decision-making uses TEM to identify potential threats and errors, and to plan countermeasures such as establishing parameters for commencing and aborting manoeuvres or sequences, so that the pilot has already made a decision as to the action required in a particular situation.

7.14.5 Avoid 'spur of the moment' decisions to conduct manoeuvres which have not been planned and the implications not thought through, and particularly avoid making such decisions based on extraneous pressures.

7.15 Fatigue Management

7.15.1 Aerobatics is very strenuous and fatiguing. Inadequate rest or hard physical exertion before a flight can affect performance and G tolerance, particularly the ability to do effective G resistance straining. Plan aerobatics sessions to be well rested beforehand and accept there is a limit to the length of a session and the number of sessions that the body can handle in a given period. Good physical conditioning will increase endurance and assist recovery from aerobatics.

7.16 Recognition And Recovery From Mis-handled Manoeuvres

7.16.1 In aerobatic flight, there is always the possibility of unintentional entry into a spin or disorienting unusual attitude, and the application of an incorrect recovery procedure is likely to exacerbate the problem.

7.16.2 It is beyond the scope of this CAAP to provide detailed procedures for recovery from all situations in all types of aircraft, but pilots need to be able to recognise and take appropriate recovery action applicable to the aircraft type for each of the following:

- Extreme unusual attitudes, upright or inverted, nose high or low;
- Upright spin;
- Inverted spin; and
- Spiral dive.

7.17 Unusual Attitude Recovery

7.17.3 The following procedure does not require immediate recognition of the aircraft's attitude, but depends on the pilot recognising when the nose has fallen below the horizon and regaining orientation from that reference. It is applicable to both high and low nose attitudes but a low nose attitude will require the following actions to be completed promptly:

- Close throttle;
- Centralise and hold controls firmly;
- As soon as the nose falls below horizon;
- Prevent yaw with rudder;
- Roll aircraft upright, wings level with the horizon; and
- Return the nose to level attitude, observing airspeed, G and engine limitations.

7.18 Spin Recovery

7.18.1 Modern aerobatic aircraft designs normally have predictable spin characteristics and respond to the standard spin recovery technique. However, older aircraft and non-certificated or amateur built aircraft may have special characteristics which require particular recovery procedures. Therefore pilots need to be familiar with, and practised in, the spin recovery procedure specified for the particular aircraft type.

7.18.2 The following standard spin recovery procedure is applicable, with variations, to most aircraft types.

7.19 Spin Recognition

7.19.1 It is important to determine if the aircraft is in a spin before applying the spin recovery procedure. The two elements which conform that the aircraft is in a spin are:

- Continuous rotation in yaw and roll;
- Airspeed is stable (not increasing);

Note that increasing airspeed indicates a spiral dive, rather than a spin.

7.20 Upright Or Inverted

7.20.1 When a spin is entered unintentionally from an aerobatic manoeuvre, it is important to establish if the spin is upright or inverted.

7.20.2 Generally, when looking out the front of the aircraft, the sky appears <u>to be above</u> in an upright spin. In an inverted spin the ground appears <u>to be above</u>. In an inverted spin, there will be -G forces tending to lift the pilot off the seat.

7.21 Direction Of Rotation

7.21.1 The direction of rotation may be determined by looking down the nose of the aircraft and confirming the direction of yaw in relation to the ground. The direction of yaw is the direction of rotation of the spin. The direction of spin may be confirmed from the turn needle or the turn coordinator. However, a turn coordinator indication may not always be reliable, particularly if the aircraft is inverted.

7.21.2 Aircraft flight manuals will specify the particular spin recovery procedure for the aircraft type, based on the aircraft's demonstrated handling characteristics during flight testing. It is imperative to know and apply the procedure specified in the aircraft's flight manual or Pilot Operating Handbook for the aircraft type.

7.21.3 The following generalised spin recovery procedure should be applicable in most situations and aircraft, but the procedure specified in the aircraft's flight manual is the ultimate authority.

7.22 Standard Spin Recovery:

- Close throttle;
- Centralise ailerons;
- Identify if the aircraft is spinning, the direction, and whether upright or inverted;
- Full rudder opposite to rotation (opposite to yaw);
- Pause;
- Elevator forward for upright and back for inverted as required to unstall;
- When rotation stops - centralise rudder;
- Roll wings level and recover to level flight.

7.23 Aircraft Type Differences

7.23.1 Spin recovery procedures will vary between aircraft types and situations. The aircraft flight manual should be the final authority for spin recovery procedure, but some issues that may need to be considered are:

- Too much or too rapid an application of elevator control may blanket the airflow over the rudder, making it ineffective;
- Too much or too rapid an application of elevator control may flick the aircraft from an upright to an inverted spin or vice-versa;
- Use of aileron into the spin may sometimes assist in recovery;
- Where there is difficulty differentiating between an upright and an inverted spin, full back control column may ensure the aircraft enters an upright spin.

7.24 Mueller-Beggs Spin Recovery

7.24.1 This method is a simplified spin recovery technique which has been claimed as effective for both upright and inverted spins. However, there are known to be a number of aircraft types in which the procedure is not effective.

7.24.2 The advantages claimed for the method are that the simplicity of the procedure avoids the problems of recognition of upright or inverted spins. It is also claimed to provide a quick recovery due to maintaining the best airflow over the elevators for maximum rudder effectiveness.

7.24.3 CASA is unable to verify these claims and recommends that pilots should use the spin recovery procedure specified in the aircraft flight manual.

7.24.4 Before using the procedure, pilots would be advised to first determine the extent to which it has been tested and found reliable in the particular aircraft type. Pilots wishing to test the procedure should also be familiar with the normal spin recovery procedure specified for that type.

7.24.5 The procedure is mentioned in this CAAP for information purposes. It is NOT being recommended as a spin recovery procedure. However it may possibly be useful if a pilot becomes disoriented.

Mueller-Beggs Spin Recovery:

- Close throttle;
- Let go of the control column;
- Full rudder opposite to rotation (yaw);
- When rotation stops - centralise rudder;
- Re-grasp control column, roll wings level and recover to level flight.

7.26 Keeping Current

7.26.1 Aerobatic skills degrade quickly and need to be maintained by constant practice, but regulations do not specify any requirements for recent experience for aerobatic pilots. Pilots therefore need to develop their own strategies for maintaining or regaining proficiency and ensuring they are sufficiently in practice to perform the planned aerobatic manoeuvres safely.

7.26.2 Strategies for regaining proficiency after lack of recent practice may include:

- Obtain dual instruction;
- Limit practice to basic manoeuvres initially;
- Operate at a higher altitude to provide a greater safety margin;
- Practice emergency recovery procedures; and

- Allow sufficient practice time to re-acclimatise to high G forces.

7.27 Recent Experience

7.27.1 For pilots planning to conduct aerobatics below 3000' AGL, the following is provided as guidance for maintaining a suitable level of aerobatic currency. However, it is the pilot's own responsibility to assess the suitability of this advice for his or her particular needs, and to decide whether the experience specified here is adequate to ensure that he or she is in sufficient current practice to safely conduct the manoeuvres planned.

7.27.2 The following recent aerobatic experience is suggested as the minimum that would provide an adequate level of current practice to safely conduct aerobatics below the levels specified in the following paragraphs:

(i) Below 3000' AGL – the pilot has performed an aerobatic sequence at least three times in the preceding 12 months;

(ii) Below 1500' AGL – the pilot has performed an aerobatic sequence in the preceding 30 days down to a height of 1500' AGL or below;

(iii) Below 1000' AGL – the pilot has performed an aerobatic sequence in the preceding 30 days down to a height of 1000' AGL or below; and preferably performed a sequence down to 1000' preparatory to performing below 1000'.

7.28 Peer Review

7.28.1 While recent experience is important in maintaining proficiency, independent opinion on performance is an equally valuable tool for enhancing safety. Because of the high level of skill and the fine safety margins involved in low-level aerobatics, it is strongly suggested that low-level permission holders should undertake a peer review of their performance on a regular basis. An appropriate frequency would ensure that a peer review had been completed within the 15 months previous to conducting any low-level aerobatics.

7.28.2 The peer review process is intended to provide an independent assessment by a similarly qualified person or persons on the way the pilot conducts the activity and to identify any incorrect techniques or practices that the pilot may have developed over time. It is not intended to be a flight test for the renewal of the permission, but an opportunity for constructive discussion with other practitioners with a view to enhancing the safety of a pilot's performance.

7.28.3 The following is the recommended procedure for the peer review process:

- The pilot should have had sufficient recent practice and/or training to be able to conduct a sequence of low-level aerobatics safely;

- The pilot should brief the observer(s) on the sequence to be flown;
- The pilot should fly the sequence under observation, either from the ground or the aircraft down to the level of the permission, or the level to which the pilot intends to exercise the permission, if higher;
- After the flight, the pilot and the observer(s) should de-brief the sequence to identify ways in which performance and safety could be improved; and
- The review is entered in the pilot's logbook and signed by the pilot and by the observers as a record to indicate that the observation and discussion has taken place. It could include a disclaimer that the observer is not certifying the pilot's competence.

7.28.4 The observers would need to have proficiency in low-level aerobatics and preferably also in assessing low-level aerobatic performance. Suitable observers would be any one of the following:

- CAR 155 delegate; or
- At least two other low-level permission holders with similar permissions; or
- CASA Flying Operations Inspector (FOI).

7.28.5 During the debriefing process it is important to be objective in identifying items that were done well and those that could have been done better. Emphasis should be on providing input and advice on ways to improve safety and performance rather than on questioning an individual’s ability.

7.28.6 Signing-off as an observer for peer review should not be construed as certifying the competency of the pilot, but that the review has taken place and that any issues of concern have been brought to the pilot’s attention.

7.28.7 The object is not to assess the pilot as suitable or otherwise to continue to hold the permission, but in cases where continued operation by the pilot would constitute a serious risk to air safety there would be some moral responsibility for the participants to counsel the pilot and, if necessary, bring this to the attention of CASA.

7.29 Aerobatic Checks

7.29.1 Aerobatics, like any other flight activity, requires a system for checking essential safety items before, during and after every flight. The following checks are specific to aerobatics and are additional to the normal checking activities that should be conducted on all flights.

7.30 Pre-flight Planning:

- Pilot is qualified and current for aerobatics;
- Pilot physical and mental fitness for aerobatics;

- Aircraft is suitable for planned aerobatics;
- Aircraft limitations checked and known;
- Day visual flight rules (VFR) with meteorological conditions suitable for aerobatics;
- Suitable area selected;
- Airspace and height limitations checked;
- Manoeuvre sequence planned;
- Manoeuvre safe entry parameters known;
- Risk management reviewed; and
- For low-level aerobatics, check aircraft all up weight and the expected density altitude for the effect on performance.

7.31 Pre-flight Inspection

7.31.1 A pre-flight inspection for an aerobatic flight will cover all the items for a normal pre-flight inspection, but with additional attention to items that are particularly critical to aerobatic safety.

Structure–check for visual evidence of damage or failure including struts and strut connections, elevator and rudder stops, wrinkles in the metal or fabric covering and looseness in any structural part. Also check control surfaces, cable trim tabs and actuating rods etc.

Seatbelts and shoulder harness - make sure the harness is suitable for aerobatics, is in good condition, and check that the latching mechanisms lock securely. Check that unoccupied seats have their harnesses secured so that controls cannot be fouled.

Doors and canopies–Check doors, windows and canopies for secure locking.

Controls–With all occupants seated and strapped in, ensure that the controls can be operated freely through the full range of movement and work in the correct sense.

Loose objects–Don't carry items that are not essential for the flight, and make sure any loose objects are secured or stowed. Check for foreign objects in the cockpit and in the fuselage to ensure that there are no loose objects which could jam the controls during manoeuvres. For all occupants, empty pockets or ensure that they are securely closed and that there are no loose items in clothing. Make sure the cockpit floor is clean and ashtrays are empty and closed.

7.32 Passengers

7.32.1 If passengers are carried on aerobatic flights they should be fully briefed on aerobatic considerations:

- Safety harness is tightly fitted and secured at all times;
- Seats securely locked in position;
- Briefed not to interfere with controls;
- Are they fit for aerobatics? (no illness or medical condition);

- The manoeuvres and sensations to be expected;
- To alert pilot of feelings of nausea or problems with harness or seat;
- Location of ventilation controls and sick bags.

7.32.2 It is advisable not to subject passengers who are not used to aerobatics to -G loadings.

8. In Flight

8.1 Airspace

8.1.1 Select an area that is not in congested airspace and is away from aerodromes and built up areas. CAR 141(2) precludes aerobatic flight in a flying training area unless it is in an aerobatics training area set aside for the purpose. Check that the area around and below is clear before performing spins or aerobatic manoeuvres, and maintain a lookout and listening watch for other traffic while performing.

8.2 Noise

8.2.1 Consider that your aircraft will be operating at high power settings during many aerobatic manoeuvres and minimise the noise effect by flying higher and over sparsely populated areas where possible.

8.3 Pre-aerobatic Checks.

8.3.1 Prior to commencing aerobatic manoeuvres carry out appropriate checks. Use of the acronym HASELL is useful.

- **H**eight–sufficient to recover by 3000' AGL (or the lower limit of the pilot’s approval);
- **A**irframe–gear up, flaps up, trims within normal limits;
- **S**ecurity–harness secure, hatches closed, no loose objects;
- **E**ngine–instruments checked, mixture rich, carburettor heat checked, fuel adequate, fuel selections made;
- **L**ocation–in an appropriate area, not over a built-up area, forced landing options reviewed, major features identified;
- **L**ook-out–clearing turns both directions and review between manoeuvres.

8.4 Low-level Checks

8.4.1 The following additional checks can be performed at a safe height prior to conducting low-level aerobatics:

- Inverted check for loose articles and for aircraft systems functionality;
- a slow loop to check aircraft handling characteristics;
- a manoeuvre that takes a known height, to check aircraft performance and altimeter indications;

- a G awareness manoeuvre, such as a high G turn. This should be three to five G for 10 seconds to allow the pilot to practice the G straining manoeuvre and to ready the cardiovascular system for high G. It is not to check maximum G tolerance.

8.5 In-flight Exceedences

8.5.1 Monitor airspeed, engine and accelerometer indications during all manoeuvres.

8.5.2 If at any time during a flight the aircraft limitations are exceeded, the aircraft should be immediately returned to the aerodrome for an inspection by a licensed aircraft maintenance engineer (LAME). If something doesn't feel right during the flight, for instance abnormal control pressures or responses, unusual vibrations etc, the same advice applies.

9. Post-flight Inspection

9.1 Overstressing

9.1.1 Conduct a careful post-flight inspection of the aircraft to check for indications of overstressing or damage that may have occurred or become evident following the flight, as if you are about to fly the aircraft yourself. Look for the same items listed in the pre-flight inspection.

9.2 Maintenance Release

9.2.1 Enter damage, defects or exceedences in the maintenance release or flight technical log.

9.3 Responsibility To Other Pilots And Operators

9.3.1 To ensure that significant safety issues are not overlooked, the pilot has a responsibility to subsequent pilots, not only to enter defects or exceedences in the maintenance release, but to bring to the attention of the owner, operator or subsequent pilot, any matter about which there could be a concern in relation to airworthiness. A number of in-flight airframe failures have been attributed to stresses experienced by the aircraft on a previous flight or accumulated over a number of previous flights.

9.3.2 Do not reset the accelerometer, leave it as evidence to the next pilot of the G loadings experienced.

9.4 Aerobatics Safety Summary:

- Aircraft is airworthy and prepared;
- Pilot physically and mentally ready for spins and aerobatics;
- Know the limitations of both yourself and the aircraft;
- In case of disorientation, plan to roll upright, level to the nearest horizon rather than pull through, and take time out to recover equilibrium;

- Review the emergency spin recovery procedure for upright and inverted;
- Review procedure for unusual attitude recovery;
- Assess the possibility of GLOC in the manoeuvre sequence.
- Do the full 'HASELL' check before commencing manoeuvres;
- Use a clearing procedure before all manoeuvres;
- Review the entry parameters for ensuring safe manoeuvreing.
- Start with sufficient height to give plenty of margin for recovery;
- Maintain a good lookout during any sequence of manoeuvres;
- Do not exceed maximum engine RPM or manifold pressure;
- Monitor and react appropriately to engine temperatures and pressures, particularly during prolonged inverted flight;
- Never exceed the G or V_{NE} limits of the aircraft;
- Do not make full-range or aggressive control movements near or above manoeuvring speed (V_A/V_{MAN});
- Do not roll the aircraft above its rolling G limit;
- Do not do flick manoeuvres above the speed stipulated in the flight manual;
- Do not pull significant G above V_A in turbulent conditions (a gust could overstress the aircraft);
- Constantly monitor your height for recovery margins;
- Constantly monitor G forces in relation to physiological and structural limitations.

Appendix A to CAAP 155-1(0)

RECOMMENDED AEROBATICS COMPETENCY STANDARDS

Range of Variables

Competency is demonstrated when performance standards are achieved consistently 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.

Infrequent temporary divergence from specified tolerances is acceptable if the pilot applies controlled corrective action.

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 human factors 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 to be 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 should not involve simulation of more than one emergency at a time.

Aerobatic Pilots should demonstrate that control of the aircraft or procedure is maintained at all times so that the 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 including weather and NOTAMs;
- 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 instructor's comments, to support assessment of consistent achievement; and
- The trainee’s logbook for evidence of flight training completed.

Unit 1: Recover from Spin – Flight Standard

Unit Description: Skills and knowledge to recover from an upright spin.

Elements	Performance Criteria
1 Recover from spin	• Performs pre-manoeuvre checks. • Enters and establishes an upright spin. • Identifies upright spin and direction of yaw. • Closes throttle. • Stops yaw. • Unstalls wing (aircraft). • Recovers to controlled flight. • Recovers within the number of turns normally required for spin recovery in the aircraft type, within aircraft and height limitations.

Range of Variables

- Day visual flight rules (VFR) flight in visual meteorological conditions (VMC).
- Within the lateral and vertical limitations of the planned manoeuvring airspace using an approved aerobatic aeroplane.

Underpinning Knowledge

Explain what actions, by a pilot, with an aeroplane in any attitude, at the point of stall, are likely to cause a spin.
Explain the blanketing effects the elevator can have on the rudder during spin recovery.
Discuss the significance of stick/control wheel position with respect to spin recovery.
Explain the aerodynamic causes of a spin.
Explain what aerodynamic factor determines the direction of a spin.
Explain how to recognise a stable spin.
Explain the difference between a stable spin and an unstable spin.
Explain the difference between a spin and a spiral dive.
State factors which may lead to a flat spin.
Explain the difference between an upright and an inverted spin.
Explain what visual indications are used to determine the direction of a spin.
Explain which instrument indications confirm the direction of a spin.
State standard spin entry and recovery techniques for the aircraft being flown.
State the number of turns normally required for spin recovery in the aeroplane type.
State the height normally required to enter and recover from a stable spin.
Explain the 'Mueller-Beggs' spin recovery action and limitations on its application.
State the 'G' and any other limitations applicable to spinning for the aeroplane type.

Unit 2: Recover from Inverted Spin-flight Standard

Unit Description: Skills and knowledge to recover from an inverted spin.

Elements	Performance Criteria
1 Recover from inverted spin	• Performs pre-manoeuvre checks. • Enters and establishes an inverted spin. • Identifies inverted spin and direction of yaw. • Closes throttle. • Stops yaw. • Unstalls wing (aircraft). • Recovers to controlled flight. • Recovers within the number of turns normally required for inverted spin recovery in the aircraft type, within the aircraft and height limitations.

Range of Variables

- Day visual flight rules (VFR).
- Approved aeroplanes.
- Aircraft certified to perform inverted spinning manoeuvres.

Underpinning Knowledge

Explain the difference between an inverted spin and an upright spin.
Explain the aerodynamics of an inverted spin.
Explain what aerodynamic factor determines the direction of an inverted spin.
Explain the relationship between the direction of yaw and the direction of roll during an inverted spin.
Explain the G effects of an inverted spin, including low and high nose attitudes.
Explain how to recognise an inverted spin from visual, G and instrument indications.
State standard inverted spin entry and recovery techniques for the aircraft type being flown.
State the number of turns normally required for inverted spin recovery in the aeroplane type.
State the height normally required to enter and recover from an inverted spin.
Discuss the significance of stick/control wheel position with respect to spin recovery.
Explain how to maximise rudder effectiveness during inverted spin recovery.
State the G and any other limitations applicable to inverted spinning for the aeroplane type.
Explain the likely cause of an aircraft transitioning from an upright spin to an inverted spin.
State the height loss for each turn of an inverted spin.
Explain the 'Mueller-Beggs' inverted spin recovery action and limitations on its application.
State the inverted flight limitations for the aircraft flown.
State the possible effect on a pilot of prolonged spinning.

Unit 3 - Aerobatic Manoeuvres

Unit Description: Skills and knowledge to perform aerobatic manoeuvres and recover from any unusual attitudes while remaining within aircraft and physiological limitations during visual flight.

Elements	Performance Criteria
1. Prepare for aerobatic flight	• Checks airworthiness and security of aircraft and occupants and personal fitness before aerobatic flight. • Selects suitable airspace that allows the completion of all aerobatic manoeuvres above the authorised minimum altitude. • Performs pre-manoeuvre checks and selects appropriate aircraft configuration. • Maintains lookout using a systematic scan technique at a rate determined by traffic density, visibility and terrain.
2. Perform loop	• Initiates loop at the specified entry airspeed (± 5 kts). • Pitches the aircraft with +G at a continuous rate through 360°. • Maintains balanced flight, wings parallel to the horizon. • Maintains alignment with a nominated line feature (±15°) of heading. • Complies with engine, airframe and physiological limitations. • Maintains aircraft not below the specified height.
3. Perform barrel roll	• Initiates barrel roll at the specified entry airspeed (± 5 kts). • Pitches and rolls the aircraft at a continuous rate along a spiral path with the aircraft inverted at the highest point of the manoeuvre. • Maintains aircraft balance and +G throughout. • Pitches aircraft sufficiently to maintain +G with inverted and upright pitch positions equidistant from the horizon. • Maintains alignment with a nominated line feature (±15°) of heading. • Maintains aircraft not below the specified height.
4. Perform slow roll	• Initiates slow roll at the specified entry airspeed (± 10 kts). • Rolls the aircraft around the fore and aft axis through 360° while maintaining direction (± 10°) and altitude (± 100'), or a height loss appropriate to the aircraft type. • Rolls aircraft at a constant rate, less than the maximum rate of roll, experiencing -G when inverted. • Maintains alignment with a nominated line feature (±15°) of heading. • Maintains aircraft not below the specified height.

Elements	Performance Criteria
5. Perform roll off the top	• Performs half a loop to inverted level flight. • Rolls the aircraft to upright level flight (±15°) of heading, ±100' of altitude. • Maintains alignment with a nominated line feature (±15°) of heading. • Maintains aircraft not below the specified height.
6. Perform stall turn (vertical yaw reversal)	• Initiates entry at the specified entry airspeed (± 10 kts). • Pitches aircraft to nose up vertical attitude with the wings parallel to the horizon without roll. • Yaws aircraft through 180° to nose down vertical attitude with wings parallel to the horizon without roll. • Recovers the aircraft from the dive to straight and level flight. • Complies with engine, airframe and physiological limitations. • Maintains alignment with a nominated line feature (±15°) of heading. • Maintains aircraft not below the specified height.

7. Recover from unusual attitudes	• Recovers aircraft to controlled flight, in the height available, from any attitude, bank angle or speed within the limitations of the aircraft. • Recovers aircraft to controlled flight, in the height available from any inverted negative G attitude, bank angle or speed within the limitations of the aircraft.

Range of Variables

During assessment, the pilot should demonstrate the required aerobatic manoeuvres in accordance with the following criteria:

- Day visual flight rules (VFR) flight in visual meteorological conditions (VMC);
- Within the lateral and vertical limitations of the planned manoeuvring airspace;
- Using an approved aerobatic aeroplane;
- In accordance with procedures and limitations specified in approved checklists, placards, aircraft's flight manual, Pilot's Operating Handbook (POH), or Operations Manual for the aeroplane used.

Underpinning Knowledge
State the minimum altitude to perform aerobatic manoeuvres. Recall rules prohibiting conduct of aerobatics. State airworthiness requirements for aircraft used for aerobatics. Explain the meaning of the terms positive and negative G. State the symmetrical positive and negative G limits for the aircraft flown. Explain the limitations: V_A, V_{NE}, and V_{NO}. Explain the effect of aircraft weight on V_A and appropriate precautions. State the engine, manoeuvre, configuration and any other aerobatic limitations for the aircraft flown. Explain expected effects on airframe of exceeding G limitations. State what structural irregularities may indicate that an aircraft has been overstressed. Explain the meaning of the term 'rolling G'. State the rolling G limits (if any) for the aircraft flown. State the rule used to calculate the rolling 'G' limitation of an aircraft. Explain the characteristics of pre-stall buffet and the relationship between pre-stall buffet and rate of turn or rate of pitch. State the effect that increased G loading has on stall speed. Explain the effect of increasing airspeed on stick force. Explain the actions to recover from a nose high reducing airspeed or a nose low increasing airspeed situation from upright and inverted flight. Explain why it is necessary to level wings before recovering from a nose low attitude. State the emergency spin recovery procedures for upright, inverted and flat spins. Explain the physiological effects of positive and negative G. Differentiate between low-level, black-out, red-out and GLOC. Explain the physiological effects of sustained and rapid change of G loading. State the conditions under which G induced loss of consciousness (GLOC) is most likely to occur. State the symptoms (if any) of impending GLOC. State the expected sequence and duration of recovery from GLOC Explain what physiological factors can reduce G tolerances. Explain the physical actions that may be used to increase G tolerance. Explain how to recover from manoeuvre induced disorientation. Explain how to assess personal fitness for aerobatic flight.

Unit 4 - Low-level aerobatics standards

Unit Description: Skills and knowledge to design an aerobatic sequence, plan an aerobatic performance and conduct aerobatics safely below 3000' AGL.

Elements	Performance Criteria
1. Design a low-level aerobatic routine	• Designs a low-level aerobatic sequence consisting of a minimum of six aerobatic manoeuvres that meet a specified requirement, involves practical transitions between manoeuvres, and identifies performance parameters that will ensure safe completion of all manoeuvres above the minimum planned height AGL. • Identifies performance parameters based on a combination of aircraft attitude, power setting, altitude and speed that provide go/no-go guidance for safe completion of all manoeuvres above the minimum planned height AGL within the physical limitations of the pilot and structural limitations of the aircraft.
2. Plan a low-level aerobatic performance	• Applies threat and error management principles to planning the low-level aerobatic performance. • Identifies the stakeholder requirements for the aerobatic sequence and formulates a plan to safely perform the sequence, meeting the specified requirements. • Ensures pilot's aerobatic approvals are appropriate and valid and that pilots physiological condition, skill level and recent aerobatic experience are adequate for safe operation. • Analyses prevailing and forecast weather and applies wind velocity, visibility and cloud base to ensure aircraft remains within lateral limits and vertical limits and in visual meteorological conditions (VMC). • Considers methods to safely modify aerobatic performance if required by environmental considerations or other requirements. • Identifies the go/no-go performance criteria for commencing each manoeuvre and plans to break off manoeuvres at any point of the aerobatic sequence where performance criteria are not achievable. • Identifies escape manoeuvres that could be required during the aerobatic sequence stating the go/no-go criteria and details the escape manoeuvres that will result in (return to) controlled flight above the minimum planned height above ground level (AGL).

3. Perform low-level aerobatic manoeuvres	• Completes pre-flight and in-flight aerobatic checks.
	• Completes a low-level aerobatic sequence consisting of a minimum of six aerobatic manoeuvres in accordance with a prepared plan within the specified time (±30 seconds).
	• Ensures performance parameters required for safe completion of each manoeuvre are achieved prior to commencement of the manoeuvre and manages any failure to achieve required parameters.
	• Maintains VMC, orientation and situation awareness within planned area of operation.
	• Manages the energy potential of the aircraft to ensure completion of manoeuvres and sequences of manoeuvres within aircraft structure and minimum height limits.
	• Maintains height at or above a specified altitude not below minimum planned height AGL.
	• Demonstrates each of the following manoeuvres:
	    • Three turn upright spin (or the maximum permitted in the aircraft, if less);
	    • Loop;
	    • Slow roll to the left;
	    • Slow roll to the right;
	    • Aileron roll;
	    • Four point roll.
	    • Half Cuban eight;
	    • Reverse half Cuban eight;
	    • Stall turn;
	    • 90^o inverted turn; or in aircraft not capable of sustained inverted flight, half roll to inverted, pause and half roll in the opposite direction;
	    • Inverted spin (Not required if aircraft not approved for inverted spins or aerobatics limited to above 1500' AGL).
	• Maintains lookout and traffic separation.

4. Perform low-level aerobatic sequence	• Performs an aerobatic sequence consisting of at least six manoeuvres. • Maintains an altitude down to, but not below, the minimum specified throughout the sequence. • Maintains alignment with, and at least 500' to one side of, a nominated ground line, including in crosswind conditions. • Achieves appropriate height and airspeed entry parameters for all manoeuvres. • Demonstrates the ability to interrupt the sequence at any point and resume the sequence from the point of interruption.
5. Review low-level aerobatic performance	• Reviews the low-level aerobatic performance to identify ways of improving performance and safety.

Range of Variables

During assessment, the pilot should demonstrate the required aerobatic manoeuvres in accordance with the following criteria:

- Day visual flight rules in VFR in visual meteorological conditions (VMC);
- Within the lateral and vertical limitations of the planned manoeuvring airspace;
- Using an approved aerobatic aeroplane;
- In accordance with procedures and limitations specified in approved checklists, placards, aircraft's flight manual, Pilot's Operating Handbook (POH), or Operations Manual for the aeroplane used.

Underpinning Knowledge

Explain the factors to be taken into account when designing a low-level aerobatic sequence.
Explain how to apply risk management principles to the conduct of a low-level aerobatic sortie.
Explain the term 'energy management' as applied to aerobatic routines.
State the minimum height required to complete a pull-through manoeuvre, remaining within the structural limits of the aircraft, from inverted flight at 80 kts in the aircraft type being flown.
State the minimum height required to recover from a spin in the aircraft type being flown.
Describe the recovery technique to regain physiological and aircraft control when disorientation is experienced.
State the G limitations for the aircraft being flown.
State the rolling G limitations for the aircraft being flown.
Explain the emergency spin recovery technique for the aeroplane.
Explain the precautions that should be taken with regard to radius of turn when operating at a high density altitude.
State the considerations in planning to conduct low-level aerobatics over unfamiliar terrain.
Explain how the pilot will maintain competency in low-level aerobatics.
Explain the benefits of peer review in maintaining competency for low-level aerobatics.

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Appendix B to CAAP 155-1(0)

SAMPLE ACHIEVEMENT RECORDS

Recover From Upright /Inverted Spin - Achievement Record

(cross out whichever does not apply)

NAME:………………………………………………ARN:…………. ….

The standard for certification of each element is that all performance criteria for that element are met.

Unit	Element	Instructor/ ARN/ Date	Student/Date
Recover from spin	Recover from spin.		
Underpinning Knowledge Examined and Satisfactory	All items.		

I have completed the training specified in the elements, which have been certified on this Achievement Record.

....(Signature)

Logbook endorsed for upright / inverted spins in accordance with Civil Aviation Order (CAO) 40.0

……………………………………………………………….. (Instructor Signature)

…………………………………….…… ARN ……………….…………… Date

LOW-LEVEL AEROBATICS – SAMPLE ACHIEVEMENT RECORD

NAME:……………………………………………………ARN:………………

For Unit 1, Aerobatic manoeuvres, each of elements 1, 6 and 7 and at least one of elements 2, 3, 4 and 5 of, must be achieved prior to issue of the aerobatic endorsement. Each element must be certified as having been achieved at the specified standard by the instructor responsible for the assessment and the applicant must certify this Achievement Record.

Unit	Element	Instructor/ ARN/ Date	Student/Date
1. Aerobatic manoeuvres	Prepare for aerobatic flight. Perform loop. Perform barrel roll. Perform slow roll. Perform roll off the top. Perform stall turn (vertical yaw reversal). Recover from unusual attitudes. Recover from spin.		
Underpinning Knowledge Examined and Satisfactory	All items		

I have completed the training specified in the elements, which have been certified on this Achievement Record.

....(Signature)

Logbook endorsed for aerobatic manoeuvres listed below in accordance with Civil Aviation Order (CAO) 40.0 (delete manoeuvres not endorsed).

Loop, Barrel roll, Slow roll, Roll off the top, Stall turn

……………………………………………………………….….. (Instructor Signature)

……………………………………..… ARN ……………………………… Date

LOW-LEVEL AEROBATICS - SAMPLE ACHIEVEMENT RECORD

NAME:………………………………………………………ARN:………………..

The listed units and elements of competency have been achieved.

Unit	Element	Instructor/ ARN/ Date	Student/Date
Low-level Aerobatics	Design an aerobatic sequence.	.	
	Plan an aerobatic performance		
	Perform manoeuvres at a safe height. Three turn upright spin. Loop. Slow roll to the left. Slow roll to the right. Aileron roll. Four point roll. Half Cuban eight. Reverse half Cuban eight. Stall turn. 90^{o} inverted turn, or half roll to inverted, and back. Inverted spin.		
	Perform low-level aerobatic sequence.		
	Review low-level aerobatic performance.		
Underpinning Knowledge	All items.		

Competency was demonstrated down to (cross out if not applicable):
1500'/ 1000'/ 500' AGL and the applicant is recommended for assessment for Civil Aviation Regulation (CAR) 155 permission.

....(Instructor Signature)
………………… ARN ………………………………………..Date
I have completed the training in the elements specified on this record.

....(Signature)

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Appendix C to CAAP 155-1(0)

LOW-LEVEL AEROBATIC PERMISSION – SAMPLE APPLICATION

Australian Government
Civil Aviation Safety Authority

Application For Low-level Aerobatics Permission

PERSONAL DETAILS

Family Name	Given Names	Title	Date of Birth
Postal Address			

Telephone No. Work	Home	Mobile	Fax
Licence type:			Licence No (ARN)
Permission applied for: (cross out if not applicable or specify) Down to 1500 / 1000 / 500 feet AGL / Unlimited			

EXPERIENCE DETAILS

Total Hours	Aerobatic Hours	Low-level Aerobatic Hours	Aerobatic Aircraft Flown
Other aerobatic experience			
Aerobatic Low-level Endorsements - manoeuvres listed in CAO 40.0 including spin recovery.			
CAR 155 Low-level permission issued for ground observation by: Instrument No.			ARN Date

DECLARATION OF THE APPLICANT

I certify that the particulars I have provided above are, to the best of my knowledge, true in every respect. • I apply for approval to conduct aerobatics down to __________ feet AGL.	
Signature of Applicant	Date

I certify that I have assessed the applicant in accordance with the low-level aerobatic standards and he/she is competent to safely perform aerobatic manoeuvres down to the height specified. I have issued a Civil Aviation Regulation (CAR) 155 low-level aerobatic permission to the pilot with the following details:				
Date	Instrument No	Minimum Height	FW Piston < 800hp, or type	Expiry date
Any other condition/ comment:				
Delegate Signature				ARN

ASSESSMENT FOR LOW-LEVEL AEROBATIC PERMISSION

- Competency in the units and elements listed on this form must be demonstrated for the issue of a low-level aerobatics permission.
- For the aerobatic manoeuvres items 1 to 12 on this pro-forma, competency may be demonstrated at a safe height.
- Any of the aerobatic manoeuvre items 9 to 12 may be deleted from the assessment if the flight is conducted in an aircraft not approved to perform, or not capable of performing, the manoeuvre.
- The planned low-level aerobatic sequence must be demonstrated down to the level required to be approved (1500' AGL or 500' AGL).

	Underpinning Knowledge	
1	State rules for conduct of low-level aerobatics.	
2	State manoeuvre and G limitations of aircraft.	
3	State the minimum height required to complete a pull through manoeuvre and to recover from a spin in the aircraft type.	
4	State how limits on symmetrical and rolling G will be observed.	
5	Explain the effects on an airframe of exceeding G limitations.	
6	State the spin recovery procedure for the aircraft type.	
7	Explain factors affecting spin recovery characteristics of aircraft.	
8	Explain physiological effects of G in fast and slow applications.	
9	Explain meaning of ‘GLOC’ and ‘black/grey/red-out’.	
10	Explain conditions conducive to ‘GLOC’, onset symptoms and recovery.	
11	State physical strategies used to delay or reduce onset of G effects.	
12	Explain how to recover from manoeuvre-induced disorientation.	
13	Explain how to assess personal fitness for aerobatic flight.	
14	Explain the considerations in planning to conduct low-level aerobatics over unfamiliar terrain.	

	Plan and fly a low-level aerobatic sequence	
1	Design an aerobatic sequence.	
2	Plan an aerobatic performance.	
3	Conduct low-level aerobatics.	
	Performed at a safe height	
1	Three turn upright spin.	
2	Loop	
3	Slow roll to the left.	
	Slow roll to the right.	
4	Aileron roll.	
5	Four point roll.	
6	Half Cuban eight.	
7	Reverse half Cuban eight.	
8	Stall turn.	
9	90 inverted turn; or	
10	Half roll to inverted and back.	
11	Inverted spin.*	
	Performed down to level of permission	
12	Low-level aerobatic sequence	

***** Only required for approvals below 1500 feet AGL and if aircraft is approved for inverted spins.

Competent? Yes ✓ No X
Not assessed

Sequence demonstrated down to: 1500'/ 1000' / 500' above ground level (AGL) (cross out item not applicable) Comments: I certify that I have assessed the applicant in accordance with the low-level aerobatic standards and he/she is competent to safely perform aerobatic manoeuvres down to the height specified.				
Delegate Signature				ARN
Date	Ground Time	Flight Time	Aircraft Type	VH -

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Appendix D to CAAP 155-1(0)

CAR 155 Low-level Aerobatic Permission.

INSTRUMENT NUMBER: 05/NNNN/delegate's ARN
CIVIL AVIATION ACT 1988
CIVIL AVIATION REGULATIONS 1988

PERMISSION UNDER REGULATION 155

I, *[insert full name of delegate]*,
a delegate of CASA, under sub-regulation 155(6) of the Civil Aviation Regulations 1988 (CAR 1988), permit:

[Full Name of Person]
(Aviation Reference Number [ARN])

to engage in aerobatic flight in
[Insert 'fixed wing piston-engine aircraft of less than 800 hp and/or specific aircraft type in all other instances]

at a height no lower than

[Minimum Height] feet above ground level (AGL),

in accordance with Regulation 303A, this permission is subject to the conditions set out in the schedule.

SCHEDULE

1 The minimum heights and distances from a group of persons must be those specified for spectators in Civil Aviation Order (CAO) 29.4.

2 This permission is not a permission to conduct manoeuvres below the minimum heights specified in Civil Aviation Regulation (CAR) 157, Low Flying. A separate low flying permission under CAR 157 is required to conduct manoeuvres below those minimum heights.

3 Passengers must not be carried during manoeuvres below 1500', nor during any aerobatic demonstration, display or competition.

4 This permission does not constitute a permission under CAR 156 to conduct aerobatic flight over public gatherings.

5 Aerobatic manoeuvres must not be conducted within or over:

(a). any location likely to be a hazard to the navigation of other aircraft;

(b). any location known or likely to be noise sensitive; or (c). over any area that in the event of an aircraft malfunction persons on the ground or water would be endangered.

This instrument remains in effect until suspended or cancelled.

[Signature of CAR 155 Delegate]

[Print name of CAR 155 Delegate and ARN]

[Date]

NOTES:

1. This permission does not confer on its holder any rights, as against the owner of the land over which the operations may be conducted, or prejudice in any way the rights and remedies which any person may have in law in respect of any injury to person or damage to property caused directly or indirectly by the permission holder.

2. This permission is not an approval to conduct aerobatics at an air display. To conduct aerobatics at an air display, a person must make a written application in accordance with section 29.4 of the Civil Aviation Order for a permission under CAR 156.

Appendix E to CAAP 155-1(0)

Sample CAR 155 delegation

INSTRUMENT NUMBER: CASA /06
CIVIL AVIATION ACT 1988
CIVIL AVIATION REGULATIONS 1988

INSTRUMENT OF DELEGATION

I, ...,., Director of Aviation Safety,
under Subregulation 7 (1) of the *Civil Aviation Regulations 1988* (CAR 1988) delegate to:

..Aviation Reference Number (ARN) ....

CASA's powers and functions under the provisions of CAR 155 (6), to give a permission to engage in aerobatic flight in an aircraft at a height lower than 3000' above terrain in accordance with the following conditions:

(i) The delegate must be approved under Civil Aviation Order (CAO) 40.0, paragraph 2.6 to give instruction in aerobatic flight or hold a current flight instructor rating and be certified to give aerobatic flight instruction under CAO 40.1. paragraph 7, 9.5.
(ii) The delegate must hold a low-level aerobatics permission under CAR 155.
(iii) The delegate must have personally assessed the applicant's competence in accordance with the standards of CAAP 155-1(0) and be satisfied that the applicant is competent to safely conduct the aerobatic flight under the conditions specified in the permission.
(iv) The delegate must not issue a permission for a type or class of aircraft that is not listed on the delegate's own CAR 155 low-level permission.
(v) The delegate must not issue a permission to operate lower than the minimum level specified on the delegate's own CAR 155 low-level permission.
(vi) Within the 12 months previous to issuing a permission, the holder must have demonstrated competency in conducting low-level aerobatics to one of the following:
    (a) a CASA Flying Operations Instructor (FOI); or
    (b) another holder of a delegation under CAR 155(6); or
    (c) at least two holders of a permission under CAR 155(6).
(vii) The delegate has evidence of the demonstration entered in his or her pilot's logbook, certified by the person(s) assessing the demonstration.
(viii) The permission must be issued in the form specified in CAAP 155-1(0) Appendix B and must include any other conditions that the delegate considers necessary in the interests of flight safety.
(ix) The delegate must forward to CASA a copy of each permission issued under this delegation with seven days of issuing the permission.

This instrument remains in effect until suspended or cancelled.

....
Director of Aviation Safety
…..................2006