CANADIAN FORCES
FLIGHT SAFETY INVESTIGATION REPORT (FSIR)

FINAL REPORT

FILE NUMBER: 1010-Gliders (DFS 2-4-2)
DATE OF REPORT: 8 April 2005

AIRCRAFT TYPE: Schweizer 2-33A Glider, C-GDZF
DATE/TIME: 241640Z July 2003
LOCATION: Central Region Air Cadet Gliding School, Picton, Ontario
CATEGORY: "B" Category Accident

SYNOPSIS

The instructor pilot (IP) and the student were conducting a pre-solo training flight in the Central Region Air Cadet Gliding School Program. The student completed the launch and upper air sequences prior to joining a circuit that was flown higher than normal. In an effort to lose height, the student entered a right wing-low forward slip on the base leg of the circuit. The slip was continued until 250 feet above ground level (AGL) on final when the student terminated it in accordance with standard procedure. Believing that the aircraft would overshoot the landing area, the instructor then took control and continued with the forward slip.

The glider's right wingtip and main skid simultaneously struck the ground. The glider rotated 30? to the right and bounced into the air. After the glider struck the ground again, it continued to rotate to the right as it slid across the wet grass landing strip, finally coming to rest approximately 90? from the direction of landing.

Both occupants egressed under their own power. The instructor received minor injuries while the student was uninjured. The glider sustained "B" category damage.

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1. FACTUAL INFORMATION

1.1 History of the Flight

The IP and student pilot were conducting a pre-solo training flight at the Central Region Gliding School (CRGS) at Picton, Ontario. The accident flight was the student's first flight of the day and the IP's second. The aircraft had been previously flown that day on three flights without any noted problems. The objective of the flight was to complete lesson plan (LP) D19 of the syllabus; this was to be a student review of all previously learned manoeuvres. The LP was to be flown primarily by the student who was to demonstrate his progress with various flight manoeuvres prior to returning to the circuit for landing.

Gliding operations were delayed on the morning of the accident flight due to inclement weather. Once the weather was suitable for operations to commence, a briefing for all CRGS personnel was held to discuss the current weather and the effects of light winds on the glider in the circuit. It was mentioned that unless proper corrective action was taken early in the circuit, the light and variable winds would result in the glider being high on final and subsequently landing well past the intended landing point.

Two earlier attempts to complete the flight had been cancelled by weather, resulting in a third pre-flight brief for the LP. This brief was shorter than the previous ones; nonetheless it included all the manoeuvres the student was to perform. Particular attention was given to the light winds and their impact on flying the circuit.

At the time of launch, the IP noted that it was raining moderately though she assessed that there was no impairment to forward visibility. However, due to deteriorating weather conditions, this was to be the last flight before ceasing CGRS gliding operations for the afternoon. With the IP in the rear seat, the student performed the take-off from the front seat on runway 05. During the tow to 2500 feet AGL (all heights are AGL) for release from the tow-plane, the IP noted some negligible scud clouds while climbing through 500 feet. Once in the practice area, the student performed steep turns, gentle and medium stalls, and incipient spins. The IP did not note the stall speeds of the glider during these manoeuvres.

The student then correctly joined the circuit for the grass strip to the south east of runway 05 at 1000 feet and at 50 miles per hour (MPH). A solo student who was also airborne joined the left circuit shortly thereafter. Although the IP believed the glider to be appropriately spaced on the downwind leg, she felt that it bordered on being slightly too close to the runway. The glider did not lose much height during this leg and turned base at 900 feet versus the standard 500 feet. Once on base, the student recognized that he was high and, in an attempt to lose height, he fully opened the spoilers and entered a right wing-low forward slip.

Both pilots believed that base leg was flown with adequate spacing from the runway and no drift was experienced.

A slipping final turn was made, although neither pilot could recall the height at which it was conducted; the turn to final must be completed by 300 feet. Based on previous experience, the IP felt that the higher than normal flight path was not excessive. Although the IP did not recall this event, the student reported that a slight un-commanded wing drop and yaw occurred after turning final. Even though he could not recall which wing dropped or the direction of yaw, the student was quick to correct back to his desired flight path.

At 250 feet, the student closed the spoilers and ceased slipping in accordance with direction in the Air Cadet Gliding Manual (ACGM) that prohibits slipping below 250 feet except during emergency situations. Aware of how high they were and believing that they would overshoot the runway, the IP took control and re-commenced the right wing-low forward slip. The glider was re-configured with the spoilers fully opened, the right wing down approximately 20?-30?, and the nose approximately 20? to the left of the flight path as the glider tracked along the intended landing path. The IP believed that she took control of the glider just abeam of the Launch Control Officer’s (LCO) truck positioned beside the normal landing area; however, the student recalled that the transfer of control occurred prior to the LCO truck. Ground witnesses estimated that the glider passed the LCO truck at between 50-60 feet.

Five to ten seconds after taking control, the IP and student both noted a left wing drop and a subsequent yaw to the left. To correct for this, the IP moved the control column to the full right position, leaving the left rudder fully applied. The IP noted that this action failed to pick up the left wing.

In a near-level attitude heading approximately 25? to the left of the landing direction, the glider’s main skid and wheel and the right-wing tip struck the wet, grass landing strip about 300 feet past the LCO truck. The glider then rotated 30? to the right and bounced back up into the air. It struck the ground again and continued to rotate to the right as it slid across the landing strip. The glider finally came to rest with its left wing down and facing approximately 120? right from the direction of landing (Photo 1). Both occupants then egressed unassisted.

The second solo glider then landed without incident and well clear of the accident area.

The student and LCO observed that at the time of accident, there was light rain, good visibility, and little wind.

At no point during the circuit, other than the 50 MPH on downwind, the 900 feet turn to base, and the 250 feet at which point she took control, did the IP recall either the glider’s airspeed, height, or rate of descent. The IP stated that she did not routinely check these instruments, but rather flew the aircraft by attitude only.

1.2 Injuries to Personnel

Table 1: Injuries to Personnel

Injuries	Crew	Passengers	Others
Fatal	0	0	0
Serious	0	0	0
Minor	1	0	0

The IP suffered minor injuries resulting in the temporary loss of her medical category. She has since returned to flying duties.

1.3 Damage to Aircraft

The glider's right outrigger was torn from its wingtip mounting. The underside of the right wing's mid-section skin buckled (Photo 2) while the leading edge skin parted between skin panels.

The glider sustained "B" category damage.

1.4 Collateral Damage

Nil.

1.5 Personnel Information

Table 2: Personnel Information

	Instructor	Student
Rank	OCDT	Cadet
Currency/Category valid	Yes	U/T
Medical Category valid	Yes	Yes
Total Flying Time (Hrs)	150	5
Instructional (Hrs)	35	0
Flying hours on type	96	4
Flying hours last 30 days	16	4
Duty time last 24 hrs	4	4

1.6 Aircraft Information

The Schweizer 2-33A is a tandem seat training glider used by the Royal Canadian Air Cadets. The high wing construction allows excellent visibility from either the front or rear seat. The 2-33's rugged construction withstands the rigors and demands of ab initio flying, making it well suited to the Air Cadet training environment. Additionally, the glider's exceptional occupant protection has been well documented during its years of service.

The cockpit avionics consist of an airspeed indicator (ASI), vertical speed indicator (VSI), altimeter, and a hand-held radio that is secured within the cockpit. Flight controls additional to the rudder pedals and control column are a flight control column trim adjustment and over/under wing spoilers. Movement of the spoiler control handle past the fully extended position controls braking action for the single fuselage-mounted wheel. Both wingtips have an outrigger wheel that prevents ground-wingtip contact.

The aircraft was serviceable prior to the accident. All maintenance and inspections were up to date. The weight and balance was within limits.

1.7 Meteorological Information

The meteorological reports from 8 Wing Trenton at the time of accident were:

METAR: CYTR 241600Z 29003 KT 15SM BKN 015 OVC 100 RMK CU6AC2 TCU ASOCTD SKYXX=

TAF: AMD CYTR 241612Z 241612 VRB03KT P6SM -SHRA BKN012 BKN 100 TEMPO 1618 P6SM NSW SCT015 BKN100 FM 1800Z VRB03KT 6SM SCT030 BKN090 TEMPO 1822 P6SM –SHRA BKN025 PROB30 1822 2SM –TSRA BR BKN020CB

Density Altitude: 1340 feet.

Pressure Altitude: 272 feet.

The meteorological observations from the nearby Point Petre Automatic Weather Observation Site (AWOS) were:

METAR: CWQP 241600Z AUTO 36006KT 21.2/19.1 RMK PCPN 1.0MM PAST HR ALTM MISG SLP138 51012=

The Picton gliding site relies on weather information from both the above sites. Interpretation of data from both sites is required to provide an accurate weather picture for local gliding operations. At the time of the accident, Picton gliding staff observed light rain, light and variable winds, and approximate ceilings of 1500 feet.

Although the ceilings were thought to be about 1500 feet, it was not unusual for the glider under tow to climb to the planned release height of 2500 feet provided that the weather minima for visual flight rules could be maintained.

1.8 Aids to Navigation

Nil.

1.9 Communications

The CRGS at Picton utilizes a mandatory frequency for all operations. The LCO, tow-planes, and gliders all monitor the mandatory frequency while in the local area and circuit. Other than the normal report made by the glider on downwind, there were no ground-glider communications made during the accident flight.

1.10 Aerodrome Information

The Picton gliding site is located 40 km southeast of 8 Wing Trenton. It has a triangular runway layout with grass strips suitable for aircraft operations abeam each runway. Glider and tow-plane launches are conducted on the runways and grass strips while recoveries are made, simultaneously from left and right circuits, to the grass strips.

The LCO monitors and controls all Air Cadet flying operations, giving launch clearances. A site supervisor oversees the entire operation while an Emergency Response Officer (ERO) also remains on site to manage and coordinate actions required during any emergency situation.

The cadets, instructors, and staff, including LCO and ERO, maintain a position in the centre of the runway abeam the touchdown points on the grass landing areas. After a glider has landed, cadets retrieve and align the glider for re-launch.

The Bellanca Scout tow-plane with a 250 feet towrope is utilized at the CRGS to launch and then tow the glider to the release point.

1.11 Flight Recorders

The Schweizer 2-33A glider is not equipped with any onboard voice or flight data-recording device.

1.12 Wreckage and Impact Information

The wreckage site was on the grass landing strip on the south side of runway 05. Ground scarring from the right wingtip and main landing skid was evident on the wet grass landing strip and was consistent with the observed aircraft damage. The initial impact scarring was 250 feet past the LCO truck.

1.13 Medical Information

Both pilots were attended to by the 8 Wing Trenton Flight Surgeon. It was determined that the IP received minor injuries. Although the uninjured student was above the age of consent, parental permission was sought and granted prior to medical examination. Toxicology samples from both aircrew provided negative results for all screened indicators. A review of the IP's medical records identified nothing relevant to the flight safety investigation.

1.14 Fire, Explosives Devices, and Munitions

Nil.

1.15 Survival Aspects

1.15.1 Crash Survivability

The crash was survivable as the deceleration forces proved to be within the tolerance level of the human body. The cockpit maintained its survivable volume and was undamaged, allowing both pilots to egress the glider unassisted.

1.15.2 Life Support Equipment

The glider's ruggedness and four-point harness systems likely prevented further injury from occurring.

1.15.3 Emergency Transmitters

The glider was not equipped with, nor was it required to be equipped with, any type of aviation Emergency Locator Transmitter (ELT).

1.16 Test and Research Activities

Liaison with the Schweizer Aircraft Corporation, the glider Original Equipment Manufacturer (OEM), was initiated in an effort to determine possible insight to the flight characteristics of the accident glider. These efforts were beneficial to the conclusion of this investigation, as discussed in Section 2 - Analysis.

1.17 Organisational and Management Information

The CRGS is a summer gliding scholarship program for eligible Ontario Air Cadets. The school is six weeks long and qualifies the students to Canadian Ministry of Transport licensing standards. Approximately 98 students were participating in the 2003 CRGS at the Picton and nearby Mountainview gliding sites.

1.18 Additional Information

Nil.

1.19 Useful or Effective Investigation Techniques

Nil.

2. ANALYSIS

2.1 The Approach Path

The pre-flight briefing was adequately conducted for the third attempt to complete the student's D19 mission. The briefing included the tendency to fly the circuit higher than normal due to the given weather conditions. With the exception of the IP noting moderate rain at the time of launch, the launch and flight continued normally until the student joined the circuit. This section deals with the flight path and the decision to slip below 250 feet. The noted wing drops are discussed in Section 2.2.

The generally stable air mass resulted in very little sink during the downwind leg. As a result, the glider was high when the turn to base was initiated. The student, after recognizing that the glider was high, correctly employed techniques to lose height by entering a right wing-low forward slip with the spoilers fully open. This flight profile was continued until the glider was established on final when the student ceased the forward slip at 250 feet in accordance with direction in the ACGM.

At this point the IP believed that the glider was abeam the LCO truck at 250 feet and that the useable landing area ahead was rapidly decreasing. Thinking that the glider would overrun the landing area abeam runway 05, the IP took control of the aircraft and re-entered the right wing-low forward slip with a 20?-30? angle of bank and with the spoilers fully open. The ACGM permits slipping to continue below 250 feet only in an emergency situation. To analyze the decision to continue slipping below 250 feet it became necessary to determine the glider's flight path and subsequent resting place.

Runway 05 is 2580 feet long, excluding 300 feet of overrun beyond the departure end. Glider operations are generally conducted from this length of runway but can be carried out on runways as short as 1500 feet in length. Pilots typically require about a 300-400 feet/minute (FPM) rate of descent on short final before using about 300 feet to flare the glider, to touch down, and come to a full stop. However, a skilled IP with favourable weather conditions can do this in as little as 100 feet. On the day of the accident, the LCO truck was positioned, as per normal, in the area abeam the glider's touch down point, between 300-400 feet from the threshold of Runway 05. The glider came to rest approximately 300 feet past the LCO truck, leaving about 1880 feet of useable landing area beyond the glider's final resting place.

Although the IP indicated that she seldom made reference to the glider's instruments, the student believed that the airspeed remained relatively constant around 50 MPH throughout most phases of the circuit and approach. Had the glider been at 250 feet by or near the LCO truck as stated by the IP, then, based on a constant 50 MPH airspeed, the approximate rate of descent required for the glider to come to rest as it did would have been in the neighbourhood of 3667 FPM, an incredibly high rate of descent during this stage of flight. On the other hand, had the glider passed the LCO truck at around 50 feet as described by ground witnesses, the rate of descent needed for the glider to come to rest as it did would have been approximately 733 FPM. Finally, had the glider been abeam the LCO truck at 50 feet and configured for a normal wings-level approach with a 300 FPM rate of descent, it would have landed about 733 feet beyond the LCO truck and left at least 1400 feet before the 300 feet overrun area. The impact of landing long would have been negligible, requiring only a longer than normal push back to the launch area.

A basic test flight was conducted to reproduce various rates of descent while configured like the accident glider on final approach. The results, presented in Table 3: Test Flight Results, showed that, while in a 50 MPH right wing-low forward slip with spoilers fully open, a rate of descent up to 800 FPM was encountered. It is interesting to note that this rate of descent is comparable to the rate of 733 FPM as calculated above.

2.1.1 Approach Path Analysis Conclusion

Based on this discussion, it is concluded that the glider likely passed the LCO truck at approximately 50 feet as stated by ground witnesses. This determination is significant because it shows that the glider, although flying a higher than normal approach, had a significant amount of available landing area to carry out a safe landing without having to conduct the low-level slip. This casts doubt on the accuracy of the IP's perceived requirement to continue slipping below 250 feet rather than continue with a normal approach profile, regardless of where she was on the final approach. Section 2.3 explores the influences acting on the IP during the final approach that may have led her to believe that slipping below 250 feet was required.

2.2 Impact Theories

Just after turning to final, the student perceived a wing drop and a yaw, although he could neither recall which wing dropped nor the direction of the yaw. Shortly thereafter, and while in the same configuration, both the IP and the student noticed a pronounced left wing drop and yaw to the left. Given that the glider was in the same configuration as when the first wing drop occurred, it is believed that the first wing drop and yaw also occurred to the left. These wing drops and yaws are relevant in that they are common to the following four possible scenarios.

Four possible scenarios were considered in examining why the glider impacted the ground as it did: controlled flight into terrain as the IP failed to achieve a normal landing attitude prior to impact; turbulence; an aerodynamic stall from which recovery was not possible due to insufficient height; or some other departure from controlled flight at an altitude that precluded recovery of aircraft control prior to landing.

2.2.1 Controlled Flight into Terrain

Based on the reported wing drops, yaws, ineffective control inputs, and statements of both pilots, the Flight Safety Investigation Team felt that the likelihood of controlled flight into terrain was negligible. Therefore, it was concluded that controlled flight into terrain was not causal to this accident.

2.2.2 Turbulence

The air mass on the day of the accident was moist and stable, with no convective activity and negligible lift or sink. It was also reported on previous flights that day that no turbulence existed. Tow plane wake turbulence could not have affected the accident glider for two reasons: first, the tow plane touch down point was about 150 feet before the LCO truck, approximately 450 feet before the glider touch down point; and, second, the tow plane utilizing the landing area around the same time as the accident took off several minutes before the accident glider crashed. Because the tow plane's lift-off point was beyond the glider's final resting point and because winds were light and variable, the tow plane's vortices could not have been in the vicinity of the glider's flight path. Therefore it was concluded that turbulence did not influence the glider's flight path.

2.2.3 An Aerodynamic Stall

The discussion on stall theory within the ACGM provides a good background to understanding this aerodynamic phenomenon.

The term stalling describes the condition in which the lift from the wings can no longer support the weight of the aircraft. Normally, the airflow over the wings is smooth, with some minor turbulence towards the trailing edge. As the angle of attack is increased beyond the optimum angle, the airflow begins to break up and becomes progressively more turbulent and the area of turbulence thickens and spreads towards the leading edge. Greater angles of attack produce even more turbulence until a point is reached beyond which there is a sudden loss of a large percentage of total lift. The angle is known as the critical angle or stalling angle. The IAS (indicated airspeed) *at which the wings stall is known as the stalling speed. An aircraft can stall at any airspeed, in any attitude, provided that the critical angle is exceeded.*

An aircraft can stall at any airspeed and in any attitude. Pre-conditions for a stall typically include a nose-high attitude and low airspeed. Just prior to the stall onset, sloppy control response and airframe buffeting occur. At the point of stall, the nose drops, the glider loses altitude, rate of descent increases, and in the case of a wing drop, yaw in the direction of the dropped wing also occurs. Not every stall symptom is identical in severity from stall to stall. To further explore stall characteristics, the Flight Safety Investigation Team conducted a basic test flight with the CRGS standards pilot. The glider was manned and configured in a manner similar to the accident glider; results are indicated in Table 3. Flight control inputs were similar to those of the accident glider during the time of forward slip and just prior to ground impact.

Table 3: Test Flight Results

Stall #	Stall Configuration	Rudder Input	Control Column Input	Entry Airspeed	Bank Angle	Rate of Descent	Indicated Stall Speed	Potential Maximum Stall Speed	Stall Characteristics
1	wings level, spoilers open	nil	fully aft	55 MPH	0?	500 FPM	37 MPH	40 MPH	gentle stall, mushing
2	right forward slip, spoilers open	full left pedal	almost fully right and aft	55 MPH	30?	600 FPM (in slip)	43 MPH	48 MPH	buffet, left wing drop
3	right forward slip, spoilers open	full left pedal	almost fully right and aft	50 MPH	30?	800 FPM (in slip)	42 MPH	47 MPH	slight buffet, mushing

Stall recovery is effected by releasing the control column back pressure, arresting the wing drop with opposite rudder, closing the spoilers, levelling the wings with aileron after the wing becomes un-stalled, and easing out of the resultant dive. There are several components of stall theory that were found to be consistent with the accident glider’s flight profile:

a. The presence of rain on the wing increased parasite drag, reduced lift, and increased the stall speed by 1-2 MPH (estimated by the glider OEM);

b. Because it was not the IP’s practice to monitor the glider’s instruments, it was possible that she did not notice any decay in airspeed;

c. During the forward slip, the effective angle of attack of the left wing was greater than that of the right wing, thus increasing the stall susceptibility of the left wing;

d. With the onset of ground rush just prior to anticipating touch down, the IP may have subconsciously or instinctively pulled back on the control column, thus raising the nose and causing the airspeed to decrease (note that the stall speed may have been as high as 50-52 MPH as discussed below);

e. The left wing drops were consistent with behaviour of a stalled wing;

f. The left yaws associated with the wing drops were consistent with the consequence of a dropped left wing post-stall;

g. During the IP's attempt to recover from the wing drop, full right control column deflection was ineffective in raising the dropped wing;

h. The spoilers were not closed during the recovery attempt, further aggravating the stalled condition; and

i. Full right rudder was not applied, further aggravating the stalled condition.

The following dual stall speed data is published in the ACGM and was extant at the time of accident:

a. 0? bank angle, 33 MPH;

b. 0? bank angle, with spoilers fully open, 35 MPH;

c. 30? bank angle, 35 MPH; and

d. 30? bank angle, with spoilers fully open, dual stall speed is not provided, although the test flight indicated from 42-43 MPH.

A warning accompanying this data states that, because of the differences attributable to variations in individual aircraft weights, the 2-33 "may stall as much as 5 MPH faster than the placard speeds." It is therefore possible to see dual indicated stall speeds of up to at least 40 MPH with spoilers open at 0? bank angle. Because stall data for 30? bank angles with spoilers fully open is not available, it is assumed that, based on the test flight data in Table 3: Test Flight Results, the dual stall speed for forward slipping with open spoilers is approximately 42 MPH. By applying the 5 MPH error identified in the ACGM warning, it may be possible that stall speeds of up to 47-48 MPH exist in this configuration.

Light rain was present at the time of accident. The effect of rain accumulating on a wing at slow airspeeds increases parasite drag. The OEM indicated that airspeeds must be increased by 1-2 MPH when flying in the rain. Consequently, the accident glider experienced an increase of parasite drag that likely further increased the stall speed by 1-2 MPH, to 48-50 MPH.

Furthermore, post-accident analysis of the accident glider's pitot-static system identified an ASI error of 2 MPH slower than actual values. This implies that the glider could have, potentially, stalled at an IAS 2 MPH lower than those mentioned above. Therefore it is conceivable that the glider's indicated stall speed while in a forward slip with the spoilers open was as high as 50-52 MPH IAS. This is critical in that the IP believed the stall speed during the forward slip to be 35 MPH, as per the ACGM. The impact of such a high stall speed during the forward slip is significant in that the IP's target airspeed on approach was 50 MPH.

The logical conclusion to this analysis would indicate that it appears as if the glider was at or near the stall speed during the forward slip with open spoilers. The first wing drop, noticed only by the student just after turning final high and above the normal 300 feet final turn height, was possibly a gentle stall, unknowingly recovered from through his control inputs and the fortune of being relatively high. The second wing drop appears to have been more pronounced as both pilots noticed it and the subsequent yaw. The IP reported that, in response to this wing drop, she used full right control column input in an effort to pick up the dropped left wing even though the left rudder remained fully applied. Given the low altitude, there may have been insufficient time and height to recognize this suspected stalled condition and then fully react to it. The IP's control column input was, however, ineffective and the glider struck the ground before any control input became effective. Notwithstanding the possibly increased stall speed, which is further discussed in Section 2.5, there are four inconsistencies that discounted this theory and prompted OEM involvement with flight testing: the aircraft is aerodynamically very stable and indeed difficult to stall as was noted during the test flight documented in Table 3, the aircraft remained in a nose-low attitude while slipping, there was no buffet preceding the stall, and the right wing struck the ground prior to the left wing.

2.2.4 Previously Unknown Departure from Controlled Flight

Based on the above-mentioned outstanding issues, the OEM was approached to help rationalize the accident glider's flight path. The OEM conducted four test flights, two to calibrate the airspeed system and baseline aircraft performance in dry conditions and two to replicate the accident glider's performance in a stable air mass with light rain present.

The test flying in rain revealled a "departure from controlled flight" mode quite similar to the uncommanded left roll, or wing drop, described by the IP Three qualities of this "departure" were of significant interest:

a. <u>Unexpectedness</u>. During a stable left wing-high forward slip configuration with constant airspeed, flight attitude, and control input, a left wing drop occurred. It was theorized by the OEM that this un-commanded response might have been the result of one of two possibilities:

(1) Water build-up, somewhere on the wing's upper surface, that acted as a "trip strip" which, upon reaching some critical depth, caused airflow to separate from the wing's surface; or

(2) A similar build-up or raindrop arrangement acted as a "turbulator" which broke larger wing vortices into more, smaller vortices. Upon being shed, these smaller vortices caused the airflow to suddenly separate from the wing.

However, without further in-depth flight-testing, the only conclusive statements derived from this phenomenon were that it affected the high wing in the slip more than the low wing and that rain was a factor;

b. <u>High Roll Rate</u>. The resulting roll rate was about three times faster than what the "intentionally stalled" departures yielded. Because of the stable aerodynamic nature of the 2-33 glider, this was very unusual. The IP could not accurately describe the roll rate during the wing drop, however, she did believe it to be faster than a normal wing drop caused by a stall. While slipping, the departures experienced during test flying almost always occurred only in roll and not in pitch. In a left wing-high forward slip, the right wing is operating at a higher angle of attack (because of dihedral) than the left wing. To balance the lift between wings, the control column is held towards the right wing to keep the low wing from rising. The left wing's aileron is thus positioned down and increases the effective angle-of-attack just as the right wing's aileron, which is in the up position, decreases its effective angle-of-attack. This causes the left wing's (high wing) airflow to separate from the wing's surface and the wing to drop. By attempting to pick up that wing with more right control column input, the condition is only aggravated. It is the now-dropped left wing's "down" aileron that experiences airflow separation first, causing control degradation more than loss of lift;

c. <u>Pilot Response</u>. During OEM flight testing, recovery from the left wing drop consisted of slight forward control column movement in conjunction with relaxing the full left rudder application; no change in the aileron input occurred. This action largely decreased the yaw, stopped the roll, and, once the airflow reattached to the wing, left the aircraft in a 10^{o} left bank with very little change in heading, pitch, or airspeed. It was theorized by the OEM that had the response to this wing drop been to input full right control column without applying right rudder, as the accident IP did, or without at least easing off on the full left rudder, a large yaw excursion to the left and a very slow aileron response to stopping the left roll would have resulted. The left aileron would not have become effective (except in generating drag) until the airflow reattached to the wing.

One pre-condition to this phenomenon is suspected to be the presence of stable meteorological conditions. Turbulence and/or the control responses to the turbulence may either keep the rapid departure mechanism from developing fully or push the departure into another less sudden mode.

The second pre-condition to this phenomenon is the presence of rain. During flight testing, it was found that slipping in the rain seemed smoother than in dry conditions and without the usual buffeting normally felt through the rudder pedals. It was thought that this could have been as a result of the raindrops acting as turbulators that shed the vortices that cause the typically described roughness. This could also account for the reduction or absence from the accident glider of the buffetting that would typically warn of an impending stall.

Further flight-testing subsequent to these four flights was not carried out by the OEM.

2.2.5 Impact Theory Conclusion

Based on the above discussion, it is likely that one of two scenarios occurred prior to impact:

a. The glider experienced a conventional low-level stall on final approach from which recovery was not possible; or

b. The glider experienced a previously unknown condition that resulted in its departure from controlled flight.

Early discussion about stall theory indicated that an aerodynamic stall could have resulted in the left wing drop. However, this scenario was not fully consistent with the expected aerodynamic reactions, leaving several issues unresolved. This prompted the Flight Safety Investigation to seek OEM assistance and resulted in subsequent flight-testing that provided a more probable scenario.

It was concluded that, based on the OEM flight-testing, the glider likely experienced a previously unknown phenomenon in which, during a forward slip configuration in stable conditions and in the presence of rain, an airflow separation mechanism was created. This separation mechanism could have been initiated by a build up of water on the wing's surface that created an airflow separation "trip strip" to occur. Alternately, this water build up may have acted as a "turbulator" that caused many smaller wing vortices to also induce airflow separation from the wing. In either case, the likely result was that the left wing's aileron became ineffective and caused the left wing to rapidly drop. In response, the IP used right control column input in an attempt to pick up the dropped left wing. With no easing of the full left rudder, the IP's application of full right control column only aggravated the situation. A significant left yaw developed primarily due to opposite (right) aileron being applied prematurely before the airflow separation and uncommanded left roll had been addressed either through the release of full left rudder or the application of right rudder. At some point, once the airflow re-attached to the wing's surface, the left roll motion ceased and the left aileron became effective once again. Now yawed approximately 25° to the left, the IP probably attempted to line the glider up with the landing area using further right control column. The glider then banked to the right, however, given its low height, insufficient clearance remained between the right wing tip and the ground. In a near-level attitude, the glider's right wing and main skid then simultaneously struck the ground.

2.3 Human Factors Affecting the Approach

There were several human factors affecting the IP during the approach phase of the flight that likely caused her to perceive that she was higher than she actually was: ambiguous terrain information including weather influences, the glider's attitude in the forward slip, and the IP's proprioceptive (seat of the pants) flying technique.

2.3.1 Ambiguous Terrain Information

The weather at the time of accident was overcast and raining, resulting in a canopy that was covered by light water droplets. Light levels resulted in few ground shadows. Typically, conditions similar to those at the time of accident tend to reduce a person's ability to acquire height information by visual cues alone. Determining distance from objects is primarily a function of focal vision activity. Cues used to judge distance include size constancy, shape constancy, motion parallax, interposition, texture gradients, linear perspective, illumination perspective, and aerial perspective. In this situation, the IP's gradient texture and aerial perspective were reduced. Additionally, the refractive error caused by rain on the canopy resulted in ambiguous interpretation of visual cues.

a. Texture gradient refers to differences in the texture of objects. Objects with little texture, such as the landing area of a grass strip, will appear to be farther away. Additionally, due to the grey overcast of the accident day, a reduction in ground shadows produced reduced visual information and thus reduced the contrasts between the light and dark areas of the landing environment. These reduced contrasts reduced the IP's texture awareness, which in turn presented the IP with a ground picture that appeared farther away than it actually was;

b. Aerial perspective refers to the perception that objects are more distant if they are bluish or hazy. With a high level of airborne moisture, water on the canopy, and an overcast sky, the ground would have appeared hazier than normal. Therefore this too would tend to make pilots believe that they are higher than they actually are; and

c. Rain on the canopy obstructs a pilot's view and in some cases may cause distortions to the visual field; this is known as refractive error. The Canadian Forces Weather Manual states that "Rain or drizzle streaming across a windscreen reduces the visibility from the cockpit and also causes a ''Refractive Error.'' This error is such that objects appear lower than they actually are. For instance, a hilltop at half a nautical mile ahead of an aircraft could appear to be about 260 feet lower than it really is," thus leading pilots to believe that they are higher than they actually are. The same could be said of a glider pilot's landing aim point.

During the glider's landing phase, most depth perception information would have been taken from such things as size and shape constancy (trees, shrubs, people, the runway, the LCO truck, etc), motion parallax (generating ground rush) and stereopsis (depth information from retinal image differences) cues. The effects of texture gradient, aerial perspective, and refractive error, while subtle, were nevertheless a source of visual illusions associated with landing the glider and could have affected the IP's perception of the landing environment.

2.3.2 The Glider's Attitude in the Forward Slip

The IP was flying from the rear seat. She indicated that no restrictions to either forward or lateral vision resulted from her student's position in the front seat. The IP also indicated that while in the forward slip, there were no restrictions to landing area visibility as a result of interference from the student or aircraft components such as wing strut or door frame.

A forward slip attitude changes the sight picture from what is usually seen on landing. With the nose and right wing low and heavily cross-controlled with left rudder, the landing sight picture consequently differed from that of a routine landing and thus would likely require some cross-reference to the glider's instruments for confirmation of positional data with reference to the ground, particularly to initiate the key stages of the final approach such as levelling the wings and assuming the landing attitude. With degraded visual cues, the landing became more challenging and instrument crosschecking likely became more important.

2.3.3 Proprioceptive Flying

The term "proprioceptive" refers to the sensory systems that provide concepts of static body position and dynamic body movement. The systems include the inner ear, muscle stretch sensors, pressure sensors in the skin and tissues, and the sense of touch in joint capsules. Strong proprioceptive sensations are generated most significantly by skin nerve endings, particularly from the back and the back of the knees. Proprioceptive flying, therefore, refers to flying with reference to the "seat of the pants" and visual information rather than with reference to an aircraft's instruments; this proprioceptive information can be inherently unreliable. As a source of spatial information, proprioceptive or "seat of the pants" sensations can be easily fooled by reduced "G" or accelerative forces.

Flying a glider is generally taught using visual and proprioceptive sensory input with instrument crosscheck as a back up. LP 2, the second flight of the Air Cadet training syllabus, introduces students to the use of instruments for providing secondary positional information that assists their visual clues. The IP stated that she seldom cross-referenced visual information with the glider's instruments (ASI, altimeter, and VSI). In fact, during the accident circuit, the IP could not recall looking at the instruments nor could she recall any airspeeds, heights, or rates of descent. The transfer of control at 250 feet on final approach was only initiated by the student's acknowledgement of slipping restrictions below 250 feet and his subsequent return to coordinated flight. During a normal approach without environmental conditions conducive to visual illusions, proprioceptive senses alone are normally sufficient to land without incident. However, during the forward slip the IP had no way to ensure that she correctly perceived the aircraft's true position and spatial orientation without reference to the glider's instruments. As a result, the IP's susceptibility to the visual illusions of texture gradient, aerial perspective, and refractive error was increased and could have reasonably led her to conclude that she was higher than she actually was. Additionally, it was possible for the IP not to notice any deviations in airspeed.

2.3.4 Human Factors Conclusion

In summary, the weather at the time of accident produced several visual illusions that affected the IP's sight picture. It is believed by the Flight Safety Investigation Team that texture gradient, aerial perspective and refractive error complemented one another to influence the IP's perception that the glider was higher above the ground than it actually was. Furthermore, because the IP did not cross-reference her sight picture with the glider's instruments during the forward slip and she relied solely on proprioceptive senses, her susceptibility to visual illusions was further heightened.

2.4 Other Flight Safety Concerns

2.4.1 ACGM Published Airspeeds

Further to the potential increase of ACGM published stall speeds, as discussed in Section 2.2.2, the Flight Safety Investigation identified several other issues of concern regarding current ACGM published airspeeds. Consultation with the OEM was initiated and resulted in the following concerns:

a. Stall speed. The ACGM dual stall speed, 0? bank angle, is 33 MPH. This stall speed is predicated on the assumptions that no instrument (ASI) error is present, the glider has a gross weight of 1040 pounds, the glider is loaded at the most forward (worst case) centre of gravity limit, and the published IAS equals calibrated airspeed (CAS) plus position error. From the original OEM flight test information, the dual stall speed (normalized to a 1040 pound gross weight) is 35.5 MPH CAS. With position error determined to be +2 MPH, the dual stall speed is therefore 37.5 MPH IAS, not 33 MPH as published.

The OEM conducted four test flights in support of this investigaiton and resulted in the determination of an airflow separation mechanism as discussed in Section 2.2.4. Based on the discussion in Section 2.2.3 which focussed on the validity of existing ACGM stall speed data, the OEM conducted one further flight test. The preliminary details of this test flight did not support the existing ACGM and original OEM airspeed values. Basic re-assessment of original OEM data indicated that possibly the position error value of +2 MPH was incorrectly incorporated into original airspeed calculations. As a result, Table 4: Interim Revised Airspeed Data was derived and indicates substantially increased values above the currently published stall, slip, and spiral airspeeds (up to 5 MPH or 15% higher). As the glider's airspeed increases, the position error value decreases from +2 MPH near the stall, to 1.5 MPH at 50 MPH, eventually becoming a negative value at higher airspeeds in the range of "manoeuvre with caution" and "never exceed" airspeeds; thus these values are not affected and remain valid. Therefore the concern with the errors in the original calculations is primarily focused on the validity of manoeuvring airspeeds less than about 55 MPH.

TABLE 4: INTERIM REVISED AIRSPEED DATA

SGS 2-33 AIRSPEEDS (MPH) (Note 1)					
CONDITION	**GR0SS WEIGHT (LBS)**	**ACGM IAS** (Note 2)	**CAS**	**REVISED IAS** (Note 3)	**DELTA**
DUAL, Stall	1040	33	36	38	+5
SOLO, Stall	790	31	32	34	+3
DUAL, Stall Dive Brakes Open	1040	35	38	40	+5
SOLO, Stall Dive Brakes Open	790	34	34	36	+2
DUAL, Stall 30^{O} Bank	1040	35	38	40	+5
SOLO, Stall 30^{O} Bank	790	34	34	36	+2
Buffeting Speed (Level)	1040 / 790	Dual 35-38 Solo 34-37	Dual 36-39 Solo 32-35	Dual 38-41 Solo 34-37	Dual +3 Solo 0
Spiralling (30^{O} Bank)	1040 / 790	Dual 42 Solo 38	Dual 41 Solo 37	Dual 43 Solo 39	Dual +1 Solo +1
Slipping	1040 / 790	Min 50	-	50-55	+5

Although finalized airspeed data is still forthcoming, the OEM has indicated that a Service Bullitin will be published providing formal revision to existing airspeed data.

Notes:
1. This data is preliminary only and based on an initial OEM test flight. Comprehensive OEM flight-testing has not been finalized.
2. Based on OEM performance data for dual gross weight of 1040 lbs and solo gross weight of 790 lbs.
3. IAS speeds assume zero instrument error.

b. <u>Circuit Speed</u>. Discussion with the OEM identified concern with ACGM circuit airspeeds. The published circuit speed is 50 MPH plus the wind speed, to a maximum of 65 MPH. Although the OEM's gliding school manual, admittedly out of date, is based on 1960's-1970's data and practices, the current practice at the OEM's gliding school, also used by the majority of American soaring/gliding organizations, uses a minimum circuit speed based on the best lift/drag ratio (L/D) plus 5 MPH plus ½ the wind velocity. Based on this methodology, the minimum circuit speed should be 55 MPH in zero wind conditions (best dual L/D of 50 MPH plus 5 MPH). The Soaring Association of Canada (SAC) utilizes a minimum circuit speed of 1.3 times the stall speed plus the wind. Based on SAC guidelines and the revised interim 40 MPH dual stall speed with spoilers open (from Table 4), the minimum circuit speed should be 52.5 MPH (1.3X40 MPH) in no wind conditions.

From June 2003 to June 2004, 398 Transport Canada glider licenses were granted. Of these, 309 licences were granted to Air Cadets within the gliding program. Considering that the vast majority of Canadian ab initio gliding training is done through the Air Cadet Gliding Program and the fact that most occurrences take place in a training environment, it would be reasonable to increase slightly the SAC-based minimum circuit speed from 52.5 MPH to 55 MPH. This would facilitate ease of use in identifying the airspeed value on the ASI and it would also provide an added safety margin. Regardless of method of calculation used to determine the minimum approach speed, the OEM "strongly advocated" the institution of a minimum 55 MPH approach speed within the Air Cadet Gliding Program (ACGP); this was adopted by the ACGP in Oct 04.

c. <u>Flight in Rain</u>. In rain, water droplets on the static side of the pitot-static mast may affect the airspeed system and induce an increased position error. During OEM test flying in the rain, water droplet formations on the pitot-static mast appeared like they could be varying the effective pitot-static disk shape and size and/or covering the static holes behind the disk. As a result, when comparing the wet and dry airspeeds, there appeared to be a possible 1-2 mph increase in wet stall speed over dry stall speed, however, no further flight testing was conducted. There is no mention of this airspeed variation within the ACGM.

2.4.2 Glider Flight Operations in Precipitation

In accordance with the ACGM, glider operations are currently permitted in daylight visual flight rules conditions; as stated, this includes flight in precipitation. Upon closer examination of this issue, it was determined that prior to the introduction of the current ACGM wording, a flight restriction which prohibited glider operations in precipitation existed. After introduction of the Canadian Aviation Regulations (CARs), however, ACGM wording was aligned with these new regulations. As a result, it is possible to adhere to both the ACGM and the CARs while flying in precipitation, although some Air Cadet Gliding Program regions have instituted procedures to prohibit glider operations during periods of rain. Considering that the potential exists for a departure from controlled flight to occur as the result of water build-up on a glider wing's upper surface, as discussed in Section 2.2.3, it would be prudent to ensure that glider flight operations are prohibited in all regions during periods of any precipitation. Furthermore, in the event that a glider encounters precipitation while airborne, an appropriate airspeed increase in all regimes of flight, particularly during the circuit to land, should also be made. This is based on the 1-2 MPH increase to published airspeeds that the OEM has identified in Section 2.4.2 (C).

2.4.3 Pilot Decision Making

Due to the often hectic and intense nature of gliding operations during the Regional Gliding Schools' summer training program, the demands placed on IPs can sometimes fixate their attention to the detriment of performance. As there is no pilot decision making training provided to pilots within the ACGP, there is no avenue for issues such as this to be formally addressed.

3. CONCLUSIONS

3.1 Findings

3.1.1 The weather conditions at the time of accident were consistent with permissible weather limits indicated within the ACGM.

3.1.2 Meteorological conditions at the time of accident were conducive to negligible sink in the circuit. As a result, the IP and student anticipated the tendency to be high in the circuit and on final approach.

3.1.3 The IP relied solely on proprioceptive or "seat of the pants" sensations to provide her aircraft information instead of cross-referencing her flight instruments for confirmation of positional information.

3.1.4 Given the rain and ambient lighting conditions, the IP was likely affected by visual illusions that made her believe she was higher than she actually was. She believed that she passed abeam the LCO truck at 250 feet whereas in reality she likely passed abeam the LCO truck at about 50 feet.

3.1.5 The IP incorrectly perceived that she was about to run out of useable landing area and consequently elected to continue the forward slip below 250 feet. In reality, as she passed the LCO truck, the IP had about 1700 feet of useable landing area ahead, requiring only about 733 feet to conduct a normal landing.

3.1.6 The ACGM does not provide stall speed data for slipping configurations.

3.1.7 The actual stall speed of the glider may have been significantly higher than the stall speed published within the ACGM.

3.1.8 Although very similar in nature to an aerodynamic stall, the glider's flight profile was determined through OEM flight-testing to most likely be the result of a previously unknown phenomenon in which a glider can depart controlled flight while in a forward slip attitude and configuration.

3.1.9 Preconditions for this control departure include stable meteorological conditions and flight in rain.

3.1.10 Glider operations in precipitation were prohibited in an earlier edition of the ACGM. To bring it in line with current Canadian Aviation Regulation terminology, the ACGM was rewritten limiting glider operations to day VFR conditions with no mention of flight in precipitation.

3.1.11 There is no warning within the ACGM about the potential for water on the wings to increase the glider's stall speeds by 1-2MPH.

3.1.12 The control departure mechanism rests with the build up of water on the high wing's upper surface. This water build up creates either a "trip strip" or a "turbulator" that effectively initiates airflow separation from the wing in the area of the aileron. The aileron is then rendered ineffective and thus allows the high wing to drop.

3.1.13 In response to the left wing drop, the IP applied full right control column input. Because she had not released any left rudder or applied full right rudder, the action of full right control column input exacerbated the dropped wing condition and resulted in a 25° degree yaw to the left.

3.1.14 At some point the airflow separation was eliminated and the left aileron regained its effectiveness. However, in attempting to re-align the glider with the landing area by using right control column input in very close proximity to the ground, the right wing tip and main skid simultaneously struck the ground and caused the glider to skid uncontrollably to a halt.

3.1.15 In the process of investigating the stall theory as causal to this accident, original OEM stall speed calculations and data were reviewed and found by the OEM to be incorrect.

3.1.16 The OEM determined interim revised airspeed data that, upon completion of formal assessment, will be published through a Service Bulletin.

3.1.17 The OEM recommended a minimum circuit speed of 55 MPH.

3.1.18 There is no pilot decision making training provided to pilots within the Air Cadet Gliding Program.

3.2 Cause Factors

3.2.1 It was concluded that the glider departed controlled flight, as the result of a previously unknown phenomenon, while in a forward slip attitude and configuration.

3.3 Contributing Factors

3.3.1 The weather was conducive to creating visual illusions.

3.3.2 The IP was likely affected by visual illusions such that the decision to slip below 250 feet was not required to affect a safe landing.

3.3.3 The IP did not crosscheck her perception of the situation with the glider’s instruments.

4. SAFETY MEASURES

4.1 Safety Measures Taken

4.1.1 CRGS flying operations were ceased until the following afternoon. Prior to the re-commencement of flying, senior CRGS leadership held separate staff and student discussions focussed on decision-making processes, slipping techniques, and general airmanship; and

4.1.2 The 2003 gliding season bore witness to a significant increase in the Air Cadet Gliding Program's accident rate. As a result, the Directorate of Flight Safety (DFS) attended the Annual Air Cadet Flying Training Conference, in October 2003, with the aim of identifying general deficiencies within the gliding system and determining possible solutions. In DFS 1010-1, DFS Report For The Vice Chief of the Defence Staff (VCDS): Air Cadet Gliding Program, 13 November 2003, several recommendations were identified including:

a. A Glider Standards Evaluation Team should be established. This recommendation was completed in Sep 04;

b. Central Flying School (CFS) should facilitate the development of a standard Glider Instructor Refresher Course in conjunction with the RGS. This was completed in Jun 04;

c. Consideration should be given to incorporating the CFS Flight Instructor Course into glider instructor training. This was completed in Jun 04;

d. Resources should be made available to Central Region to improve the safety of the Picton site. This was completed by Jun 04; and

e. The Regional Cadet Air Operations Officers should be considered for appointment as Commanding Officers for the entire year. The 2004 Flying Training Conference Record of Decision indicated that this issue would be resolved by a change in the chain of command structure and not by appointment as a fulltime CO.

4.1.3 On 1 Oct 04, information was disseminated that identified the potential for this previously unknown phenomenon of departure from controlled flight to occur.

4.1.4 On 1 Oct 04, the OEM's interim revised airspeed data, including the 55 MPH minimum circuit airspeed, was adopted for immediate use within the Air Cadet Gliding Program.

4.1.5 On 3 Feb 05, the OEM published finalized revised airspeed data via its Technical Publication Service. The revised airspeeds included recommended a slipping airspeed of 50-55 MPH dual and updated stall speeds.

4.2 Safety Measures Recommended

4.2.1 Glider operations should be prohibited during periods of precipitation. Reference to the potential for a departure from controlled flight to occur in precipitation should be referred to within the ACGM.

4.2.2 Guidance with respect to appropriately increasing airspeeds by a minimum of 1-2 MPH should be given within the ACGM for occasions when a glider inadvertently encounters precipitation while airborne.

4.2.3 Flight-testing should be conducted to determine the full range of the glider's stall speed envelope in all flight configurations; this information must be incorporated into the ACGM.

4.2.4 Once the OEM's final revised airspeed data is authorized for use within the ACGP, this information must be disseminated and incorporated into the ACGM.

4.2.5 Training should be reviewed to ensure that all aircrew involved in glider operations understand the requirement to use aircraft instruments in addition to their proprioceptive senses to reduce the risk of sensory illusions regardless of aircraft type.

4.2.6 Training should be reviewed to ensure that sufficient emphasis on visual illusions is included within the IP and student training syllabi.

4.2.7 Pilot decision making training should be introduced to the ACGP.

4.3 Other Safety Concerns

One recommendation from the 2003 Annual Air Cadet Flying Training Conference, that methods should be found to reduce the training tempo at the RGS, remains outstanding.

4.4 DFS Remarks

At first glance, the investigation into this accident appeared to be fairly straightforward. However, as the investigation progressed, some surprising information was uncovered. After 40 years of operations with the 2-33 glider, a previously unknown flight characteristic with potentially deadly consequences was identified. Furthermore, significant errors in the original OEM air speed calculations were also revealed. There have been recent changes to the flight safety system whereby not all occurrences will be investigated. Efforts will now be focussed on those incidents and accidents where an initial assessment reveals that there is significant risk of a re-occurrence as well as a good probability of identifying valuable lessons and effective preventive measures.

The future challenge for the flight safety system will therefore be to ensure that the lessons to be learned from a seemingly innocuous accident like this one are not missed.

The final point to be made from this investigation is the importance of a rigorous airworthiness program. The investigation into this accident revealed that an airworthiness document (the ACGM) had been modified and critical information concerning flight in precipitation had inadvertently been eliminated. Hopefully, the new DND airworthiness program will prevent future errors of this nature.

A.D. Hunter
Colonel
Director of Flight Safety

ANNEX A: PHOTOGRAPHS

Photo 1: Final Resting Place

Photo 2: Right Wing Damage

ANNEX B: ABBREVIATIONS

ACGM	Air Cadet Gliding Manual
ACGP	Air Cadet Gliding Program
AGL	Above Ground Level
AIA	Airworthiness Investigative Authority
ASI	Air Speed Indicator
CARs	Canadian Aviation Regulations
CAS	Calibrated Air Speed
CFS	Central Flying School
CRGS	Central Region Gliding School
DFS	Director (ate) of Flight Safety
ELT	Emergency Locator Transmitter
ERO	Emergency Response Officer
FPM	Feet Per Minute
FSIR	Flight Safety Investigation Report
IAS	Indicated Airspeed
IP	Instructor Pilot
LCO	Launch Control Officer
L/D	Lift/Drag Ration
LP	Lesson Plan
METAR	Meteorological Aviation Report
MND	Minister of National Defence
MPH	Miles Per Hour
OCDT	Officer Cadet
OEM	Original Equipment Manufacturer
SAC	Soaring Association of Canada
TAF	Terminal Area Forecast
U/T	Under Training
VCDS	Vice Chief of the Defence Staff
VSI	Vertical Speed Indicator