RotorSport UK Ltd – Extract from Calidus Pilots Handbook, RSUK 0060, iss 6

EMERGENCY PROCEDURES

INTRODUCTION

The Calidus gyroplane uses an engine which is not certified to normal aviation standards. Whilst normally reliable, engine reliability cannot be guaranteed, so always bear this in mind.

NOTE: Plan your flight route to allow for unplanned engine failures and subsequent forced landings. Regularly practice your forced landing procedures & techniques. During your type conversion ensure that you have experienced a full engine out landing, to experience the glide angle and distance required to land.

This manual is not a replacement for theoretical and practical training as to how to operate this machine. Failure to take proper instruction can have fatal consequences.

ENGINE FAILURE

Engine failure at low speed is generally benign, in that the nose will drop and can be easily recovered to level flight for a considered emergency landing. The same will occur at high speed, but the aircraft roll & yaw response and nose drop will become more prominent the faster the speed. The roll/yaw response is due to sudden removal of engine torque, meaning then that the roll trim tries to correct the aircraft attitude without a force to oppose it. Allowed to continue unchecked, the aircraft will pick up speed in the descent and roll level. The correct response is to gently pull the nose up to the airspeed and attitude required for the considered emergency landing.

In case of failure of the engine the following actions are recommended:

Taxying, before take-off – maintain directional control, brake and stop where safe.

Immediately after take-off - land immediately ahead.

In flight. with some height (depends on wind speed and direction) - consider the wind speed and direction. Select a suitable forced landing field, preferably up any slope, and if practical land into wind.

Landing in trees or high vegetation – take the vegetation surface as the runway, and position the landing to leave the minimum fall to the ground. Try to flare onto the surface to achieve minimum roll on speed. When the wheels contact the vegetation centre the control stick to reduce the risk of the rotor contacting the vegetation.

Rough running of the engine and power loss can be caused by carburettor icing. This is extremely unlikely on this aircraft as warm air is drawn into the engine under the engine covers.

WARNING! Taking off into carb icing conditions without the engine warmed up properly may result in carburettor ice forming.

NOTE! A fast pull up from engine failure at high speed (in excess of 100mph) may result in a low frequency vibration (a rumble) felt and heard through the body of the aircraft. This is due to the out of balance forces in the rotor causing more flexure than normal in the mast bushes, such that the limit stops are reached. The impact between the limit stops causes the rumble. It is not detrimental to flight operation.

ENGINE START IN THE FLIGHT

The engine should not be deliberately stopped in flight except as part of forced landing training under the supervision of a competent Instructor. During such training, and where practical, to limit engine damage, leave the engine to idle at 3000 rpm for about 30 sec to cool before turning it off.

The engine can be restarted in flight using the starter. Use the procedure for starting described in Section 4.2, if possible allowing a 30 second period for warming up before applying full power. Note that to restart the key must be turned completely to off, and then back to start. This interlock is to prevent inadvertent starter engagement.

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ABANDONING THE AIRCRAFT

In normal circumstances occupants should not leave the aircraft while either the propeller or the rotors are turning.

If abandoning the aircraft in an emergency the pilot should turn off the engine magneto switches and turn the Master switch to "OFF" if this can be done without endangering the occupants.
If abandoning the aircraft with either the propeller and/or the rotors turning the occupants should follow a path in line with the nose of the aircraft with heads as low as possible, to minimise the risk of being struck by either the rotor or the propeller.

Occupants should be briefed before flight on emergency evacuation procedures, including:

- Actions to be taken in the event of a forced landing
- Operation of the seat harness
- Disconnection of any intercom leads or other connections to the aircraft
- How to open the canopy, or to break the canopy if required (note use of emergency hammer to break the plexiglass)
- How to safely exit and move away from the aircraft

SMOKE AND FIRE

Indications of smoke should be treated in the same way as a fire. Note that the fire warning system will illuminate a RED flashing warning lamp on the panel when the special cable in the engine bay has melted due to the effect of high temperatures (fire). This lamp shows solid red when a fault is detected.

The most likely cause of fire in the air is an oil fire due to an oil leak, or an electrical fire. Petrol fires are unlikely due to the requirement for an ignition source (not heat). Should there be an ignition source and a petrol leak, then cutting off the fuel supply can stop the fire quickly – the engine covers are made of fire resistant resin, so do not burn easily, and the cut off is very close to the tank exit, mounted on the front lower face of the rear occupant seat. An oil fire is fed either by a split pipe or broken coupling/fitting, and as the oil is pumped around by the engine, a stopped engine will limit the available fire fuel.

Further, a split line will quickly empty the oil system, which will drain out through the cowlings. An electrical fire will be very short-lived as there is very little fuel to feed it.

Fire on the ground: Turn off engine. Turn off the keyswitch, and the emergency fuel tap (located in front of passenger seat base). Exit and abandon the autogyro, call the emergency services, use local fire fighting equipment if trained to do so.

Fire in the air: If the warning is from the Fire warning lamp, try to establish if the fire warning is true with tight turns or similar to check for smoke and flame. If satisfied that the danger is present, turn off the emergency fuel cut-off located in front of the passenger seat base, and stop the engine (this completely isolates the engine bay from the fuel system). Make an emergency descent, not exceeding Vne (90mph) and expedite the landing. NOTE! The engine bay firewall is fireproof to 15minutes minimum duration, so a descent from 10,000ft operational ceiling at 1500fpm will enable a landing within the fireproof limits. Land as soon as possible. After landing, if not already stopped, turn off engine. Turn off the keyswitch. Exit and abandon the autogyro, away from the fire. Call emergency services, use local fire fighting equipment if available & trained to do so.

GLIDING FLIGHT & FORCED LANDINGS
The minimum rate of descent speed is 40mph, (engine idle), giving a vertical descent rate of about 500ft/min at low aircraft loading, and 800ft/min at MTOW.
Note that the rate of descent does not increase dramatically with speed increases up to 55mph. However, with the engine off, airflow over the rudder surface reduces as airspeed drops, to the point where there is limited directional control - so take care at very low airspeeds. The best glide speed is 60mph. The height:distance ratio with engine on tickover at maxTOW is approximately 1:4 (400 feet of forward movement for every 100 feet of height). With the engine stopped the ratio is approximately 1:3.

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If there is sufficient height, take the time at best glide airspeed to make the choice of landing site, and then balance airspeed versus descent rate to make a safe landing in that area. When gliding with a headwind, increasing airspeed will have a significant effect on groundspeed and noticeably improve the glide ratio. Eg, if in a 30mph headwind, increasing the airspeed to 70mph from 60 will not reduce the glide ratio significantly, and increases the aircraft glide range.
In the final approach ensure airspeed is above 55mph, by lowering the nose, to give sufficient rotor energy for the deadstick flare, and airflow over the rudder for positive directional control.

Height loss with engine failure is, of course, greater than that with idle power. Ensure you understand the HV chart (5.3) to know what airspeed and height combinations are safe to operate within.
If gliding for a long distance, either keep on a little power, or increase power periodically to keep the engine warm.

PRECAUTIONARY LANDINGS

Forced landings, and Precautionary landings (eg suspected mechanical problem or weather problem).
For a landing with a deflated tyre:
Approach normally, with the intent of a zero or minimal groundspeed touchdown, directly into wind (& across the runway if needed). Flare the aircraft to achieve this, and use the rotor drag/brakes to limit forward speed. Only if impossible to recover the aircraft from the landing area should it be manoeuvred under its own power, as this could further damage the tire and wheel rim.

LOSS OF CONTROL FUNCTION

Loss of primary control systems could be

1. Engine power control. If jammed open, use ignition switches turned on/off to reduce power, and turn off when clear to land in a suitable place. If jammed closed, land as per engine off.
2. Rudder control. Use power and rotor to drive into wind, and descend for landing into as large and as soft an area as possible, flaring for minimum ground roll.
3. Rotor head control. Normally the trim device will keep the aircraft flying in pitch. Roll control failure may lead to a flat descending turn. Use rudder, trim and power to balance aircraft, and descend for immediate landing into as large and as soft an area as possible.
4. Loss of trim control (full trim force, or no trim force). Malfunction of the trim system can result in control stick forces reaching a maximum of 6Kg in both pitch and roll, a higher than normal control loading well within the capability of a normal strength adult.

Stick trim malfunction can be perceived if the rotor brake selector has been left engaged during take-off; if this occurs, change the Flight/Brake switch to Flight, which will reset the trim.
If the pitch trim pressure is high and will not release, turning the Flight/Brake switch to Brake will vent the trim cylinder and release the pitch trim load. Then recycle the switch back to Flight.

3.9 ALTERNATIVE METHOD OF ENGINE SHUTDOWN

Turning the engine off with the mag switches simply earths the coils. If there is an electrical fault the engine can be stopped by isolating the fuel supply. For both engine derivatives the emergency fuel cut off may be closed, which closes the fuel supply valve. It will take about 20 to 30secs min for this method to stop the engine. Alternatively, in an emergency, fully close the choke, wait a few seconds, and open the throttle suddenly. This normally chokes the engine and causes it to stop, but is not guaranteed. If the engine does not stop, close the throttle.

3.10 WHAT TO DO IN THE EVENT OF PITCH OSCILLATION OR ROTOR RPM REDUCTION DUE TO LOW OR NEGATIVE “g”

There are generally two types of pitch oscillation: that caused by pilot over control (‘PIO, Pilot Induced Oscillation’) and that caused by aerodynamic oscillation.
PIO is not generally found on two seat tandem gyroplanes due their inherent stability. It is initiated by the pilot over-controlling the stick. If a situation develops where a divergent aircraft pitching oscillation is occurring in sympathy with fore-aft control stick inputs, firstly stop the control input - never try to control PIO with the stick.
For both situations, smoothly closing the throttle whilst maintaining a level flight attitude will return the aircraft to a stable, slow speed condition very quickly, from which the pilot can recover to normal flight.
Recovery from PIO or aerodynamic oscillation can result in height loss.

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Reduced G loading on a gyroplane is extremely hazardous. Rotor speed is maintained by the thrust of the engine pushing the aircraft through the air, and by the weight of the aircraft exerting a 'G' load on the rotor. This combined loading is dragging the rotor through the air, forcing the rotor to spin and creating lift to hold the aircraft aloft.
In doing this the forces make the rotor spin to an extent that the centripetal (tensile) force that pulls the rotor blade outwards is many times more than the bending moment induced on the blades by the weight of the aircraft, so that the narrow, light blade can support the weight of the aircraft. When the applied load to the rotor is allowed to reduce, through
normal manoeuvres, the rotor will quickly slow to a level to match the reduced load – and similarly speed up to match increased loads.
If the load is reduced to a point where the centripetal load can no longer support the bending load, then the blades will fold up, and the aircraft will enter an uncontrolled terminal descent.
The point of blade fold is significantly below any operational flight speed, provided G is not significantly reduced.
Attempts to fly manoeuvres that induce negative or low G are extremely dangerous. Manoeuvres such as highly banked slow turns or those where a sudden engine failure would lead to significant loss of rotor loading may result in a fatal accident!
If in doubt, smoothly close the throttle whilst maintaining a level flight attitude. This will return the aircraft to a stable, slow speed condition very quickly, from which the pilot can recover to normal flight.

3.11 VIBRATION

A gyroplane is subject to a number of out of balance forces which will generate different levels of vibration depending on the engine and rotor rpms, and on loading conditions. Rotors are normally balanced two seated, so a reduction in occupant loading will naturally change the rotor response.

1. Engine and propeller. Vibration in this area will change with engine rpm, and can therefore be affected and isolated by the pilot. The propeller is normally balanced to less than 0.1ips, meaning low vibration. Vibration will increase as the propeller gets dirty, and will also increase if damaged. A sudden change in flight will indicate a fault has developed, either through an impact (loose luggage, bird strike etc passing through the propeller) or by some mechanical failure. In the event the pilot should make a precautionary landing for evaluation. Propeller damage may also be evident from a change in noise level.
Upon landing, carefully check the propeller for damage, loose bolts or evidence of mechanical failure within the prop or engine. Especially check the engine to engine bearer connections, and the engine bearer to airframe connections.

2. Rotor.
Rotors will vibrate in flight due to tracking errors (side to side stick shake), rotor CG misalignment with the axis of the bearing in the flat plane (oscillatory stick shake), and also in the vertical plane (two per rev shake). The amount of shake will not suddenly change in flight or between flights unless there has been mechanical failure, external influence or rotor strike.
Vibration will increase (and performance decrease dramatically) with dirt build up on the rotor blades, so before any analysis make sure they are clean.
If there is a change in vibration in flight make a precautionary landing and investigate. If on rotor startup, stop and investigate.
Things to check:
Rotor impact with tail of aircraft.
Hanger damage eg twist or distortion of trailing edge.
Blade bent from ground handling.
If after re assembling the rotor, that the blades and hubs are serial no matched, and that the shim washers are correctly matched to the hub bar and rotor tower.
A reduction in vibration may be caused by increased flexibility between the rotor head and the occupant. This may be control system looseness, so check all system joints for tightness, and also for cracks at the base of the mast. Check security of all fastenings between the rotor and the pilot.

If a cause cannot be found, remove on ground to a suitable repair facility for analysis.
Flight in icing conditions may also lead to ice forming on the inner leading edge of the blade (see photo), leading to vibration and loss of lift performance. Flight in icing conditions is NOT allowed!

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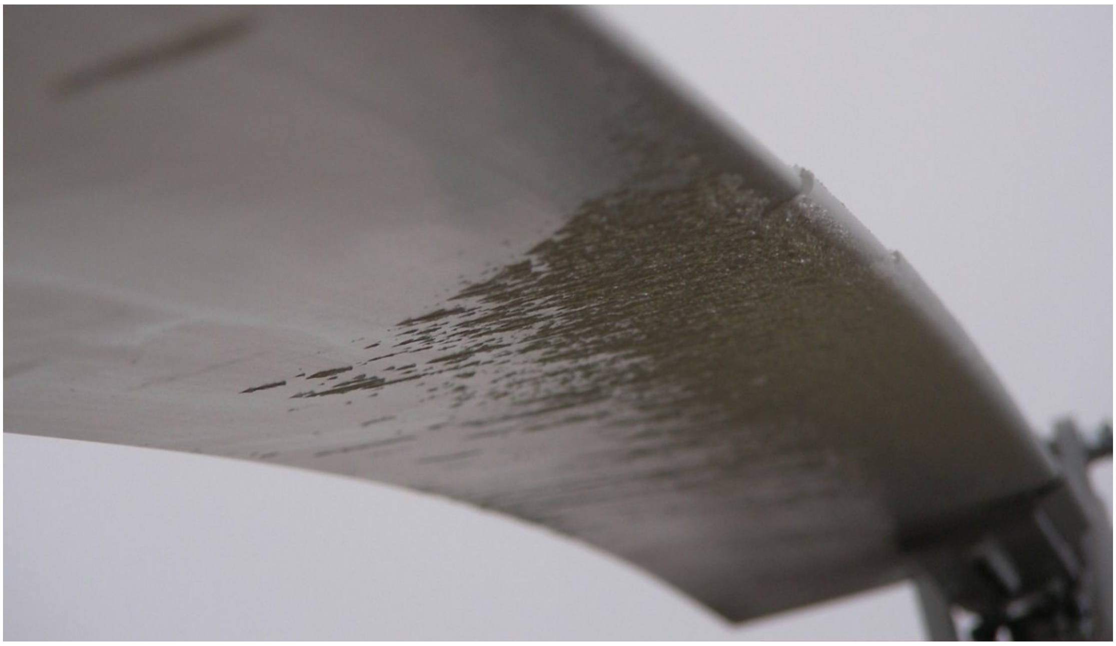
Photo of rotor blade with significant icing built up.

3.12 OTHER EQUIPMENT FAILURE

Good judgement must be used in monitoring instruments, and timely action taken should a reading be in doubt. If in doubt, make a precautionary landing and resolve the issue rather than continuing a flight.

Actions recommended:

ASI failure: In level flight fly with an engine rpm of 4,200 lightly laden to 5,000 heavily laden which will give approx 60 to 80mph. When descending (nose down) throttle back to prevent overspeed, to approx 3,000 to 3,500rpm to your designated landing site, maintaining speed for a flare on landing in the final descent. Leave plenty of space to land in should the flare be prolonged. Experience will aid judgement of the best engine rpm to maintain to match the desired flight speed and payload.

Altimeter failure: In a gyroplane it is reasonably easy to judge height. If in controlled airspace ensure the controlling authority is informed to prevent traffic conflict. Otherwise continue to a safe landing using navigational skills to avoid potential collisions.

Compass failure: Resort to map, aided by GPS if available, fly at a speed to suit navigational requirements or make a precautionary landing if unable to identify position.

Rotor RPM gauge failure: This is not essential for safe flight, and rotor rpm cannot normally be affected in flight unless significant “g” or negative “g” is exerted – and then will only provide an indication of the rpm. If failed in flight, repair on landing

Engine RPM: The engine is rpm-self limiting by propeller pitch in flight. If the gauge fails, replace on landing. Use audio cues to establish rpm

Oil pressure, oil temp and water temp. A failure of one gauge can indicate an engine fault or simply a gauge fault. Watching the other gauges will indicate the likely failure mode.

For example,

1. Gauge suddenly goes to full scale deflection, other gauges reading normally – likely gauge fault
2. Oil pressure falls to zero, possible loss of pressure. Stop engine, make precautionary landing
3. Water temp gradually or suddenly rises above max temp. Possible loss of coolant. Stop engine, make precautionary landing
4. Oil temp suddenly falls to zero, other gauges reading normal – probable gauge failure.
5. Oil temp rises above maximum, other gauges normal – possible very low oil level, blocked radiator or thermostat. Stop engine, make precautionary landing.
6. Fuel level gauge suddenly falls to zero or FSD. Probable gauge failure, but always cross check to predicted fuel burn. Low fuel light will light as a backup.

Sudden, large deflections are normally unlikely, with the exception of loss of pressure readings.

3.13 CANOPY OPEN IN FLIGHT
The canopy is locked in place by a latch on the right of the occupants, and it must be locked down before flight. A panel warning lamp indicates if it is unlocked, and pre rotation is prevented if it is unlocked. If the canopy is inadvertently unlocked in flight, apply left side slip, such that the canopy is pushed closed by the oncoming air. Slow down, and lock the canopy. If impossible to lock, make an immediate landing at as slow a speed as is practical, side-slipping the aircraft until straightening out for landing

3.14 LOSS OF VISION
Sudden loss of forward vision may occur through a birdstrike or unexpected canopy icing (eg freezing rain). Immediately ensure the aircraft is in a safe attitude by reference to the side view, using if required the emergency viewing hatch on the left of the pilot. If at a safe height, slow the aircraft to 50mph, and, using a hand through the hatch, clear if possible the viewing obstruction. If this is impossible, then the aircraft may be flown in a side slip to a precautionary landing, landing as slow as possible, kicking the aircraft straight with the rudder just before touchdown. Make sure the area for landing is suitable for such an event, if practical extending the landing to an airfield.

3.15 FURTHER INFORMATION (914UL)
Under MC-264/SB-073 a protection relay is introduced to provide continued electrical supply to the P1 fuel pump in certain failure conditions.
No power in the cabin indicates either the main circuit fuse has failed, or that the battery has failed and the pump protection relay has opened. In this case the P1 primary fuel pump remains powered by the regulator directly, maintaining fuel supply to the engine. The turbo control unit is not powered in this instance, and will remain in whatever position it was in when power was lost – so mixture and manifold pressure control will be lost. Take care to only use the minimum power required to land safely to prevent engine damage.
In these circumstances the primary fuel pump will continue to run until the engine alternator stops providing electrical energy. If required, fuel supply can be shut off via the fuel cock located behind the seats.