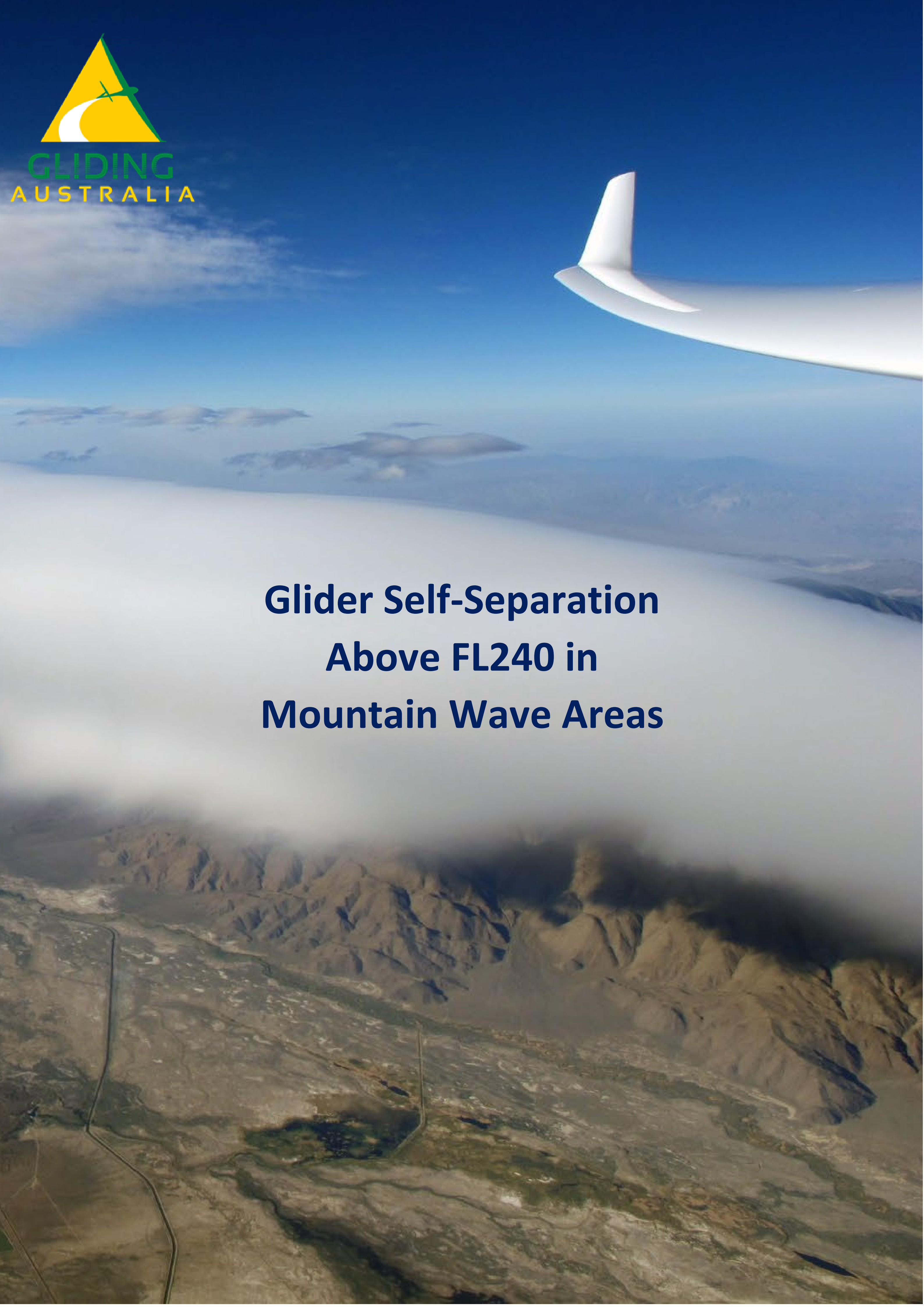

Glider Self-Separation Above FL240 in Mountain Wave Areas

Contents

Revision History

	Date	Prepared by	Control
Original Document	July 2018	Drew McKinnie, Christopher Thorpe	EMO
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INTRODUCTION

The Gliding Federation of Australia (trading as Gliding Australia) is a CASA-approved Part 149 Self-Administering Sport Aviation Organisation (ASAO), responsible for the administration and oversight of gliding activities in Australia and performance of approved functions. These are defined in the Exposition and Manuals of Standard Procedures (MOSPs) governing gliding, and referenced manuals.

Gliding is a high-performance aviation sport and high-altitude flights are pursued worldwide. The Fédération Aéronautique Internationale (FAI), which is the world air sports federation, recognises claims for badges and records that are defined by kilometres of distance and metres of altitude gained.

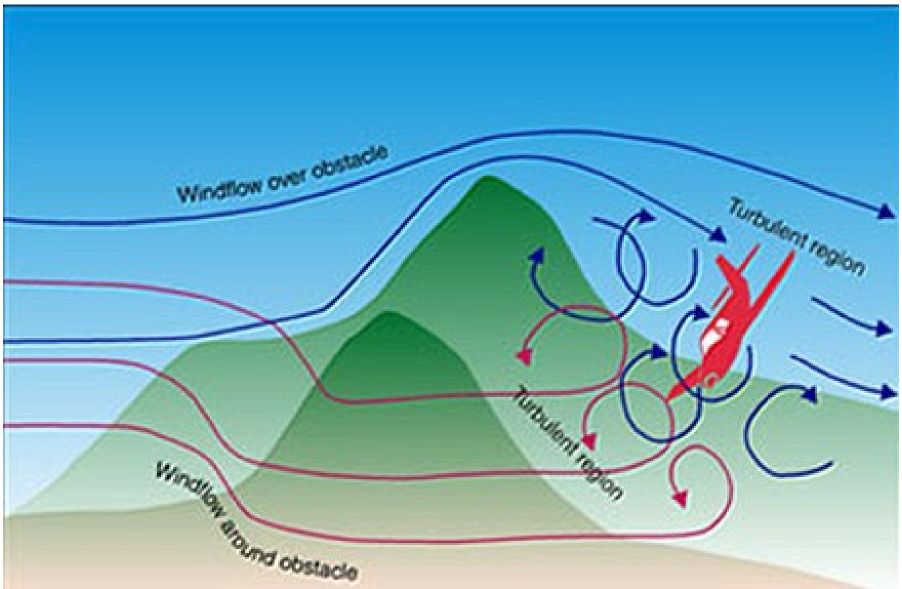
For example, a pilot who has completed the three parts of the Diamond Badge has flown over 300 kilometres (186 mi) to a pre-defined goal, has flown 500 kilometres (311 mi) in one flight, and gained 5,000 metres (16,000 ft) of height; all without the aid of a motor.

The following gliding altitude records have been established in Australian Mountain wave:

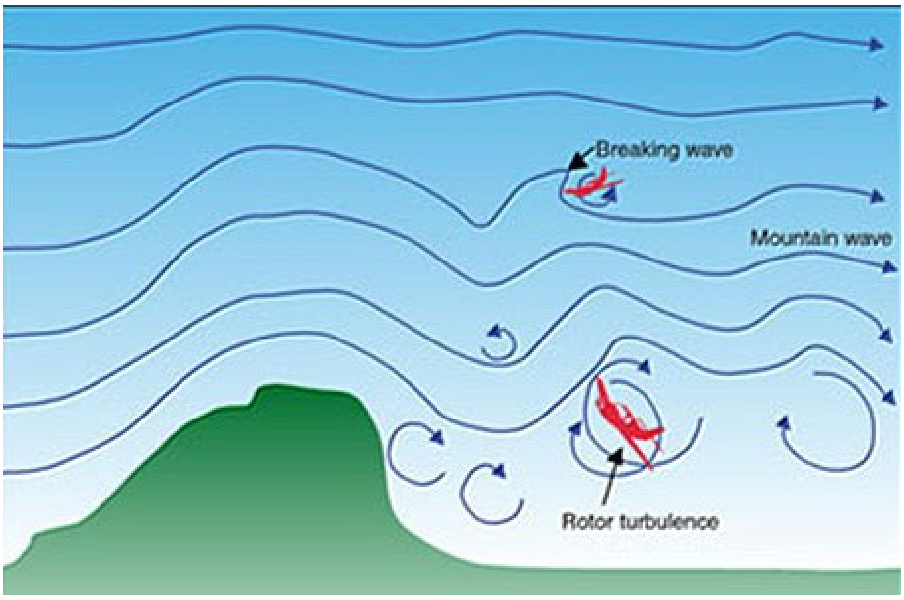
- Absolute altitude
  R.Q. Agnew 26/8/95 Std Jantar 10,058m (33,000ft)
- Gain of Height
  L. Armour 7/7/87 Astir CS 7,750m (25,426ft)

In Australia, mountain waves are commonly experienced over and to the lee of mountain ranges in the south-east of the continent and in the Stirling Mountains of Western Australia. They often appear in the strong westerly wind flows in late winter and early spring. Mountain waves are increasingly used in long distance cross country flights, particularly in attempts at FAI speed records over long distances.

Mountain waves are a different phenomenon to the mechanical turbulence found in the lee of mountain ranges, and usually exist as a smooth undulating laminar airflow or may contain clear air turbulence in the form of breaking waves and 'rotors'. Mountain waves are defined as 'severe' when the associated downdrafts exceed 600 ft/min and/or severe turbulence is observed or forecast.



'Breaking waves' and 'rotors' associated with mountain waves are among the more hazardous phenomenon that pilots can experience. Glider pilots are trained in the dynamics of the wind and learn to use these mountain waves to their advantage; typically to gain altitude.



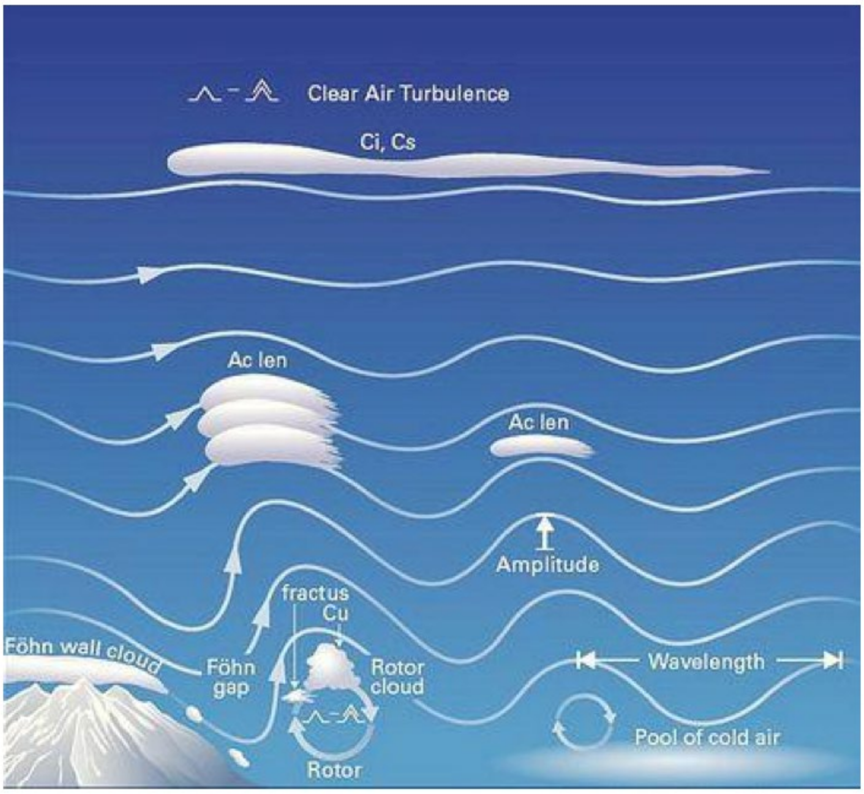
Mountain waves are the result of flowing air being forced to rise up the windward side of a mountain barrier, then as a result of certain atmospheric conditions, sinking down the leeward side. This perturbation develops into a series of standing waves downstream from the barrier and may extend for hundreds of kilometres over clear areas of land and open water.

Mountain waves are likely to form when the following atmospheric conditions are present:

- the wind flow at around ridge height is nearly perpendicular to the ridge line and at least 25 kts.
- the wind speed increases with height.
- there is a stable layer at around ridge height.

If the wave amplitude is large enough, then the waves become unstable and break; like the breaking waves seen in the surf. Within these 'breaking waves', the atmospheric flow becomes turbulent.

The crests of the waves may be identified by the formation of lenticular clouds (lens-shaped) if the air is sufficiently moist. Mountain waves may extend into the stratosphere and become more pronounced as height increases. Some pilots have reported mountain waves at 60,000 feet and beyond. The vertical airflow component of a standing wave may exceed 8,000 ft/min.



Rotors or eddies can also be found embedded in mountain waves. Formation of rotors can also occur because of down slope winds. Their formation usually occurs where wind speeds change in a wave or where friction slows the wind near to the ground. Often these rotors will be experienced as gusts or windshear. Clouds may also form on the up-flow side of a rotor and dissipate on the down-flow side if the air is sufficiently moist.

Many dangers lie in the effects of mountain waves and associated turbulence on aircraft performance and control. In addition to generating turbulence that has demonstrated sufficient ferocity to significantly damage aircraft or lead to loss of aircraft control, the more prevailing danger to aircraft in the lower levels in Australia seems to be the effect on the climb rate of an aircraft. General aviation aircraft rarely have performance capability sufficient to enable the pilot to overcome the effects of a severe downdraft generated by a mountain wave or the turbulence or windshear generated by a rotor. However, gliders are built to withstand the high forces encountered in wave and glider pilots are trained to maintain safe flight within the manoeuvre envelope.

Research into 'breaking waves' and 'rotors' or eddies continues, and gliding is leading the way to upper atmospheric research internationally through the Perlan project. The aim of this project is to fly a sailplane to 90,000 feet at the edge of space to explore the science of giant mountain waves that help create the ozone hole and change global climate models. On September 2, 2018, Airbus Perlan Mission II climbed to 76,124 feet. These missions will provide education and inspiration for young people seeking careers of exploration and adventure in aviation, engineering and science.

HIGH ALTITUDE OPERATIONS IN AUSTRALIA

The Gliding Federation of Australia, in conjunction with the Civil Aviation Safety Authority and Airservices Australia has, for many decades, safely operated gliders at high altitudes under CASA exemption and in accordance with conditions and procedures published in Letters of Agreement (LOA) between certain Gliding Clubs/Regions and Airservices Australia.

As a Part 149 ASAO, Gliding Australia has rigorous glider airworthiness standards and requirements defined in MOSP Part 3 including oxygen requirements, approved by CASA. MOSP Part 2 Operations governs the operational requirements for pilots, syllabi, training and qualifications, and air navigation. MOSP Part 5 Safety Management System formalises the gliding SMS and risk management processes, including emergency response planning, as approved by CASA. The SMS is consistent with both CASA requirements for aviation safety risk assessment and ISO/AS/NZS 31000 Risk Management Guidelines. Clubs conducting high altitude soaring have routinely provided training and briefings for pilots, conducted camps safely for many years, with approved procedures reflecting the mandated contents of Airservices Australia Letters of Agreement and CASA exemption instruments.

These well-established procedures have proven effective and safe, for individual glider access above FL240, and multiple gliders above FL240 during the Annual Wave Soaring Camps. These procedures are predicated upon effective communications and establishment of suitable protective airspace in which glider self-separation under normal VFR procedures occurs.

ADS-B is used, either alone or in combination with radar, for the provision of air traffic services. Within the established protective airspace defined for high altitude flights by multiple gliders, air traffic services are not supplied and gliders operating in that protective airspace will maintain separation using the principles of alerted see and avoid, supplemented by FLARM and EC low-power ADS-B where fitted. Wave soaring clubs routinely track ADS-B data on Electronic Flight Bag software, Flight Radar 24, and FLARM data on Open Glider Network (OGN) software, where electronic coverage exists.

Relevantly, current standards for ADSB preclude a suitable unit being manufactured for aircraft that are not fitted with an engine driven electrical system capable of continuously powering a transponder. Another aspect that precludes full TSA-compliant ADSB for gliders at present is the cost of a suitable GPS receiver. Currently the GPS specifications require a certified unit and the cost of these units is more than the transponder. If an unapproved GPS is plugged into an ADSB, the position is transmitted but all receiving systems ignore it because the system integrity level number is set to zero. Many glider pilots use Electronic Conspicuity (EC) ADS-B units approved by CASA for VFR flight and situational awareness. EC units (SIL=0 or 1) cannot be used for formal ATC flight separation.

An Airspace Risk Assessment is conducted prior to a wave camp commencing. The outcome of this risk assessment identifies residual airspace risks that cannot be mitigated by GLIDING AUSTRALIA. As a consequence, an airspace change proposal (ACP) is submitted to the Office of Airspace Regulation (OAR) for assessment of a suitable airspace solution. In the past, either a Temporary Restricted Area (TRA) or Temporary Danger Area (TDA) have been declared. Such protective airspace has enabled safe high-altitude gliding operations in controlled airspace.

Comprehensive risk management procedures have been established, which have included the submission of an airspace risk assessment to the OAR by the relevant gliding organisation conducting the high altitude flying. The OAR and relevant gliding organisation consult with Airservices Australia in the preparation of a LOA, which details the airspace management protocols put in place to enable safe operations.

SAFETY CASE AND RISK ASSESSMENT METHODOLOGY

This safety case is supported by risk management logic based upon the principles and process guidance in MOSP Part 5 SMS and AS/NZS 31000:2021 *Risk management principles and guidance.* The principles, framework and processes are summarised in Figure 1 below.

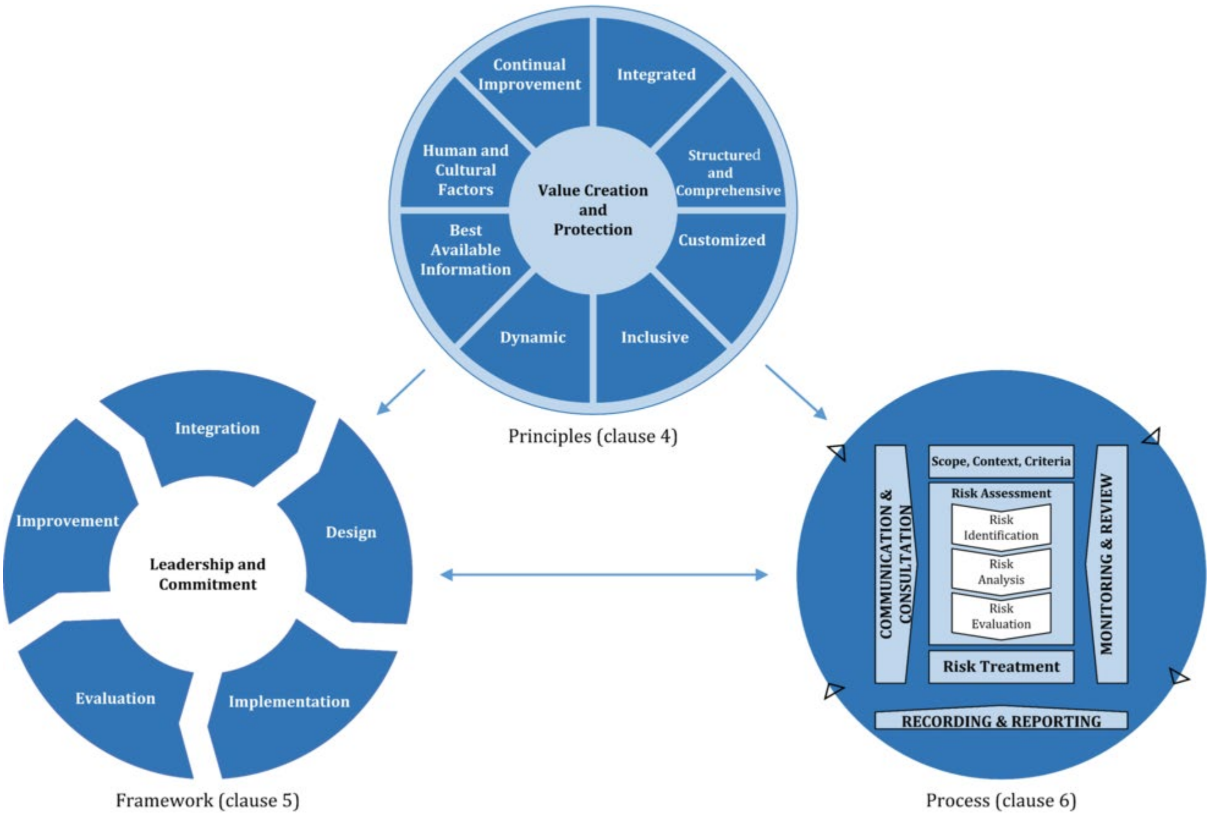


Figure 1: AS/NZS 31000:2018 Risk Management Principles, Framework and Process

The risk analysis and evaluation logic are based on assessments of risk likelihood (rare to almost certain) and risk consequences (Insignificant to catastrophic), resulting in risks described as low, moderate, high or extreme.

Risk Matrix						
Consequence		Insignificant	Minor	Moderate	Major	Catastrophic
Likelihood		1	2	3	4	5
Almost Certain	5	Moderate (5)	High (10)	High (15)	Extreme (20)	Extreme (25)
Likely	4	Low (4)	Moderate (8)	High (12)	High (16)	Extreme (20)
Possible	3	Low (3)	Moderate (6)	Moderate (9)	High (12)	High (15)
Unlikely	2	Low (2)	Low (4)	Moderate (6)	Moderate (8)	High (10)
Rare	1	Low (1)	Low (2)	Low (3)	Low (4)	Moderate (5)

Figure 2 Risk Matrix

Measures of Likelihood			
Level	Rating	Description	Frequency
5	Almost Certain	The event is expected to occur in most circumstances	More than once per year
4	Likely	The event will probably occur in most circumstances	At least once per year
3	Possible	The event should occur at some time	At least once in 3 years
2	Unlikely	The event could occur at some time	At least once in 10 years
1	Rare	The event may only occur in exceptional circumstances	Less than once in 15 years

Figure 3 Measures of likelihood

RISK ASSESSMENTS FOR SAFETY CASE

The following section describes risk assessments for multiple glider self-separation when operating above FL245 in a high-altitude protective airspace under VFR procedures.

Risk Scenario:

Breakdown of Separation – Glider to Glider, and Glider to Other Aircraft, causing AIRPROX event or Mid-Air Collision.

Risk Drivers:

- Atmospheric conditions including visibility at altitude (such as turbulence, windshear, light conditions).
- Degraded lookout and consequential degraded situational awareness (flight crew).
- Lack of power generation capability and limited battery capacity (Glider).
- Sleek profile limiting visibility (Gliders).
- Blind arcs in gliders and powered aircraft.
- Poor procedural awareness by flight crew.
- Loss of procedural and surveillance standards by ATC and crew of IFR aircraft resulting in access by non-glider traffic into the protective airspace.

The Consequence of a Mid-Air Collision is assessed as being Catastrophic. The Consequence of a Near/Miss or AIRPROX is Moderate. We also assume for this safety case that the Consequence for these risk events is not a variable. The logic here is based upon issues that affect *Risk Likelihood*.

Numerous risk mitigation strategies are applied to reduce the probability or likelihood of an adverse risk event arising. These strategies address the above risk drivers.

Risk Mitigations:

A key component of the risk mitigation strategy is that all operations are conducted within defined parameters established with Airservices Australia and documented via Letters of Agreement particular to the geographical location of the high-altitude wave area.

- Normal VFR operations do not operate above FL200.
- Flight within Class 'A' controlled airspace and separation is provided by ATC.
- Defined boundaries and navigational tolerances are applied within established protective airspace.
- The OAR will determine an appropriate airspace solution to permit gliders to operate in Class A airspace.
- Separation will not normally be provided by ATC between gliders.

The following risk mitigations are applied to gliding operations, to provide safe mutual self-separation when soaring at high altitude:

- Use of radio is a prerequisite for gliders operating within protective airspace.
- Within the protective airspace, gliders use radio on predefined frequencies to maintain communications with ATC, the Glider Base station, and other gliders, as an aid to alerted see and avoid.
- Gliders are required to descend and transmit blind if radio failure is suspected.
- Glider pilots are briefed before operating within the defined boundaries and, in some cases, require logbook endorsement verifying procedural awareness. Briefings are supported by provision of notes and Waveguide publication, to enhance procedural understanding.
- Normal GLIDING AUSTRALIA operations in accordance with the GLIDING AUSTRALIA Manual of Standard Procedures including operational requirements for radio use and lookout, supporting see-and avoid-and alerted see-and-avoid.
- Training of glider pilots in alerted see-and-avoid and lookout techniques and use of situational awareness aids such as Flarm and EC.
- GLIDING AUSTRALIA annual pilot checking practices including verification of safe lookout practices, situational awareness, and effective use of radio.
- Operations oversight by host club senior instructors during wave camp operations Within the protective airspace, with high operational standards enforced.
- Flight profiles in wave systems have less collision risk than thermal and ridge flying:
  - Into wind flight profile when soaring in wave, with low to zero ground speed, low relative velocities between soaring gliders hence higher detection probabilities.
  - Higher relative velocities when gliders are transiting between wave systems, cruise flight profile usually involves high separation distance or deliberate lead and follow.
  - Flight profile within Class A airspace is normally of short duration to reduce exposure in hostile environment, already limited by endurance of O2 systems used.
  - Airbrakes used to initiate fast descent if ever needed, reduce time above FL245.
  - Descents are normally conducted in downward part of wave system, separated from upward part of wave system.
- Glider pilots are accustomed to visual separation and close quarters flying (e.g. when thermalling or cruising close together).
- Routine use of radio to clarify pilot intentions and better assure separation.

- Many gliders have FLARM[1] fitted to augment visual lookout between gliders. A smaller number have EC low power ADS-B units fitted. Host clubs can monitor these using EFBs, Flight Radar 24 and Open Glider Network software, within areas of electronic coverage.
- Host clubs are required to have Emergency Response Plans, addressing accident and missing aircraft scenarios. MOSP Part 5 SMS refers.
- Navigational tolerances, both vertical and horizontal are specified in the individual Letter of Agreement (LOA) with Airservices. The horizontal boundaries are inclusive of buffer. The vertical buffer zones are specified in the VFR CASA guide. The LOA is the definitive guide.
- Oxygen is mounted and carried in a glider in accordance with MOSP 3 Airworthiness.
- Expected rate of descent is determined by the gliders Pilot Operating Handbook (POH). Typically, a glider will descend in an emergency-controlled descent at a rate of approximately 4000 to 6000 feet per minute. Expected descent from FL300 to FL150 would be in the order of 4 to 2.5 minutes.
- In the event of a collision and the glider pilot(s) must abandon the aircraft a “bail-out” O2 bottle is encouraged to be carried. High altitude flying is a known hazardous environment and the Pilot in Command (PIC) has control over this decision.

NOTES:

1. Self-separation within the protective airspace applies.
2. Glider operations in high altitude wave systems are predominantly into-wind, at low airspeeds and, due to wind strengths, a very low ground speed. Gliders are also incapable of maintaining an altitude and are constantly climbing or descending.

[1] FLARM is a traffic awareness and collision avoidance technology for General Aviation, light aircraft, and UAVs. With FLARM installed, the pilot is alerted of both traffic and imminent collisions with other aircraft similarly equipped, so they can take avoiding action before it is too late.

Risk Scenarios

Breakdown of Separation – Glider to Glider, causing AIRPROX event or Mid-Air Collision.

Risk Assessment with Mitigations Implemented:

Likelihood (AIRPROX): Unlikely

Consequence (AIRPROX): Moderate

Risk: Low

Likelihood (Mid-air Collision): Rare

Consequence (Mid-air Collision): Catastrophic

Risk: Moderate

NOTE: If there is only one glider at a time operating in the protective airspace, there are no glider-to-glider separation issues.

Breakdown of Separation – Glider to Other Aircraft, resulting in an AIRPROX event or Mid-Air Collision.

Risk Assessment with Mitigations Implemented:

Likelihood (AIRPROX): Unlikely

Consequence (AIRPROX): Moderate

Risk: Low

Likelihood (Mid-air Collision): Rare

Consequence (Mid-air Collision): Catastrophic

Risk: Moderate

NOTE: A LOS between aircraft in controlled airspace generally occurs either because of an ATC error, pilot error, a combination of controller and pilot errors, or more rarely, other issues not directly related to the controller or pilot (such as weather or a technical problem with an aircraft). Although LOS occurrences are common (about once every 3 days), most pose no or a low risk of aircraft colliding, and there have been no mid-air collisions in Australia between two aircraft under air traffic services control. [reference: ATSB publication AR-2012-034 '*Loss of separation between aircraft in Australian airspace, January 2008 to June 2012*'.]

CONCLUSIONS

Gliding Australia's Part 149 approved ASAO systems and processes, documented in manuals of Standard Procedures for Airworthiness, Operations and SMS, contain proven mitigation measures for foreseeable risks. Existing LOA procedures for high altitude wave flying operations, without fitted transponders or ADSB equipment have proven effective. Lookout plus radio, alerted see and avoid supplemented by situational awareness aids such as Flarm and now EC, have proven appropriate for VFR self-separation of gliders soaring in wave lift at high altitude. Many layers of training and briefing on risk mitigation measures are applied to reduce the likelihood of breakdown of separation, i.e. AIRPROX or mid-air collision. Risks are, at worst, medium after mitigation measures are applied. There has been no recorded collision in a high-altitude wave area in Australia.

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20th July 2024