Basics of Flying a Powered Parachute

Warning---This article is not intended to replace the hands on training from a qualified flight instructor.

FEDERAL AVIATION RULES AND INFORMATION YOU SHOULD KNOW ABOUT

The following illustrations and explanations are generic for a powered parachute and will vary according to manufacturer and the type of aircraft that you are flying. Many "Thanks" are extended to a host of companies and individuals for making this page possible.

I - STRUCTURE OF POWERED PARACHUTES

A. AIRFRAME

The airframe structure is manufactured with aircraft grade 6061 and 6063 aluminum, assembled with aircraft grade ny-lock nuts and bolts, and stainless steel cable. The standard engine is the Rotax 503, dual carburetor, dual ignition which develops 52 hp, however most 2-seat aircraft use the Rotax 582 with 65 HP.

Starting at the front of the craft, I will identify the major components of the craft. First is the pneumatic front tire which is connected to the front fork. The front fork is attached to the nose gear carrier. Those items are made out of mild steel. Steel of course is heavier than aluminum, but as these components may be subject to high loads (e.g... rough landings and rough terrain), we feel steel is a better choice of materials for this application.

The controls for in-flight steering are the rudder pedal tubes, which are attached to the frame rail tubes, behind the nose gear carrier. As in conventional aircraft style, pushing with your left foot pulls the steering control line which is attached to the back of the chute on the left side. This pulls down that left section of the chute, resulting in drag on that side of the chute. As the right side of the chute continues on, the craft will turn to the left. Conversely, push right to go right. Ground steering is by side-mounted control stick: stick right to steer right, stick left to steer left. Note that the control stick controls ground steering only. Conventional aircraft pilots should especially note that unlike conventional aircraft, there is no "control stick" for in-flight steering.

The seat is an integral structural part of the airframe. The bottom of the seat mounts to the frame rails, the top mounts to the pylons just forward of the engine mount. The pilot sits in the front seat and the passenger sits in the rear.

The pylons extend upward from the rear axle to which the pull start is mounted for easy overhead use of the pilot. Extending outward from the pylons are the outrigger arms which attach to the CG (center of gravity) adjuster tubes. The CG adjuster tubes are slid in or out in accordance with pilot weight. The pilot must be forward of the center of gravity to compensate for the weight of the engine in the back. The lighter the pilot, the more forward of the CG he must be. The craft has a slightly nose-high attitude while in flight.

The CG is adjusted properly when the engine is nearly level in flight, thus producing optimum angle of thrust.

The standard engine in the Rotax 503, dual carburetor, dual ignition, 52 horses, two cycles, two cylinders or as mentioned earlier, the Rotax 582, dual carburetor, dual ignition, 65HP, liquid cooled. It has two Bing carburetors with a washable K-N air filter. The fuel system uses a primer bulb which must be squeezed before starting the engine to insure adequate fuel supply.

The recommended ignition switches location is on the instrument deck, but can be mounted to suit pilot preference. Familiarize yourself with their location, as they will immediately stop power to the engine should you desire to abort any takeoff. Using them will stop power to the prop when your tires touch down on landing, and it will result in an engine-off landing should you accidentally hit them in flight.

The throttle control is usually mounted on the right side of the seat. It is a throttle quadrant. Pushing it forward will increase power resulting in an ascent, while decreasing power by pulling it back will decrease power result in a descent. A three blade composite prop is standard equipment in the two-seater.

The fan guard consists of two complete aluminum hoops fore and aft of the prop. Its primary purpose is to reduce the likelihood of catching lines or parachute in the prop.

B. PARACHUTE

The high performance chute is made of 1.1 oz zero porosity rip stop nylon. The high performance chute has 13 cells. These sections are closed at the back edge to prevent air from escaping. There are cross ports between the cells facilitating inflation. Once the chute is filled with air, it becomes a rigid wing similar to any other aircraft wing. The area of the extra high performance chute is 550 sq. ft. The chute is attached by nylon lines. Each line is capable of holding over 600 pounds.

The suspension lines are attached to four quick links rated for a working load of 880 lbs. each, which connect to one long riser on each side. Another cable, the backup cable (safety riser), attaches from the quick link down to the pylons on each side. Engine torque of the engine pulls the craft to the left. The backup cable on the right side of the craft is slightly shorter than the left side. This shorter right backup cable increases load on the right side of the chute, thereby compensating for engine torque.

The condition of suspension cables, lines and chute are evident at preflight. During ground roll the pilot must always inspect alignment of lines and symmetry of the inflated canopy.

The parachute should be kept out of direct sunlight when not in flight as ultraviolet rays will eventually damage the fabric. A damp chute should be air dried before storage to prevent serious damage from mildew. Holes in the rip stop fabric can be easily repaired by a qualified parachute rigger. A properly cared for chute should last for many years of flying.

Summary I - STRUCTURE OF POWERED PARACHUTES

You should be familiar with all major components of the craft and chute, what their purpose is, and how to operate them. It is recommended that the pilot spend a good

amount of time just sitting in the craft familiarizing himself long before he attempts to fly the craft. The major components are:

1. The ground steering control stick - move right to turn right, left to turn left.

2. In-flight steering rudder pedal tubes - push right deflects the back edge of the chute, resulting in a right turn. Pushing left results in a left turn.

3. The adjustment for center of gravity control - compensates for pilot weight, putting the craft in a slight nose-high attitude.

4. The throttle located on the right side - pushing it forward will result in an ascent, pulling it back will result in a descent.

5. The ignition on-off switches usually located on an optional instrument deck - results in engine off when turned off. KNOW WHERE THEY ARE AND BE ABLE TO TURN THE ENGINE OFF IMMEDIATELY.

6. The pull start located at the top of the pylons - with the engine ignition switches on, pull the start handle to start the engine.

7. The choke and fuel primer bulb located between the fuel tank and engine - they are necessary to properly start the engine when cold for the engine warm-up procedure.

8. The steering control lines - operated by the rudder pedal and attached to the back edges of each side of the chute to control drag and result in turns.

9. The parachute suspension lines - 10 front and 5 rear on each side.

10. The parachute wing with 13 cells - opens at the front and closed at the back to maintain the air pressure required to form a rigid wing.

11. The parachute torque trim - set by the right backup cable, which is shorter than the left side.

II - AERODYNAMICS OF POWERED PARACHUTES

A. RAM AIR PARACHUTE

As stated earlier, the powered parachute wing retains its rigid shape during flight due to air pressurization, just as a conventional aircraft's wing is rigid due to internal structure. Both craft's wings have a top skin, a bottom skin, a leading edge and a trailing edge. Both have curved upper surfaces and relatively flat lower surfaces. The only difference is the fabric construction and the cell openings in the leading edge.

The chute is made of zero porosity material which prevents air escaping. Once air flows in, it has no means of escape except back through the leading edge. In flight, outside air cannot enter the pressurized wing and is forced to flow around the leading edge. This results in the prevention of air escaping from the wing, and in the formation of an aerodynamically correct wing.

B. LIFT, WEIGHT, THRUST, DRAG

In straight and level, non-accelerated flight:

LIFT EQUALS WEIGHT

AND

THRUST EQUALS DRAG

When the wing, with its curved upper surface and flat lower surface, moves through the air, it forces the air to flow around it. Air flowing over the curved upper surface has to travel further and therefore faster, than air going under the wing. Air traveling at a higher velocity creates a lower pressure than air traveling at lower velocity. This higher pressure air traveling beneath the wing produces an upward force called LIFT.

Weight is produced by gravity which is equal to the weight of pilot and craft.

When lift and thrust exceeds weight and drag, the craft will climb. When weight and drag exceeds lift and thrust, the craft will descend.

Thrust is produced by the prop powered by the engine.

Drag is produced by air resistance as the craft moves through the air. Resistance is produced by the chute, the lines, the craft, and pilot.

C. THROTTLE CONTROL

The throttle controls your climbs and descents in a powered parachute rather than your speed. It does this by changing the angle of attack of the wing, that is, the angle at which the wing meets the air.

When the throttle is pushed to increase power the thrust of the prop moves the airframe forward. This changes the angle of attack of the wing, resulting in a climb. Maintaining this increased thrust will maintain the climb.

When the throttle is pulled back to decrease power, the cart moves back under the wing. This changes the angle of attack of the wing, resulting in a descent. During normal climbs, cruise and descents, the wing automatically adjusts to the proper angle of attack.

The rate of climb is controlled by the throttle setting. Each pilot must experiment with the throttle setting required for climb and descent given the pilot weight and the atmospheric conditions.

Pilots should be aware that a slight delay time (approx. 2 to 5 seconds) exists between making throttle changes and the resultant climbs or descents. Be ready to add power during flybys before you actually need the climb to avoid touch-and-go.

D. PENDULUM STABILITY

The key to the powered parachute's safety and ease of operation lies in its pendulum stability. This principle allows the powered parachute to fly straight and level all by itself.

Consider a pendulum which consists of a suspension point with a weight attached to the other end. With a powered parachute, the wing acts as the suspension point, the craft and pilot are the weight.

When the weight of a pendulum is moved out from under its suspension point and released, it will immediately swing to get back to its original stable position. An object is considered "stable" when it has a natural tendency to return to its original position after being disturbed by an outside force.

A "stable" aircraft will return to level flight whenever the controls are released. Likewise, whenever a force such as a wind gust moves the powered parachute, the suspended weight of the pilot and craft will always return to its natural stable position. With such excellent stability, a powered parachute almost flies itself.

Due to this feature, pilots should be aware that there is almost constant gentle motion in powered parachutes, While it is most noticeable in the first few minutes of flight, this gentle movement soon becomes quite natural to the pilot. Lighter pilots will feel slightly more movement than heavier ones.

E. EFFECTS OF WIND GUSTS ON PENDULUM STABILITY

A wind gust will cause the larger and lighter wing of the powered parachute to move first, displacing the suspension point of the powered parachute. Its pendulum stability will cause the smaller and heavier craft to swing back into its normal position directly below the wing.

A side gust will move the wing to the side first. Then the craft will swing back under the wing, resulting in a flight path slightly to the side of the original.

A gust from the front will move the wing backward, increasing the angle of attack. The powered parachute begins a climb. Then the craft will swing back under the wing, reducing the angle of attack. The powered parachute begins to descend. When the craft centers itself under the wing again, level flight will continue.

A gust from the rear will move the wing forward, decreasing the angle of attack. The powered parachute begins a descent. Then the craft will swing back under the wing, increasing the angle of attack. The powered parachute will climb. When the craft centers itself again, level flight will continue.

F. AXES OF MOVEMENT: YAW, PITCH AND ROLL

Aircraft pivot about three axes of movement. The axes: yaw (movement around the vertical axis), pitch (movement around the lateral axis), and roll (movement around the longitudinal axis). Conventional aircraft generally control yaw through use of rudders, pitch through elevators and/or canards, and roll through ailerons or drag rudder. Learning control of these systems increases the complexity of flying conventional aircraft.

The unique pendulum effects of the powered parachute controls movement through the lateral and longitudinal or pitch and roll, axes. The pilot needs only control the vertical, or yaw, axis. To turn the powered parachute, the pilot pushes either rudder pedal. This introduces the yaw (or turn). The craft's pendulum stability automatically controls the roll (or banking). Pitch movements introduced by wind gusts are controlled by the craft's self stabilizing pendulum design. Pitch movements for climbs or descents are controlled by the throttle control.

The very simple control of movement about these three axes makes the powered parachute relatively easy to fly.

G. STEERING CONTROLS

Ground steering is accomplished by pushing the control stick right to go right, left to go left. The control stick is used for steering during your taxiing for takeoff and on landing.

The pilot controls in-flight steering with the two rudder pedal tubes which are attached to the steering control lines. The steering control lines are attached to a tang on the rudder pedal tubes, routed through pulleys on the outriggers and are then attached at four points of the trailing edges of the parachute.

When the pilot pushes either rudder for a turn, the steering control lines pull down that side of the parachute to which it is attached. Push left to turn left, right to turn right. The drag created by the lowered trailing edge slows that side of the chute, causing the other side to fly around it, turning the powered parachute. The more trailing edge deflected, the faster the turn, the shorter the radius, and the more altitude lost.

Whenever drag increases, as in turning maneuvers, there is a loss of lift. This altitude loss, which can be 30 feet or more in a very tight turn, can be minimized or eliminated by simply adding throttle during the deflection of the rudder pedal. Losing altitude in a steep turn, coupled with gusting winds and no addition of throttle can result in unintentional landings. Therefore, steep turns should not be made close to the ground (below 50 feet).

The rudder pedals have two other uses not related to turning the powered parachute. The first use is to assist in opening closed end cells on takeoff. On the pre-takeoff roll, often the last two cells of each side of the chute will be prevented from fully opening due to outside pressure on the canopy surface. As the pilot looks overhead at the chute during the pre-takeoff roll, he will see the upper edge of the canopy folded down over the cell openings. To open these cells, the pilot should push both rudder pedals out and hold a slight flare. If the problem is not corrected easily abort the takeoff and inspect the powered parachute for possible rigging problems before attempting another takeoff.

End cell closures will eventually correct themselves as air being forced into the open leading edge will push through the cross ports within the cells to fully inflate the chute. Flaring the chute forces air forward in the outer cells, opening the cells, allowing air to come in for full inflation. While some pilots can takeoff with closed end cells without any problem, we recommend this flaring maneuver to ensure maximum lift for takeoff. WE DO NOT RECOMMEND LEAVING THE GROUND WITH ANY CELLS CLOSED. TAKING OFF WITH A CLOSED END CELL ON ONE SIDE, IMMEDIATELY CAUSES THE PPC TO BEGIN TURNING WHEN YOU LEAVE THE GROUND. YOU MAY OR MAY NOT BE ABLE TO REGAIN CONTROL OF THIS TURN.

The second non-steering function of the rudder pedals is in the performance of an optional landing technique called flaring. To flare, the pilot pushes both rudder pedals to full deflection. In case of an engine-out landing, this should be done at six to eight feet above ground. This creates a momentary decrease in the powered parachute rate of descent and can yield a softer landing when timed correctly. This is not a maneuver for novices because immediately after the momentary decrease in rate of descent comes with an increase in the rate of descent. If poorly timed, the flare can result in a much harder

landing than no flare at all. Flaring should only be performed by experienced powered parachute pilots, unless instructed to perform it by your flight instructor in an emergency, such as an engine-off landing.

H. THE EFFECTS OF WIND DIRECTION

When the craft is on the ground the chute will seek to face directly into the wind. This tendency is called "weather vaning" and the chute will try to pull the craft into the same direction. The pilot must watch the chute overhead and ground steer the craft into the same direction as the chute. Ground steering is accomplished by pushing the control stick left to go left, right to go right. If the chute is lagging to your left as you look up at it, then the wind is coming from your right and you must push the control stick right to turn the craft to the right.

A difference between the wind direction and the takeoff roll direction will not allow the chute to inflate properly and could conceivably cause the chute to produce a sideways force that might cause the craft to tip over during takeoff roll. The powered parachute is vulnerable to these effects during a critical period of just a few seconds: on takeoff (from the moment the chute flies up overhead the craft and the instant the wheels leave the ground) and on landing (from the moment the wheels contact the ground until the chute is safely down behind the craft). Slight crosswind takeoff rolls will take considerably more runway distance in completely opening the chute while the pilot steers into the wind. Crosswind takeoff rolls and landings with strong or gusty winds might result in the craft tipping over.

Therefore to minimize your exposure to these problems:

ALWAYS TAKE OFF AND LAND DIRECTLY INTO THE WIND

AND

NEVER FLY THE POWERED PARACHUTE IN STRONG OR GUSTING WIND

CONDITIONS

I. AIRSPEED AND GROUNDSPEED

Non-pilots are often confused by the terms "airspeed and groundspeed".

Think of airspeed as simply a performance statistic of the craft. The powered parachute flies through the air at 26 mph, regardless of whether the throttle is at full power or level flight setting. The powered parachute does not increase in airspeed with an increase in power because as power is increased, the angle of attack is also increased. An increased angle of attack produces more lift and drag coinciding with the increase in thrust. Therefore, the powered parachute climbs, but does not fly at a greater airspeed.

The airspeed statistic must be used, coupled with the wind speed in order to compute your groundspeed. Groundspeed is the speed at which the craft is actually moving over the ground. It varies with the wind speed and the direction the powered parachute is facing in respect to the wind.

If the powered parachute is flying into a 10 mph headwind, its groundspeed is 16 mph - or 26 mph airspeed minus 10 mph headwind, equaling 16 mph groundspeed.

If the powered parachute is flying into a 10 mph tailwind, its ground speed is 36 mph - or 26 mph plus 10 mph, equaling 36 mph.

Therefore, the airspeed never varies from 26, the groundspeed is computed with the airspeed based on the wind speed and the direction the powered parachute is facing.

This must be considered when flying "cross country". For instance, you cannot fly to a given point with a tailwind using half your gas supply and expect to get back on the other half facing into a headwind.

J. ENGINE-OUT

If you remember nothing else from this ground School, do remember this section. While engine-out situations are rare, they can happen, even on your first solo flight.

Given the high lift canopy, the average glide ratio of the powered parachute is 4 to 1. That is, the craft will glide 4 feet forward for every one foot of descent. At full gross weight, the descent rate is 8-11 feet per second. Therefore, an un-flared engine-out landing is equivalent to suspending the craft 2-3 feet above ground and dropping it. Likelihood of injuring yourself, or damaging the craft for that matter, is slim unless you land on very rough terrain or an obstacle.

The glide path will change depending upon the wind speed and the direction the powered parachute is facing. Facing into a headwind results in a steeper glide angle, but a slower groundspeed on landing. With a tailwind, the glide angle would be increased, but the groundspeed would be faster.

Should you have an engine-out situation, first of all look beneath you to see if you can comfortably land on what you are flying over. If you would rather not, turning the craft downwind to give yourself a tailwind will give you a longer glide over the obstacles. Preferably, however, you should face the craft into the wind to give you a landing with a lower groundspeed. In either case, avoid tight turns, as any deflection of the chute will result in additional loss of altitude. Last minute turns to land engine-off into the wind should be done with enough altitude as not to come into contact with the ground while turning. Your descent rate is higher in a turn and touching the ground while turning could cause the craft to roll over.

Next, begin to flare the craft at 6-8 feet above the ground. This is accomplished by pushing both rudder pedals at the same time, and pulling in additional steering line with your hands. This is the only time in flight that both pedals are held in at the same time. This action results in an almost immediate reduced descent and forward momentum, giving a softer landing unless performed too high above ground. If you begin to flare higher than 10 feet above ground, you will drop considerably harder than if you had not flared at all. This may result in damage to the craft and pilot.

In any case, if you are in training and in two-way radio contact with the flight instructor, do exactly what he says. During training flights, at which your altitude may not be greater than 150 to 250 feet, you have no time to troubleshoot the problem, so simply follow the steps outlined above. At other times however, when you have higher altitude and therefore greater time before landing, you could take a few seconds to see if you can correct the problem. Check the on-off switch to see that you didn't inadvertently turn it to "off" while flying. Then reach up overhead and pull the starter to see if you can restart the engine. Don't use up more of your time than necessary. Be sure you can land safely beneath you, at your projected glide path, and begin to flare at 6-8 feet above ground.

At the higher flight altitudes of 1000+ feet above ground level, you have greater latitude in flying over unfriendly terrain due to your distance from the ground and the longer glide angle. But this craft is not a "glider". It is a powered parachute and you are coming down at a steep angle while at a gentle speed on touch down. Therefore, do not fly over what you are not willing to land on at any time - like forests, rough terrain, lakes, or cities.

It is recommended that experienced pilots practice the flaring technique at an altitude of at least 500 feet or more over their landing area. Position the throttle at engine idle. Practice pushing both rudder pedals out at the same time and note the resultant descent rate and glide angle. Then, release the rudder pedals to restore lift to the craft and add power. Do not hold a flare position for more than three to four seconds. Allow 10 seconds between flares if you are practicing repeated flares to avoid pitch oscillations. The purpose of this exercise is to gauge the descent and glide, not to land with the parachute in the flared position. Be sure you return the rudder pedals to their normal stable position within 100-200 feet to the ground. To land in a flared position, NEVER push rudder pedals out when you are more than 8 feet above ground.

Summary II - AERODYNAMICS OF THE POWERED PARACHUTE

1. The parachute wing retains its shape due to air pressurization, just as a conventional aircraft wing's shape is maintained due to internal bracing.

2. Lift must be equal to weight and thrust must be equal to drag to produce level flight.

3. Throttle control does not change forward airspeed. Adding throttle results in the craft gaining altitude, while decreasing throttle results in a descent.

4. A powered parachute is always stable because of its pendulum design, requiring no pilot input to maintain stability.

5. Wind gusts will cause the powered parachute to momentarily climb or descend.

6. The pilot controls yaw (turning) by pushing the rudder pedal tube, the craft's pendulum design controls the roll (banking of the turn). Altitude changes by use of the throttle.

7. To ground steer, push the control stick left to go left, right to go right. In-flight steering is accomplished by pushing the left rudder pedal tube left to go left, right to go right.

8. Always take off and land directly into the wind to completely inflate the parachute in the shortest runway distance and to avoid any possible tipping of the craft.

9. Airspeed is a constant performance statistic of the craft at 26 mph. Groundspeed, travel over the ground, is computed by using the airspeed statistic with the wind speed.

10. Engine-out at low altitude (under 300-400 feet) allows time only for checking out the terrain over which you are about to land, slightly turning the craft into the wind or away from the wind if necessary, and beginning to flare at 6-8 feet before landing. Engine-out at higher altitudes allows some time for attempting to restart the engine, and provides a longer glide path to be able to fly over any small hazardous areas.

III - BASICS OF WEATHER READING

A. AIR DENSITY

Air density has an effect on the performance of any aircraft. Performance is measured in terms of how much runway is needed to take off or land and how well the craft climbs. Three factors affect the air density. They are: heat, humidity, and atmospheric pressure.

Heat makes air expand, cold makes air contract. Hot, expanded air has fewer molecules per square inch than cold, condensed air. Therefore, a wing will perform better in cold air than hot.

Humidity adds water molecules to that square inch of air, resulting in fewer air molecules, thus less air density. A wing will perform better in dry air than humid.

Atmospheric pressure is the force exerted by the weight of the atmosphere (air) and is due to the gravitational force of the earth. As you go up in altitude, the pressure of the atmosphere will decrease because there is less air at higher altitudes. A wing will perform better in lower altitudes than higher altitudes.

A pilot must take into consideration the effects of heat, humidity, and atmospheric pressure whenever he flies and adjust his expectation of runway needed and climbing performance.

B. CLOUDS

Clouds can give you a good indication of weather and air movement. There are basically two types - cumulus and stratus. These types are further classified by the addition of the word "nimbus", meaning rain.

Cumulus clouds are the puffy type, rather like cotton balls. They are fair weather clouds, as they usually mean there is very little precipitation. However, they do indicate turbulence in the area. The more cumulus clouds, the greater the amount of turbulence. The air below cumulus clouds will usually be turbulent, with more stable air above them.

Stratus, meaning "spread out" clouds (like horizontal sheets), are formed by stable air and indicate smooth air condition.

Cumulonimbus are the dark thunderstorm type that bring rain, wind, lightning and severe turbulence. While you might only see the dark cloud cover from the ground, they are very tall and anvil-shaped. Wind shears and tremendous up and down drafts (micro bursts) are usually in or around cumulonimbus clouds. Do not fly or take off when these clouds are visible.

C. WIND SHEAR

Wind shear is caused by air moving at different speeds, directions, horizontally or vertically, or temperatures. Basically, there are two causes: thunderstorms or winds aloft moving faster that surface winds. The greater the wind speeds, the greater the effects of the wind shear. If clouds are moving fast yet winds on the ground are calm, there will probably be some wind shear present. Advancing thunderstorms usually produce wind shear. Typically these conditions precede the thunderstorm by as much as 10 miles and produce winds up to 50 mph. Wind sheer conditions can also be present between cold and

hot fronts. Flying a powered parachute in mild wind shear will cause the airframe to oscillate. Flying in severe wind shear may cause the chute cells to collapse. Although you can expect the chute to re-inflate after a brief period of freefall, severe wind shear is very hazardous to all aircraft and is to be avoided at all cost. Before flying, pilots should check in with the Flight Service or get a local weather report to be aware of wind shear producing conditions such as high winds aloft or approaching thunderstorms.

D. MECHANICAL TURBULENCE

Mechanical turbulence is created when air is forced to go over and around an obstacle, such as trees or buildings. To visualize what happens to air moving up, over and down past an obstacle, think of how water reacts as it moves over a rock. The water is smooth before hitting the rock and becomes turbulent and boiling afterwards.

As air hits an obstacle, such as a building, it is forced up over the top and around the sides. The convergence of air moving in different directions creates turbulence on the downwind side of the obstacle. A 10 mph wind will produce mechanical turbulence for 1/8 of a mile or more downwind of the obstacle. As discussed earlier, the powered parachute self corrects in gusts striking it from front and rear. Even upward moving air will only cause the powered parachute to ascend. If the air is moving downward however, the chute is forced down, which relieves pressure. This may allow air to escape from the leading edge, causing cells to begin collapsing. This will cause the craft to descend momentarily, which as it does so, pressurizing the cells again. If the powered parachute lands during this momentary descent, a hard touchdown can result.

E. WIND GRADIENT

Wind gradient is the effect the drag produced by the surface of the earth has on the wind speed. While winds at 200 feet could be 25 mph, winds on the ground could be slowed to 5 mph. The closer to the ground you get, the slower the winds. The pilot needs to be concerned with wind gradient when performing flybys, touch-and-go, or landing. When facing into the wind, the glide angle of the powered parachute is steeper with increased wind speed. Thus with less headwind the closer to the ground, the more shallow the glide angle will become. As the groundspeed gets faster and faster, the closer to landing you get, and the more ground covered due to the glide angle change, the pilot will need to make minor throttle adjustments to keep the craft from landing too soon or overshooting the landing zone.

F. CONVECTIVE TURBULENCE OR THERMALS

Convective turbulence or thermals, created by air of different temperatures rising from the ground, can cause the powered parachute to rise or descend from a given flight path. Also known as thermals, hot winds are used by glider pilots to keep their craft soaring. Different surfaces reflect heat into the atmosphere at different rates. Air above warm surfaces, such as pavement, sand and plowed fields, will cause the craft to rise from its expected glide path. While air above cooler surfaces, such as water, trees, and grass fields, will cause the craft to descend. These thermal currents can cause the pilot to overshoot or undershoot the landing area unless he is aware of the effect the surfaces he flies over have on his flight path.

G. AIRCRAFT WAKE AND WING VORTICES

Aircraft wake and wing vortices are turbulent conditions that may cause the powered parachute to oscillate or cause chute cells to begin collapsing. Wake turbulence, created by all heavier than air aircraft whether they are a 747 or a powered parachute, is to be avoided when taking off or landing near other flying craft. The turbulence, which sinks at approximately 7-1/2 feet per second, should be avoided by waiting 3-4 minutes of its passing. Heavy aircraft or low airspeed equals severe wake turbulence. Wing vortexes are sideways tornados coming off the tips of the wings. If the chute comes into contact with wind vortices due to flying too close to another craft, the end cells of the chute can close as they do on the takeoff roll. This can cause a momentary loss of lift until they reopen through the normal passage of the wing through the air.

Summary III - BASICS OF WEATHER READING

1. Heat, humidity and altitude affect performance of any aircraft in terms of runway needed to takeoff or land and engine thrust when adding power.

2. The three basic cloud types are: Cumulus (white, puffy clouds) indicates fair weather, but also some turbulence. Stratus (horizontal sheet clouds) indicates smooth air conditions. Cumulonimbus (dark, thunderstorm clouds) indicates turbulence and severe weather.

3. Wind shear is caused by air moving at different speeds or directions or different temperatures, and can cause the parachute to oscillate, possibly resulting in collapse of the cells.

4. Mechanical turbulence is caused by air moving over and around obstacles such as trees and buildings, and is found over and on the downwind side of the obstacle. Any flight near obstacles should be done on the upwind side to avoid mechanical turbulence.

5. Generally, the closer to the ground you get, the slower the winds due to wind gradient. This loss in headwind should be taken into account on approach for flybys, touch-and-go's, or landings.

6. Convective turbulence, also known as thermals, caused by air of different temperatures, will result in the craft rising or descending from its given flight-path.

7. Wingtip vortices and aircraft wake turbulence may cause the powered parachute to oscillate or cells to collapse. Pilots should wait 3-4 minutes to takeoff or land in the wake of another aircraft. Pilots should avoid vortices of other aircraft's wings by not flying too close to the aircraft's flight-paths.

IV - FEDERAL AVIATION REGULATIONS

The single seat qualifies as an ultralight, governed by Federal Aviation Regulation Part 103 and as such its operation does not require a license by the pilot or for the aircraft. Since the Six Chuter Legend has two seats it does not fit the FAA's definition of an ultralight (see FAR Part 103). It may be used as a trainer if you have a training exemption 6080 offered to pilots who have qualified for a Basic Ground Instructor waiver.

While hundreds of two-seat powered parachutes are being flown illegally by persons without either a waiver or a pilot's license, we do not recommend it.

V - PREFLIGHT CHECK LIST

1. NOSE WHEEL ASSEMBLY

a) Check the wheel for proper play
b) Check tire inflation.
c) Check that the connection between the front fork and the front axle is secure.
d) Check that the connection between the front fork and the front gooseneck is secure.
e) Check that the connection between the control stick and the seat shell is secure.
f) Check for smooth steering.
g) Check that the steering mechanism is not sloppy and loose. Keeping it snug will make steering much easier.

2. AIRFRAME

a) Check all tubing for dents, bends or other damage.
b) Check all bolts for nylock nuts or wing nuts and safety rings.
c) Check all clevises for safety rings.
d) Check outriggers for proper CG adjustments.
e) Check all cables for kinks, frays, abrasions or broken strands.
f) Check each end of each cable for bolt security, and check that the thimbles are not twisted or elongated.

3. STEERING RUDDER TUBES

a) Check that the steering rudder brackets are attached firmly.
b) Check steering rudders for freedom of movement.
c) Check steering line attachment.
d) Check control pulleys for wear, cracks and secure attachment.

4. MAIN WHEEL AND AXLE ASSEMBLY

a) Check main tire inflation.
b) Check axle and axle hardware
c) Check that the leaf spring is unbroken and properly attached.
d) Check wheels for proper play.

5. POWERPLANT

a) Check that the engine mount hardware is in place.
b) Grab the prop near the hub and shake it fore-and-aft. Be sure that the prop, hub, engine, engine mount and airframe are securely attached together. Note: never turn the prop by hand unless the spark plug caps are pulled from the spark plugs. Simply turning the ignition switch "off" is not enough.
c) Inspect the engine mount carriers, and engine mount channels for cracks, bends, or corrosion.
d) Inspect the muffler mounts for cracks.
e) Examine the muffler for cracks, particularly the header pipe which is subject to wide variations in temperature. See that it is securely fastened to the engine.
f) Check the security of the carburetor, air filter, control cable and electrical wire.
g) Check the throttle for full travel and proper play.
h) Check the electrical connections.
i) Inspect the propeller for cracks and dings. They're most likely to appear around the tips and leading edge.
j) Check the fuel (quality as well as quantity). Is tank full? Look for water and dirt in the bottom of the tank.
k) Check the fan-guard for proper attachment and proper propeller clearance.
l) Check that the pull-starter is securely attached to the pylon.
m) Check that plug wires are attached securely to the spark plugs.

n) Check the safety wire on prop, exhaust header springs, muffler bracket springs, and fuel system.
o) Inspect fuel system from tank to carburetor. Inspect all fuel line and components for leaks and cracks.

6. PARACHUTE RIGGING

a) Check quick-links for proper attachment (finger tight plus 1/4 turn).
b) Check suspension and control lines for knots, tangles and wear.
c) Check control lines for proper routing through all guides and pulleys.
d) Check parachute for tears in fabric, torn or loose stitching, abrasion, and deterioration from sunlight.

Note: Whenever the parachute is not in use, keep it stored out of direct sunlight and free from moisture and mildew. Prolonged exposure to these conditions will weaken the material, shortening the useful life span of the parachute.

7. SEAT AND HARNESSES

a) Check the seat for wear damage.
b) Check the seat belts for wear damage.
c) Put seat belt on and adjust straps for security.

8. PILOT AND PASSENGER

a) Healthy? Rested? Sober? Relaxed? Dressed comfortably? (It's going to be cool up there.) Don't wear anything that is loose enough to interfere with the operation of the aircraft (e.g. a scarf that could blow back into the powerplant).
b) Helmet on and fastened? If your hair is long enough to get back into the engine, restrain it before putting on your helmet.
c) Goggles or face shield in place and clean?

9. RUN-UP

a) Brace the front wheel against an unmovable object (building, tree, fence post, automobile tire), clear the prop area directly to the sides and behind. Be aware where your prop blast is blowing. Be courteous - don't create a dust and wind storm for the surrounding people. Make certain the ground is free of all debris (aluminum cans, branches, gravel, etc.) Are all tools removed from airframe? Is the area clear? If so, shout, "Clear Prop!".
b) Squeeze the fuel primer bulb as needed to fill the carburetor float bowl. Pull the rope quickly and evenly until the motor starts. Give it just enough throttle until it runs smoothly, and lift choke lever up. If the engine starts to run rough, give it a little more throttle. Continue to manipulate the throttle as needed, until the engine is warm enough to idle smoothly.
c) Check the controls (ground steering and rudder pedals).
d) Check the ignition switch by briefly turning it off, then on.
e) Check the wind direction and strength. Is it within your limitations? Do not taxi crosswind.
f) Look for other air traffic on landing approach.
g) You are now ready for takeoff. Have a safe and enjoyable flight!

VI - POWERED PARACHUTE FLIGHT

WARNING!!! THE INSTRUCTIONS IN THIS MANUAL ARE NOT MEANT AS FLIGHT TRAINING. IT IS STRONGLY RECOMMENDED THAT ALL FIRST TIME PILOTS OF THE POWERED PARACHUTE BE TRAINED BY A QUALIFIED FLIGHT TRAINING FACILITY. THAT TRAINING SHOULD ENTAIL GROUND School INSTRUCTION, A TEST TO ENSURE THE STUDENT HAS UNDERSTOOD THE GROUND School INSTRUCTION, AND A; SUPERVISED SOLO FLIGHT WHILE IN TWO-WAY RADIO CONTACT WITH THE FLIGHT INSTRUCTOR ON THE GROUND.

THE FOLLOWING INSTRUCTIONS ARE ONLY MEANT AS A SYLLABUS, OR GUIDANCE, FOR FLIGHT TRAINING.

A. FIELD LAYOUT

In general terms, the field for your first solo flight should be in a large unobstructed area with smooth ground that is free of rocks, holes, high grass or any objects which might snag the chute. The area must be large enough to permit takeoff into any direction to coincide with the wind direction. Operations should be conducted as far away from power lines as possible. The recommended size for a first flight training field is at least 1200'x 1200', plus 200' for every 10° of temperature over 60°, and 200' for every 1000' above sea level. Therefore, a 70° day at 1000' above sea level requires a field of 1600'x 1600'. When using hybrid chutes which typically have greater lift specs, these minimums can be reduced by 25%. A windsock should be clearly visible. A first-time student should not be trained in gusting wind conditions or winds over 4-6 mph. Flight Service or the weather bureau should be called to ascertain what weather conditions are expected.

B. PREFLIGHT

A complete mechanical preflight should be performed on the craft. Use the preflight check list provided in this manual. After the check list is completed, the engine should be started and warmed up. Squeeze the fuel bulb as needed to fill the float bowl, turn the switch to on, close the throttle, yell "Clear prop" to warn of the engine starting, visually check for clear condition and wait to hear the answer "clear" from your assistant if you have one, then pull the starter. After the engine starts, open the throttle a bit. Run the engine at 3000 RPM's until Cylinder Head Temperatures (CHT) stabilize. While waiting for the CHT to stabilize turn off each ignition control separately to confirm that both sides of the ignition are functioning properly. Slowly advance the throttle to verify max RPM capability. Then slowly decrease RPM and shut it off. The pilot will then be strapped into the pilot's seat and the instructor will give a preflight briefing on the flight. You will perform radio-microphone-headset checks with the instructor to ensure the communications system is properly working. Hand signals and what maneuvers to perform (turns, fly bys, etc.), will also be discussed in the event of radio failure.

C. FLIGHT

The first maneuver to be practiced is familiarizing the pilot with the controls while he is still on the ground. This time is well spent simply sitting in the craft and becoming comfortable with the locations and positions of the ground control stick, throttle, ignition switch and rudder pedals. When the pilot is sufficiently comfortable with the flight controls, he is ready to prepare for flight. The procedures for preparing the craft for flight are as follows.

Lay the parachute out on the ground centered behind the craft. Preflight the chute, checking the parachute suspension lines, steering control lines, and risers as instructed in the preflight check list. This exercise should be performed on a calm, no-wind day. The

engine should be warmed as noted before; the pilot should get in, buckle up, radio check, "clear prop" and start the craft. Your instructor should be at the end of the field and you will be traveling toward him. The craft should be pointed into the wind, if there is any. When ready, the pilot will add throttle until the craft starts moving. This is not full power, just taxiing speed. As you start moving, the chute will be pulled along and start to move up. As it gets directly behind you, it will act as an air brake and slow you down. You will have to add more power to keep moving. As it rises up overhead, look directly up and to the sides, watching to see if it is straight or if it is leaning one way or another due to a misalignment with the wind. Use your left hand on the control stick to ground steer the craft into the direction the chute is aiming. Remember, if it is lagging off behind to the left, then the wind is coming from the right and the pilot must push the control stick right to steer to the right. You may find that the end cells are closed. If so, you will push the rudder pedal tubes out together to open the cells. By radio the instructor will tell you to turn a little left or right to keep the chute into the wind. When the cells are open, and the chute is tracking straight above you, you are ready for takeoff. You will go to full throttle, provided you have not run out of runaway by passing the abort point which the instructor has marked on the runway. <u>If at any time you do not feel everything is right for takeoff, you should abort takeoff by throttling down and turning the ignition switch to off. Never say or think the words "I think I can make it".</u>

From takeoff, you will be instructed to climb to an altitude of 150 to 250 feet. You will not be asked to watch an altimeter for this altitude on your first flight - the flight instructor will determine the altitude. To level off, you move the throttle to decrease power until you maintain altitude. Chances are you will have to make a turn before you have attained cruising altitude. You will do this by pushing the rudder pedal on the side that you wish to turn toward. You will notice at this point, the amount of pressure required to turn the craft. On your first circuit of the field, you spend your time getting used to the pendulum stability of the craft. Notice that you feel a constant gentle motion that you need do nothing about. You may wish to add or decrease throttle a little to see how it responds. On the next circuit of the field, make a complete 360 right turn. The rest of the flight usually will be performing flybys on the field to gain proficiency in controlling altitude by throttle setting. You may be directed to maintain a 50 foot pass, and then 30 foot, then a 15 foot pass over the landing area. If at any time you should touch down, don't feel you have to turn it off and land, just give it full power and take off again. Inadvertent touch-and-go are sometimes difficult to avoid on low level flybys.

Only after you and the flight instructor feel confident of your ability, will you be asked to come in for a landing. As the wheels touch down, throttle down and turn the ignition off immediately. Simultaneously, push the rudder pedal tubes out all the way to collapse the canopy behind you and you should reach out and pull the steering lines to aid in the quick collapse of the chute. Otherwise you may be pulled backward by any ground wind. Then, wait in the craft until the flight instructor reaches you.

VII - SAFETY AND EMERGENCY PROCEDURES

A. Clothing/Equipment requirements:

Pilots must wear head protection such as a motorcycle helmet, and ear protection is strongly recommended if your helmet is not noise attenuating. Sunglasses, face shield, or goggles are necessary for any type of weather, particularly for contact lens wearers. Light gloves are recommended, and clothing appropriate to the weather conditions. Floppy clothes, especially long trailing scarves a la the Red Baron, should be avoided. The pilot must wear the provided seat belt.

B. Field requirements:
As noted previously. The training field should be a clear, smooth area of at least 1200'x 1200'. Experienced pilots can use a smaller area of course, but must use a field large enough to allow multi-directional takeoffs and landings. Beyond the size of the field, the pilot must get permission from the landowner before using his field. Naturally this may prove difficult in the event of an emergency landing. Remember, you are liable for any damage you cause (e.g. crop damage).

C. On the Ground Procedures:
Get into the habit of always turning the ignition switch off and checking it to ensure it hasn't been bumped to "on". Any movement to the prop or playful pulling of the pull starter when the ignition switch could be accidentally left on can result in an immediate firing of the engine, which will start the prop, and can take your hands right off. Disconnecting the plug wires further ensures against accidental starting.

D. Parachute Handling:
Develop a set procedure for packing and unpacking your parachute to avoid tangling problems. It is recommended that the chute be put away by first daisy chaining the suspension lines from the craft back to the chute. Pull a section of chute material through the end of each daisy chain and tie it off. Then, starting at one side of the chute, roll and bunch the material to the center. Do the same with the other side. Note how the suspension lines roll with the chute so as to avoid tangles. Stuff the chute into your bag. Then, lift the bag and set it on the engine carriers when the engine has cooled sufficiently.

E. Ground Movement:
Taxiing in the airframe without the chute deployed can result in an extremely hazardous situation. Given the low weight of the craft and the high power of the engine, it will quickly reach a dangerous speed on the ground without the use of the parachute.

F. Ignition Failure:
Upon landing the craft, you could conceivably be faced with an ignition switch that refused to turn the engine off. The safest action to take in this event would be simply to wait until the fuel runs out. You should reach back and close the fuel supply line.

G. ENGINE-OUT Landing:
As discussed previously, there are two steps to take in an engine-out landing if the engine fails within 300 to 400 feet of the ground: First, by looking under you to determine what you are about to land on, decide if you need to slightly turn the craft to land into the wind (for a steeper descent but a slower ground roll) or away from the wind (a longer glide path but faster ground-roll) to avoid obstructions and underneath you. Secondly, you want to begin to flare the craft at 6-8 feet above the ground by pushing out both rudder pedal tubes and pulling the control lines by hand.

If the engine should fail at an altitude of 500 feet or more, after you have ensured yourself of a safe glide path, turned into or away from the wind, you can attempt to restart the engine. First you could check your ignition switch to be sure it is in the "on" position. Then you can reach up and pull the starter. If the engine should still fail to start, be sure you have left yourself adequate time to begin to flare the craft at 10 feet above the ground, thereby softening your landing and reducing the possibility of damage to craft or pilot.

H. End Cell Closures:
End cell closures can be caused by flying in extremely turbulent air (caused by other aircraft, thermals or other rough air conditions) which may cause air to go out of the end cells. The corrective procedure is to use the rudder pedals to straighten out any turn and

wait a few moments while the end cells re-inflate themselves. End cell closure could become dangerous if you started turning hard and spiraling on the same side where the cells were closed. In this case the cells could conceivably continue to collapse further in toward the center of the chute.

I. Stalls:

The powered parachute is a stall resistant aircraft. A stall occurs when there is not enough forward speed to maintain lift. Since a powered parachute is a constant speed vehicle, it would be very difficult to slow your forward speed sufficiently to cause a stall. WARNING. Forward speed can be arrested by inducing drag on both sides of the chute simultaneously. Both rudder pedal tubes should NEVER be pushed and held while in flight or serious damage and injury could occur. Both rudder pedal tubes may be pushed simultaneously only at 6-8 feet above ground in a flaring maneuver or at high altitude in practice flaring. Flaring the chute should NEVER be performed between 500 and 8 feet above ground.

J. Hazardous Landings:

1. Trees: While it is best to avoid trees, try to aim between two trees rather than at the top of one. Tuck your head down and use your hands to shield your face and your arms to shield your body. Perform a normal emergency flare. DO NOT TRY TO GRAB BRANCHES. As your chute will probably snag in the trees, you might be left hanging. Leave your helmet on until you are safely down. Use extreme caution in deciding how to exit the aircraft. It might be advisable to wait for help to arrive.

2. Power lines: Avoid power lines. If you see poles or towers, remember that the nearly invisible power lines run between them. Land in trees if necessary to avoid power lines. If you land in power lines, don't move, don't touch the power lines, and do not let anyone else touch the craft until help has arrived to cut power at the source.

3. High Winds: Landing a powered parachute in high winds can be dangerous, so if the wind is rising, land immediately. If the wind has come up suddenly, land as usual. Upon touchdown immediately push both rudder pedal tubes all the way out and reach out on both sides and pull in more steering control line and pull it in to collapse the canopy. The more line you pull and the quicker you pull it, the more quickly the canopy will collapse.

4. Broken Steering Line: In the unlikely event a steering line should break, the powered parachute would not be able to turn in the direction of the side the break occurred. You may practice for this occurrence by performing flybys over a safe landing area with use of only one steering direction or the other.

5. Water: DO NOT FLY OVER WATER (unless you have sufficient flotation for yourself and the aircraft). If you land on water without flotation, you increase the risk of entangling yourself in the parachute lines, and you may become trapped. We can only conjecture what will happen and what you should do in an emergency water landing because we have <u>not</u> put it to the test.

As the craft hits the water, the airframe will lose forward speed very rapidly. Depending on wind, the parachute may continue forward and drop down over you. Next, the airframe will sink, pulling the chute down with it.

There are a couple different ways we can suggest you act. We do not have (and hope we never <u>do</u> have) the experience to show which is best, or if either technique has any real practical value.

One, when a water landing is imminent, perform an aggressive emergency flare, pulling in as much steering line by hand as possible, to encourage the chute to come down behind you instead of on top or in front of you. Take a moderate breath and hold it, just before touchdown. Hold the flare as the airframe enters the water. When the airframe stops moving forward and begins to sink, release your seatbelt and push yourself out of the seat, being particularly careful to avoid entanglement with the steering lines. Swim away clear of the parachute and lines.

Another way to react when you know you are going in the water is to have your hand ready on the seatbelt instead of having your hands pulling in extra line for flaring. The instant your wheels touch water, release the seatbelt and dive over the front, to one side of the nose-wheel. Exiting the craft quickly may be very important, no matter what technique you choose, advance practice on the ground may be useful.

K. Emergency Recovery System (ERS):

Even with proper maintenance procedures and stringent preflight inspections, the remote possibility exists of a major structural failure. In the event of a structural failure or even a midair collision it is recommended that the pilot deploy a ballistic parachute in accordance with its manufacturer's instructions.

L. LAST BUT NOT LEAST:

The most important factor in any emergency is the pilot. His attitude and behavior has a tremendous bearing on his success and safety as a powered parachute pilot.

1. Be cautious: Although the craft can be flown with only a minimum of flight instruction, it is still an air vehicle and is capable of mishap. Learn the procedures described, think about what you are doing and act cautiously.

2. Preflight carefully: Preflight the craft each and every time you fly it, using a check list.

3. Taxiing: Prior to full-power takeoff, check steering lines and risers while you are checking the parachute for direction, full inflation and any irregularity.

4. Don't panic: In spite of all your precautions, if you are faced with an emergency situation, keep your wits and don't panic. If you've practiced emergency situations, you should be prepared to meet them confidently.

VIII - CARE AND MAINTENANCE

Care and maintenance of the engine should be performed in accordance with the Operator's Manual provided by the engine manufacturer.

Care and maintenance of the parachute should be performed in accordance with the instructions provided by the parachute manufacturer.

The airframe should be kept covered during storage to protect it from weathering. It is recommended that gauges be kept covered with a plastic bag especially during transport to protect them from moisture, but not as to allow condensation buildup. Modular quick-disconnect plugs can be purchased to allow easy removal of the entire instrument deck assembly for further protection.

A log must be kept to record both pilot and engine-airframe hours.

FEDERAL AVIATION RULES AND INFORMATION YOU SHOULD KNOW ABOUT

Title 14: Aeronautics and Space PART 103—ULTRALIGHT VEHICLES

Title 14: PART 91—GENERAL OPERATING AND FLIGHT RULES

Title 14: PART 71—DESIGNATION OF AIRSPACE

Title 14: PART 61—CERTIFICATION: PILOTS, FLIGHT INSTRUCTORS, AND GROUND INSTRUCTORS

Sport Pilot Rule and Sport Pilot Rule

Federal Aviation Administration (FAA)