Eagle 145,164,180

Owner / Service Manual

March 2002 - Second Edition

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Introduction

Thank you for purchasing a Wills Wing glider, and welcome to the world wide family of Wills Wing pilots. We are a company of pilots and aviation enthusiasts, and our goal is to serve your flying needs now and in the future, as we have done for pilots throughout the world since 1973.

We encourage you to read this manual thoroughly for information on the proper use and maintenance of your Wills Wing glider. If at any time you have questions about your glider, or about any aspect of hang gliding that your Wills Wing dealer cannot answer, please feel free to give us a call.

If you have access to the Internet, please visit us at http://www.willswing.com. The site features extensive information about Wills Wing gliders and products, a Wills Wing Dealer directory, a comprehensive list of service and technical bulletins, current editions of owners manuals, our complete retail price list, a search engine, and more.

We wish you a safe and enjoyable flying career, and, once again, welcome aboard!

Rob Kells, Mike Meier, Linda Meier, and Steve Pearson

Wills Wing, Inc.

Disclaimer And Warning

Hang gliding is a form of aviation. Like any form of aviation, its safe practice demands the consistent exercise of pilot skill, knowledge of airmanship and weather, judgment and attention at a level which is appropriate to the demands of each individual situation. Pilots who do not possess or exercise the required knowledge, skills and judgment are frequently injured and killed. The statistical rate at which fatalities occur in hang gliding is approximately one per thousand participants per year.

The Federal Aviation Administration does not require a pilot's license to operate a hang glider. Hang gliders and hang gliding equipment are not designed, manufactured, tested or certified to any state or federal government airworthiness standards or requirements. Wills Wing hang gliding products are not covered by product liability insurance. You should never attempt to fly a hang glider without having received competent instruction. We recommend that you not participate in hang gliding unless you recognize and wish to personally assume the associated risks.

Please fly safely.

Wills Wing, Inc.

Technical Information And Placarded Operating Limitations

The Eagle has been tested and found to comply with the HGMA Airworthiness Standards in effect as of the testing. These standards require:

1. A positive load test at root stall angle of attack at a speed equal to at least the greatest of:
   a. 141% of the placarded maximum maneuvering speed
   b. 141% of the placarded maximum rough air speed
   c. 123% of the placarded speed never to exceed

   for at least three seconds without failure.
2. A negative 30 degree angle of attack load test at a speed equal to at least the greatest of:
   a. 100% of the placarded maximum maneuvering speed
   b. 100% of the placarded maximum rough air speed
   c. 87% of the placarded speed never to exceed

   for at least 3 seconds without failure.
3. A negative 150 degree angle of attack load test at a speed equal to at least the greater of 30 m.p.h. or 50% of the required positive load test speed for at least 3 seconds without failure.
4. Pitch tests at speeds of Vs, Vne, and (Vs + Vne)/2 which show the glider to be stable from trim angle to 20 degrees below zero lift angle at Vs, and from trim angle to 10 degrees below zero lift angle at (Vs+Vne)/2, and from 10 degrees above zero lift angle to zero lift angle at Vne.
5. Flight maneuvers which show the glider to be adequately stable and controllable throughout the normal range of operation.

The Eagle has been designed for foot launched soaring flight. It has not been designed to be motorized, tethered, or towed. It can be towed successfully using proper towing procedures. Pilots wishing to tow should be USHGA skill rated for towing, and should avail themselves of all available information on the most current proper and safe towing procedures. Suggested sources for towing information include the United States Hang Gliding Association and the manufacturer of the towing winch / or equipment being used. Wills Wing makes no warranty of the suitability of the glider for towing.

Flight operation of the Eagle should be limited to non aerobatic maneuvers; those in which the pitch angle will not exceed 30 degrees nose up or nose down from the horizon, and the bank angle will not exceed 60 degrees. The Eagle is generally resistant to spinning, but will spin from a stalled turn if the pilot applies positive pitch control aggressively in combination with roll control input so as to roll towards the high wing. Recovery from a spin requires unstalling of the wing, and it is therefore important that in the event of a spin, no application of nose up pitch control be held. The Eagle will recover from a spin once control pressures are relaxed. As the nose lowers and the angle of attack is reduced, the stall will be broken and the spin will stop. However, such recovery will consume significant altitude, and will result in the glider assuming an unpredictable heading. Recovery from a spin may therefore involve a flight trajectory which intersects the terrain at a high rate of speed. An aggravated spin could result in loss of control, in flight inversion, and structural failure. Therefore no attempt should ever be made to deliberately spin the glider.

The maximum steady state speed for a prone pilot in the middle of the recommended weight range full forward on the control bar is approximately 42 m.p.h. for the Eagle. The placarded speed never to exceed for the Eagle is 53 m.p.h. (164) or 48 mph (145 & 180), and the maneuvering / rough air speed is 46 m.p.h. (164) and 42 mph (145 and 180). The Eagle can be flown in steady state high speed flight with the pilot full forward over the bar without exceeding the VNE speed. Abrupt maneuvers may cause the glider to exceed VNE, and abrupt maneuvers should not be made from speeds above 46 m.p.h. (Eagle 164) or 42 mph (Eagle 145, 180).

The stability, controllability, and structural strength of a properly maintained Eagle have been determined to be adequate for safe operation when the glider is operated within all of the manufacturer specified limitations. No warranty of adequate stability, controllability, or structural strength is made or implied for operation outside of these limitations.

The stall speed of the Eagle at maximum recommended wing loading is 25 m.p.h. or less. The top (steady state) speed at minimum recommended wing loading for a prone pilot with a properly designed and adjusted harness is at least 35 m.p.h..

All speeds given above are indicated airspeeds, for a properly calibrated airspeed indicator mounted in the vicinity of the pilot. Such an airspeed indicator is available through your Wills Wing dealer.

The recommended hook in pilot weight range for the Eagle is 130 - 200 lbs (145); 150 - 250 lbs (164); or 175 - 275 lbs (180).

Be advised that pilots with hook in weights within 20 lbs of the minimum recommended will find the Eagle somewhat more demanding of pilot skill to fly, and that pilots with hook in weights of more than 130% of the minimum recommended will experience some relative degradation of optimum sink rate performance due to their higher wing loading.

Direct supervision by a qualified instructor, or a minimum USHGA Novice (II) level of pilot proficiency in combination with an instructor supervised transition to the Eagle is required to fly the Eagle safely.

Operation of the glider by unqualified or under qualified pilots may be dangerous.

Operating the Eagle outside of the above limitations may result in injury and death. Flying the Eagle in the presence of strong or gusty winds, or turbulence may result in loss of control of the glider which may lead to injury and death. Do not fly in such conditions unless you realize and wish to personally assume the associated risks. Wills Wing is well aware that pilots have, and continue to perform maneuvers and fly in conditions which are outside the recommended operating limitations stated herein. Please be aware that the fact that some pilots have exceeded these limitations in the past without dangerous incident does not imply or insure that the limitations may be exceeded without risk. We do know that gliders which meet all current industry standards for airworthiness can and do suffer in flight structural failures, both as a result of turbulence, and as a result of various maneuvers outside the placarded operating limitations, including, but not necessarily limited to aerobatics. We do not know, and cannot know, the full range of maneuvers or conditions which may cause the pilot's safety to be compromised, nor can we test the glider in all possible circumstances.

Eagle Breakdown Procedure For Shipping And Reassembly Procedure

The Eagle can be broken down to approximately 2/3 of it's normal length by removal of the rear leading edges. The rear leading edge is slotted at its forward end, such that the slots engage around the clevis pin which is mounted in the forward section.

To break down the leading edges follow these steps

1. Lay the glider on the ground or floor, unzip and remove the bag and remove the Velcro ties. Undo the velcros which hold the sail around the sail mount plug and pull the sail rearward at each tip to dismount the sail from the rear leading edge. You may use a large, flat bladed screw driver to pry the sail mount webbing away from the slotted endcap. Take care that the screwdriver does not have a sharp edge which might cut or damage the webbing.
2. Obtain an indelible marker. Mark the rear leading edges left and right (remember that left and right are reversed if the glider is lying “on it’s back”, upside down. Push the sail up to where you have uncovered the point where the rear leading edge exits the front. Trace around the circumference of the 50 mm rear leading edge just aft of the 52 mm oversleeve so as to mark the point at which the rear leading edge is fully engaged in the front.
3. Scribe a line along the leading edge which crosses the front to rear leading edge junction. This will help to align the rear leading edge during reassembly.
4. Spray silicone spray lubricant on the rear leading edge at the point where it exits from the front.
5. Pull the rear leading edge straight aft to disengage it from the front. Put tape or otherwise protect the sharp edges of both the front and rear leading edge tubes from damaging the sail during transport..
6. Replace the sail mount ties, zip up the bag, and carefully fold the rear of the glider over against the front.

Remounting the rear leading edges

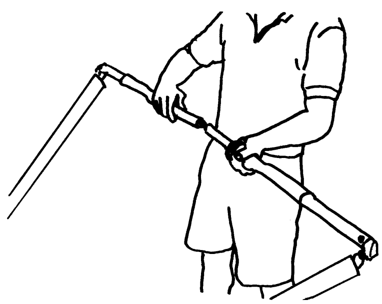
1. Make sure you are mounting the correct leading edge rear into the correct front (check the “right” / “left” designation).
2. Spray the forward six inches of the rear leading edge with silicone spray lubricant.
3. Slide the rear leading edge into the front, lining up the rotational alignment marks you made during breakdown, until the rear engages fully in the front leading edge, as indicated by the circumferential scribe made at the exit point of the rear leading edge during breakdown.
4. Pull the sail down the leading edge.
5. Remount the sail to the rear leading edge, making sure to align the inner sail mount webbing squarely in the slot and attach the securing velcros.

You may find it helpful to use a large, flat bladed screw driver to pry the sail mount webbing over the end of the leading edge tube and into the slot. Take care not to damage the webbing.

Eagle Set-Up Procedure

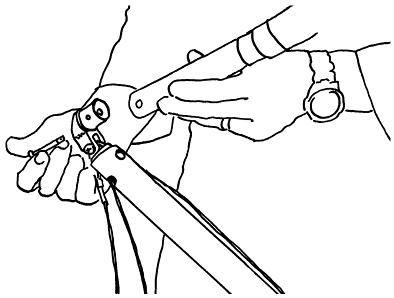
The Eagle has been specially designed to set up quickly and easily either on the control bar or flat on the ground. We will first cover the steps for setting up on the control bar.

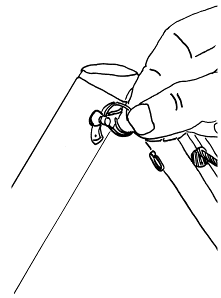
1. With the glider in the bag, lay the glider on the ground, zipper up, with the nose into the wind. If there is more than five m.p.h. of wind, or if the wind is gusty, turn the glider 90 degrees to the wind direction.
2. Undo the zipper, remove the battens, and remove the control bar bag.
3. Separate the control bar legs.
   a. If the glider is equipped with a folding basetube:
      i. Straighten the fold in the folding basetube.
      ii. Preflight the folding basetube center hardware at this time, checking that the nuts and coil spring pins are secure, and that the tangs are straight and in good condition.
      iii. Slide the basetube center sleeve over the center joint until it is positioned between the button spring pins. (Note: If you plan to clamp instruments to the basetube center, position the center sleeve so that one button passes through the hole near one end of the sleeve to prevent it from rotating.)



   b. If the glider is equipped with a non folding basetube:
      i. Remove the safety ring, wing nut and bolt from the corner bracket.
      ii. Insert the corner bracket all the way into the basetube.
      iii. Install the bolt, wingnut or speednut and safety, securing the bracket to the basetube.

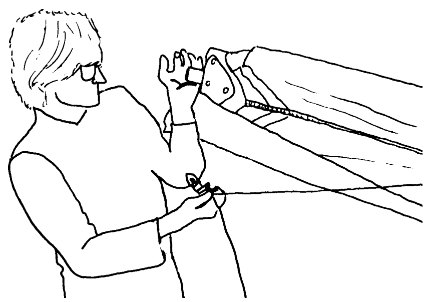
Make sure that the aluminum fitting is fully inserted into the basetube, and that the bolt is through both the basetube and the fitting. If the hole in the fitting can be seen outside the end of the basetube, the fitting is not fully installed, and will likely disengage in flight resulting in a dangerous structural collapse and loss of control of the glider.



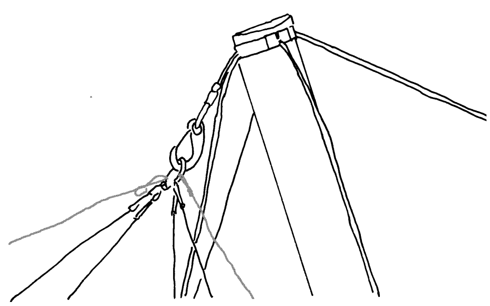


Do not insert the fitting at an angle, and do not force the fitting into the basetube if it does not slide in freely. Check for dirt or damage to the fitting or the inside of the basetube. If the fitting is forced into the basetube, it may be impossible to remove. See your dealer if the fitting becomes difficult to install or remove.

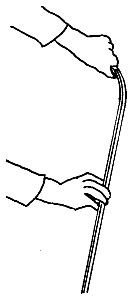
4. Flip the glider upright and set it on the control bar, and remove the glider bag and all Velcro sail ties.

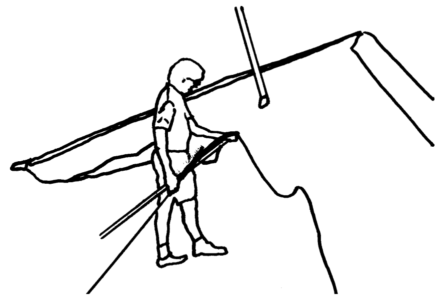


5. Spread the wings almost all the way. Rotate the kingpost into the upright position.
6. Attach the bridle ring to the snap hook at this time, taking care that there is not a twist or rotation in the bridle ring which causes the bridle lines to cross over one another.



7. Lay out the battens and check each batten for symmetry against the corresponding batten from the other wing.Wills Wing convention is that *black tipped battens go in the right wing and white tipped battens in the left*, except that both the straight #1 plug-on battens have black tips.





8. Install the 4 longest cambered top surface battens in the sail. Each batten is secured by a double loop of the batten string (double purchase). Order of insertion is longest to shortest, from the root out. Spread the wings all the way and check all cables for any twisted thimbles or tangled cables.

Take care while inserting the inboard battens that the rear edge of the mylar insert does not catch on the batten tip and become folded under. If this does happen, pull the batten out part way until the front of the batten is well behind the mylar pocket. Smooth the mylar insert down, and re-insert the batten. If the mylar insert is folded under it will cause a bump in the surface of the leading edge portion of the sail. This can cause a dangerous degree of premature airflow separation or "stall" in flight, and can make the glider difficult to control. Please read the section "Dealing With Abnormal Flight Configurations" in the flying section of this manual.

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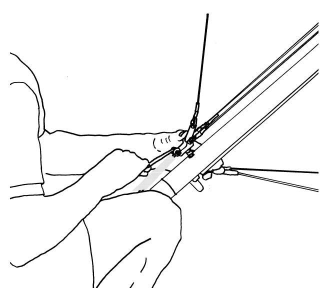
9. At the rear of the keel, tension the crossbar by pulling on the perlon rope loop which is attached to the sweep wire keyhole channel. Drop the keyhole channel all the way down over the top portion of the keyhole collar, and let it slide forward into the locked position.



Never install the keyhole channel or keyhole tangs onto the keyhole bolt without making absolutely sure that they are fully engaged on the narrow neck of the bolt and slid forward into the fully locked position. An in-flight disengagement of this attachment will cause a complete loss of structural support of the glider and a total loss of control.

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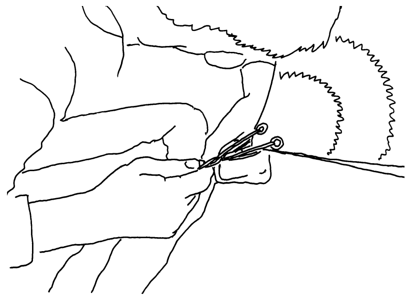
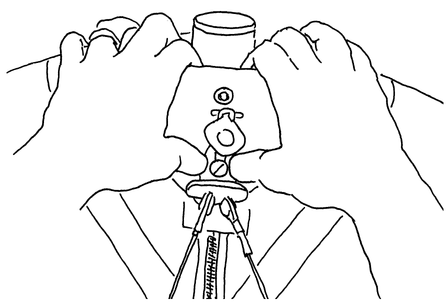
10. Remove the tip cover bags, and install the remaining cambered battens.

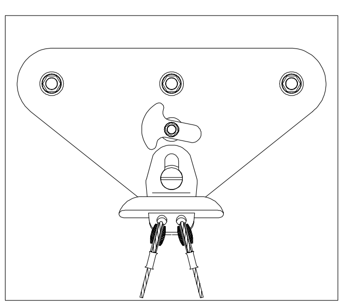
11. Install the straight plug-on #1 battens. Insert one end of the batten through the hole in the bottom surface at the tip. This end plugs onto the stud on top of the leading edge, and the batten string is secured double purchase to the other end.

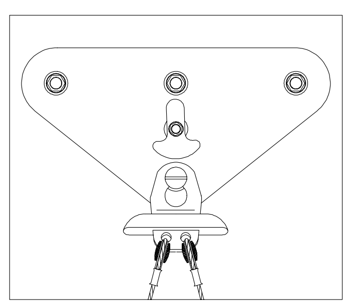


12. At this time preflight the following from the open end of the wingtip:
    a. The sail mount webbing - make sure that the inner loop of webbing is laying flat in the bottom of the slot in the sail mount endcap.
    b. The number one batten clevis pin and safety.
13. Go to the nose and attach the keyhole tang securing the bottom front wires, by pulling down on the nose of the glider while pressing the tang upwards over the shouldered bolt. (Remember it is the pulling down of the glider's nose rather than the upward pressure on the tang that allows you to install the tang over the bolt. If you have difficulty installing the tang, and no wires are twisted or thimbles cocked, it is probably because the glider is not sitting on level ground.)

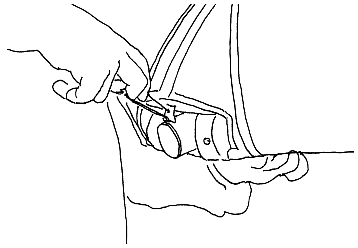


14. Secure the aluminum safety lock by rotating the lock into position such that the tang is prevented from sliding forward and disengaging from the bolt.





15. Push the nose batten fully back into the sail so that the tip rests on top of the keel. Look into the noseplate and preflight the nosebolt nuts and the safety on the bolt securing the top front wire.

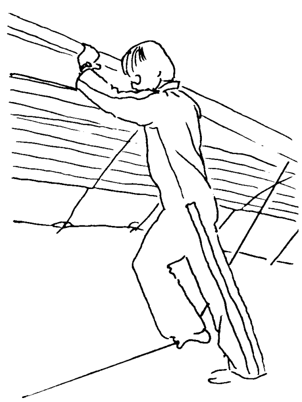


16. If you plan to fly with the keel mounted stabilizer, attach it at this time. First fit the leading edge tube of the stabilizer frame (piece of 10mm tubing with two 45 degree bends) to the trailing edge tube, by plugging the end of the leading edge tube that does not have the outer stop sleeve onto the elbow coupling attached to the trailing edge tube. Next, insert the lower ends of the leading and trailing edge frame tubes into the bushed holes in the rear of the keel. Place the stabilizer cover over the frame, and pull the two velcro flaps around the underside of the keel tube and fasten the velcro, so that the stabilizer cover fabric is taut.

17. Conduct a complete preflight of the glider, checking all assemblies which have not already been checked:

Along the left leading edge

While pushing up on the leading edge between the nose and the crossbar junction, step on the bottom side wire with about 75 lbs. of force. This is a rough field test of the structural security of the side wire loop, the control bar, the kingpost, and the crossbar, and will likely reveal a major structural defect that could cause an in-flight failure in normal operation.

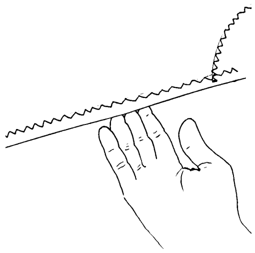


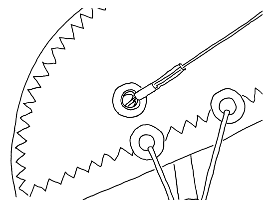
Open the zipper at the leading edge crossbar junction and check the nut and safety which secures the bottom side wire to the crossbar plate. Check that neither the bottom side wire nor the top side wire have twisted or cocked thimbles. Check the nut and safety which secures the crossbar plate to the leading edge. Close the zipper.

Along the trailing edge, left wing

Check that there are no tears in the sail material along the trailing edge.

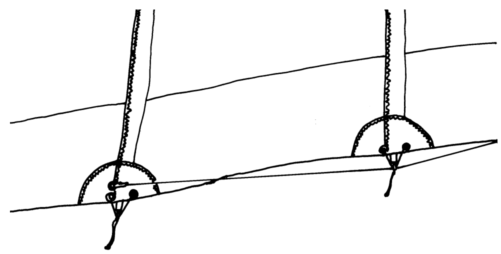
Check that all batten strings are properly secured.





Check that the bridles are properly engaged, with the plastic retainer balls fully seated against the grommet, and that no bridle cable is hooked underneath a more inboard batten.

Wrong!



From the rear keel

Check the hang loop bolt and nut that secures the hang loop to the kingpost.

Check the 1/4" rivet which secures the kingpost to the bracket..

Check the condition of the sweep wires in the vicinity of the kingpost base bracket.

Check the kingpost top for proper attachment of the bridles and condition of the top rear wire and bridle pigtail wire.

Check again that the keyhole channel is fully engaged and locked to the keyhole bolt.

Along the trailing edge, right wing

Same as for left wing.

At the right tip

Same as for left tip.

Along the right leading edge

Same as for left leading edge.

Under the glider, at the control bar

Sight down the downtubes, making sure that they are straight.

Check the cables at the control bar corners, making sure there are no kinks or twisted thimbles. Check for proper installation of all nuts and safety rings at the control bar corners.

Check the control bar apex bracket hardware, including the clevis pin safeties, the control bar top plug bolts and nuts, and the elbow to apex bracket clevis and safety.

Check the main and backup hang loops, that they are properly installed in the proper position and that they are in good condition.

Check the clevis pin and safety that secure the kingpost base in the CG adjustment track.

Un-zip the bottom surface center zipper and check the xbar center hardware. Make sure the sweep wires thimbles are not cocked or twisted on the crossbar center hinge brackets. Make sure the center hinge bolt is secure. Zip up the center zipper.

At the nose

Check the security of all nuts at the noseplate, and that the safety ring is in place above the nut which holds the top front wire. Check that the keyhole tang safety is properly secured.

Laying The Glider Down Flat

Once the glider is assembled it can easily be laid down flat on the ground.

1. Pivot the keyhole anchor safety and release the bottom front wires from the noseplate.
2. Rock the glider forward so that the basetube folds rearward and underneath the glider as you gently lower the glider to the ground.

Reverse the procedure to set the glider upright again.

Setting The Glider Up Flat On The Ground

In areas where the ground is not rocky and when there are strong winds, you may wish to set up the glider flat on the ground. This is easy to do, and relatively few parts of the set up procedure are different from what has been described.

1. After unfolding and securing the control bar, flip the glider over right side up with the control bar still flat under the glider.
2. Spread the wings and install all the battens. (Note: Perform all the normal preflight operations as described above).
3. Tension the crossbar.
4. When ready, raise the nose of the glider while pulling on the bottom front wires to raise the glider up onto the control bar. Secure the bottom front wires as described above.

Launching And Flying The Eagle

1. If the wind is more than 10 m.p.h. or gusty you should have an assistant on your nose wires on launch, and, if necessary, an assistant on one or both side wires. Make sure all signals are clearly understood. Do a hang check immediately prior to launch. The angle at which you hold the glider should depend on the wind speed and slope of the terrain at launch; you want to achieve a slight positive angle of attack at the start of your run.
2. Run aggressively on launch and ease the bar out for lift off.
3. The flying characteristics of the Eagle are typical of a medium performance flex wing. Make your first flights from a familiar site in mellow conditions to give you time to become accustomed to the glider.
4. We recommend that you hang as close as possible to the basetube in the glider - this will give you lighter control pressures and better control.

Using Wing Tufts

Your Wills Wing glider has been equipped from the factory with short yarn tufts on the top surface of each wing. The shadow of these tufts will be visible through the sail. The tufts are useful for indicating the local reversal of the airflow which is associated with the onset of the stall in that portion of the wing. You can use these tufts, as described below, to help determine when you are flying at minimum sink airspeed.

There are two important airspeeds with which all hang glider pilots should be intimately familiar; minimum sink airspeed (hereinafter referred to as VMS) and minimum controllable airspeed (MCA). The most important of these two is MCA. Minimum sink airspeed is that speed at which your descent rate is the slowest possible. It is the speed to fly when you want to maximize your climb rate in lift, or slow your rate of descent to a minimum in non lifting air. (You would normally not fly at VMS in sinking air; the strategy there is normally to speed up and fly quickly out of the sink. By minimizing your time spent in the sinking air you minimize altitude lost, even though you have momentarily increased your sink rate by speeding up.)

Minimum controllable airspeed is that speed below which you begin to rapidly lose effective lateral control of the glider. Recognition of this speed and its implications is a more subtle problem than many pilots realize. We have seen several instances of pilots who were having a lot of trouble flying their gliders simply because they were unknowingly trying to fly them too slowly; below the speed at which the glider responded effectively to lateral control inputs. It is our opinion that a great percentage of hang gliding accidents are caused by inadvertent flight below MCA, and subsequent loss of control of the glider with impact preceding recovery. Such incidents are usually attributed to “stalls,” but it is not the stall per se that causes the problem, indeed the glider need not even be “stalled” in the traditional sense.

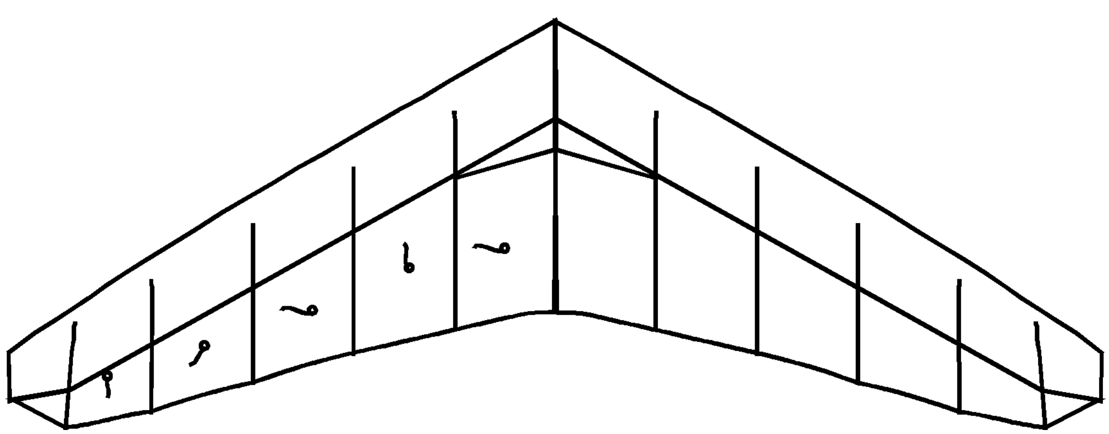
There is no necessary cause and effect relationship between minimum sink speed and minimum controllable airspeed. VMS is determined primarily by the wing loading and span loading, the wing planform, the wing section characteristics, etc. MCA is influenced most heavily by the tension in the sail; how much “billow” the glider has. However, in your Wills Wing glider, as in most hang gliders, MCA and VMS evolved towards a common value during the design and development of the glider. This is so because if the wing is tuned so tight that minimum controllable airspeed is at a higher speed than minimum sink speed, then effective sink rate performance can be improved by loosening the wing so as to lower the minimum controllable airspeed. Conversely, if minimum controllable airspeed is reached at a speed below that of minimum sink, the wing can usually be tightened so as to improve glide performance without significant sacrifice in other areas.

Using wing tufts to find the minimum sink speed of your glider

On a flex wing hang glider, the wing experiences a gradual and progressive stall, and different spanwise stations of the wing stall at different angles of attack. A hang glider wing does not necessarily stall first in the root or center section. It is true that because of wing twist the root section is at the highest angle of attack relative to the remote free stream airflow, but other factors influence the stall propagation on the wing. Most flex wing hang gliders stall first somewhere outboard of the root on each wing, approximately one fifth to one third of the way out from the root to the tip, about where your tufts are located. As the angle of attack is raised further, the stall propagates both outward towards the tips and inward towards the root. If you wish to observe the stall propagation across the whole wing on your glider, you can cut some more tufts from knitting yarn, about 3-4" long, and tape these to the top surface of your sail across the rest of the span.

During normal flight the flow will be chordwise along the wing, and the tufts will point towards the trailing edge. When the wing stalls, the tufts will reverse direction, indicating the local flow towards the leading edge.

At the first onset of stall, the tufts will indicate the impending separation by first wiggling, and then deflecting spanwise, before they fully reverse and point forward. The first onset of stall occurs well before the familiar “stall break” in which the glider pitches uncontrollably nose down to recover from the stall. By the time the stall break occurs, all tufts but those farthest outboard and those farthest inboard will have indicated reversed flow.



The first onset of midspan stall as indicated by the first tickling of the tufts indicates that you have reached the angle of attack corresponding to the glider’s minimum sink airspeed. This will also be very close to the glider’s minimum controllable airspeed. To find the glider’s minimum sink speed, fly the glider in smooth air, early in the morning or late in the afternoon. When you are well away from the terrain, and well clear of other aircraft, look up at the wing tufts while you very gradually reduce the speed of the glider. Note the speed at which the first tuft first begins to wiggle just prior to blowing spanwise toward the tip. (If the tufts contain static electricity, they may not show this lateral wiggle prior to reversal. However, you may get other clues to the beginning of separation, such as slight flutter or rumble in the top surface of the sail.) This is your speed for minimum sink rate. Familiarize yourself with the position of the control bar relative to your body at this speed, with the sound and feel of the wind, with the reading on your airspeed indicator, and with the feel of the glider in terms of pitch and roll pressures. Most of the time when you are flying it will not be practical to look up for extended periods of time at your tufts. That is why familiarization with these other, more accessible indicators is important.

After finding your minimum sink speed, experiment with roll control response at speeds just above and just below this speed to find the value of MCA and the corresponding bar position and other indicators for this speed. Realize that your effective MCA is going to be higher and higher as the air becomes more and more turbulent; control response that is perfectly adequate in smooth air will not be good enough in rougher air. Try flying the glider with the midspan tufts fully reversed; you will probably find that the glider is somewhat controllable, but only with a lot of physical effort. Note that both MCA and VMS come well before the glider actually "stalls" in the traditional sense, i.e. pitches uncontrollably nose down. You may also be able to sense, or your vario may tell you that although the glider has not "stalled" (pitched nose down) your sink rate has increased significantly. In this mode the glider is "mushing."

Once you have familiarized yourself with the glider's characteristics in this range of speeds, you will not need to look at the tufts very often. You will know from bar position and bar pressure, and from the sound and feel of the relative wind when you are at your minimum sink / minimum controllable airspeed. In general, you should not fly your glider below this speed. Be aware, however, that when you are flying at minimum sink in thermal gusts and turbulence, you will experience gust induced separation of the airflow which will periodically cause the tufts on your sail to reverse.

Of course in a turn, your minimum sink *speed* goes up because you are banked, and the bank effectively increases your wing loading which increases your flying *speed* for any angle of attack. But note this: *The tufts indicate angle of attack, without regard to airspeed!* Therefore, if you practice flying various bank angles in smooth air (while well away from any terrain or other gliders) and watch your tufts (on the inside wing, which will be at the highest angle of attack) you will get a feel for the way your minimum sink speed varies at varying bank angles.

One final caution: from time to time a tuft may to stick completely to the sail, and fail to properly indicate the direction of local flow. This may result from static buildup, or from the fine threads of the yard becoming caught on a seam or some dirt or imperfection in the sail. The tuft may stick while indicating normal flow, but most often it will stick after having reversed, such that the tuft will indicate a stalled condition that does not exist. One clue in this situation is to note whether or not the tuft is wiggling. Since flow reversal occurs during a turbulent separated flow, a reversed tuft should be wiggling rapidly. If it is not, it is probably stuck. A tuft indicating normal flow will not usually wiggle. An occasional application of silicone spray to the tufts, and making sure that they are positioned so that they cannot catch on any seam will minimize the problem of sticking.

Trimming Your Glider In Pitch

The fore and aft location along the keel of your hang point is commonly (if mistakenly) referred to as your "CG location." The location of this hang point will, all other things being equal, determine at what angle of attack and airspeed your glider will naturally tend to fly (or trim), and therefore how much bar pressure there is to pull in from trim to a given faster speed, or how much pressure there is to push out from trim to a given slower speed. The farther forward your hang point is, the faster the glider will trim, the less effort will be required to fly fast, and the more effort will be required to fly slow. It is usually best to trim the glider somewhere between minimum sink airspeed and perhaps 3 - 5 m.p.h. above that. Hang loop fore and aft position is adjusted by moving the kingpost base bracket forward or aft in the CG adjustment track. First, carefully note where the base bracket is presently mounted. Remove the safety and clevis pin which secures the base bracket in the track, re-position the base bracket as desired, and re-install the clevis and safety ring. You may find it very helpful to have someone else holding and maneuvering the kingpost from above, while standing behind the trailing edge of the glider while you manipulate the kingpost from below the sail.

We recommend that you not stow your glider bag, or any other cargo on the glider. The practice of attaching your glider bag to the keel, for example, can drastically alter the pitch trim and static balance of your glider, and adversely affect its flying and landing characteristics. The best place to carry your glider bag or other cargo is in your harness.

In the absence of the use of tufts, it has become common for pilots to talk about bar position, or about indicated airspeed, when trying to communicate how to trim a glider properly or how to fly a glider at the proper speed for a given situation. The problem is that these methods are unreliable and inconsistent from one pilot to another even on the same glider. The angle at which your harness suspends your body in your glider has a great deal to do with your perception of the bar "position" relative to your body. Airspeed indicators vary in their indicated airspeed depending on the make of the instrument, its calibration, any installation error, etc. The use of tufts gives you an absolute first hand indication of the actual aerodynamic event associated with two critically important airspeeds on your glider. It is a potentially useful tool that may improve your flying.

Speeds To Fly And Using Your Airspeed Indicator

The optional Wills Wing Hall Airspeed Indicator has been specially designed to help you fly your Eagle at the proper speeds for optimum safety and performance.

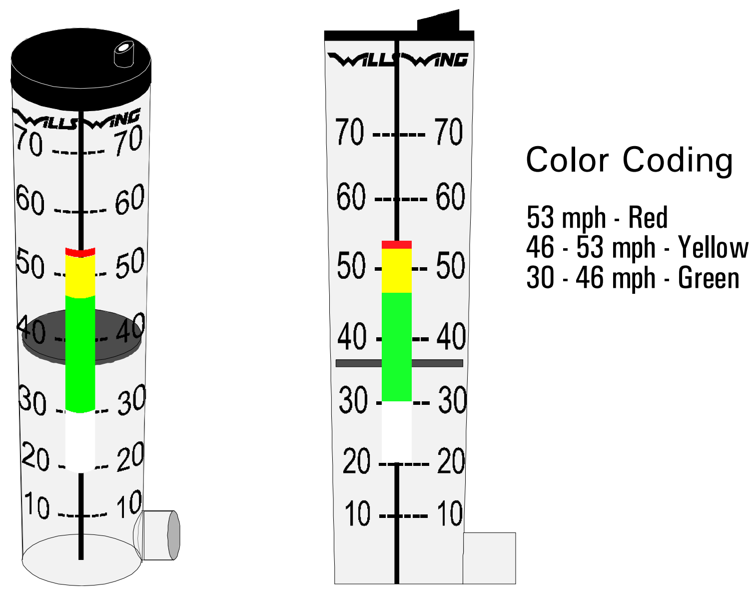
There are four color coded bands on the ASI:

White: This is the range from 20 m.p.h. to 30 m.p.h.. This is the normal flying speed range. While thermalling or climbing flying in lift, try to keep your speed within the lower half of this range. For gliding in light sink or light headwind, you will want to fly in the upper half of this range.

Green: The top of the green region represents the placarded maximum rough air and maximum maneuvering speeds. This speed of 46 m.p.h. should not be exceeded except in smooth air, and no abrupt large control deflections should be used above this speed. In heavy sink or strong headwinds it is recommended that you keep the airspeed “in the green” for best penetration and glide ratio over the ground.

Yellow: This region represents the upper speed range between maximum rough air / maximum maneuvering speed and the speed never to exceed. You should fly in this range only in smooth air as described above.

Red Line: This is your never to exceed speed. *At no time should you fly faster than this speed.*



The design of the Hall type airspeed indicator involves using a ram air versus static pressure differential to raise a disc in a tapered tube against the force of the weight of the disc. Because of this the ASI has certain operating limitations:

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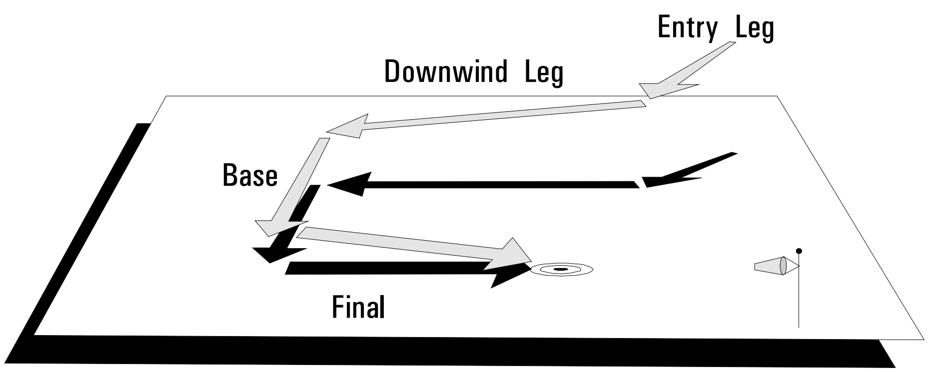
a. It is only accurate in one G flight. If you are turning at a bank angle of more than 30 degrees, the ASI will read artificially low as a result of the G loading of the turn. Reliance on the ASI for limiting airspeeds in high banked sustained spiral maneuvers will likely cause you to exceed the placarded speed limitations of the glider and will compromise your safety.

b. It is only accurate when within 15-20 degrees of the vertical orientation.

Landing The Eagle

We recommend using an aircraft landing approach (45 entry leg, downwind leg, base leg, and final leg) whenever possible, and we suggest that you practice making your approaches with as much precision as possible. Under ideal conditions, landing approaches are best done so as to include a long straight final into the wind at a speed above best L/D speed. In a very limited field, or a field which slopes slightly downhill, when landing in light wind, you may need to make your final approach at a slower speed, perhaps as slow as minimum sink, in order to be able to land within the field. In winds of less than 5 mph, if the slope is steeper than 12:1, you should seriously consider landing downwind, uphill; or crosswind, across the slope. Landing attempts which require slow speed approaches, maneuvering around obstacles or into a restricted area, or downwind or crosswind landings are not recommended for pilots below an advanced skill level.

Standard Aircraft Approach Pattern



The best way to avoid roll / yaw oscillations on approach is to fly your entire approach at a constant airspeed, and to control your touchdown point by making adjustments to the shape of your pattern. In particular, we recommend against the technique of make a diving turn onto final. This maneuver, sometimes called a "slipping turn" is often taught to student hang glider pilots as a way to lose altitude during the approach. While it will work reasonably well with low or medium performance low aspect ratio gliders which have high levels of yaw stability and damping, and which are able to lose energy by diving because of the large increase in drag at higher speeds, on a high performance glider this technique serves only to convert the energy of altitude to energy of speed, while at the same time suddenly increasing the glider's sensitivity to control inputs. The result is a high probability of overshooting the intended landing point and the prospect of roll / yaw oscillations which may interfere with a proper landing. If you develop good habits and the skills to fly precise approaches now, it will make your transition to higher performance gliders easier later on.

Once established on a straight final approach, with wings level and flying directly into the wind, you should fly the glider down to where the basetube is between three and six feet off the ground. At this altitude, let the control bar out just enough "round out" so that your descent is arrested and your flight path parallels the ground. The remainder of your approach will consist of bleeding off excess speed while paralleling the ground and keeping the wings level and the nose into the wind until it is time to "flare" for landing.

Prior to the landing flare your body position should be generally upright, but slightly inclined forward, with your head and shoulders forward of your hips and your legs and feet trailing slightly behind.

Your hands should be at shoulder width and shoulder height on the uprights. You should be relaxed, with a light grip on the bar, and your weight should be fully supported in your harness and not at all by your arms. There are several options for when to make the transition from prone to this upright position. Some pilots favor going upright with both hands moving to the downtubes while still at altitude prior to the start of the approach. Others transition at the start of the approach to a semi upright position with one hand on a downtube and one hand on the basetube, and complete the transition by moving the other hand to the downtube just a few seconds prior to flare. Still others fly with both hands on the basetube until established on final glide, and then transition one hand at a time to the downtubes prior to flare.

Whichever method you use, there are a few important principles to observe. The first is that you should not make any change in hand position unless you are flying at or very near trim speed. At speeds faster than trim, you will be holding the bar in in pitch against substantial force, and if you let go to move your hand the glider will pitch up and roll towards your remaining hand. The second is that while moving either hand, you have no control over the glider. You should move only one hand at a time. Even so, if you can't make the transition in the position of each hand quickly and reliably, you should transition both hands while at altitude, before you start your approach. Otherwise, if you fail to make a quick transition, you could be out of control close to the ground, and suffer a turbulence induced change in heading or attitude without sufficient time to recover. Many pilots make the mistake of trying to change position while flying fast and close to the ground, and experience a dangerous loss of control as a result. A third principle to observe is that if you are using a "pod" type harness, you should unzip and confirm that your legs are free to exit the harness at least 500 feet above the ground and before you start your approach. If there is any problem finding the zipper pull, or dealing with a stuck zipper, you don't want to have to try to fix that problem while also flying the approach.

Once established on a wings level short final, into the wind, body upright and with both hands on the downtubes, your final concern is the timing and execution of the landing flare. The goal is to arrive on the ground, on your feet, under control with the glider settling on your shoulders. If the wind is 15 mph or more, you will not really execute a flare at all; you will simply slow to minimum flying speed, put a foot down, and step onto the ground. In lighter winds, you will want to use some combination of a final nose up flare, and running out your landing, in order to finish the flight on your feet with the glider settling on your shoulders. The lighter the wind, the stronger should be both your flare and your run.

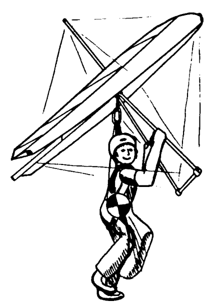
The traditional method of landing in light or no wind calls for a sharp, aggressive flare at precisely the correct moment. This technique works fine when done correctly, but it's not easy to get the timing just right. Flare too early and you will climb, and then fall with the nose pitching down. Flare too late and you won't get the nose up enough to stop your forward motion, and the glider may nose into the ground as you run into it from behind.

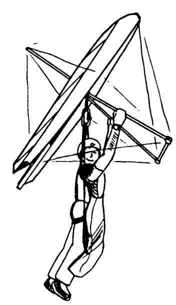
The flare timing process is made much easier by using a combination of a "crescendo flare" and a run out of the landing. As you bleed off speed on final, flying just above the ground, you are at first letting the control bar out towards its trim position. As the glider reaches trim speed, which will normally be one to three mph above stall speed, you begin to gently push the bar out to keep the glider from settling. At this point it is almost time to flare. As the glider enters the "mushing" range of angles of attack, it will begin to settle in spite of your continuing to ease the bar out. This should be happening well before your arms are significantly extended. At this point begin your flare by smoothly accelerating the rate at which you push out on the bar. At the same time, draw one leg forward, put a foot down, and start to run as hard as you can. This run should be very much like an aggressive take off run – your body should be leaning forward into the run and you should be driving with your legs. The difference here is that while you are leaning into your run and driving forward with your legs, your arms are extending fully from your shoulders, pushing out, and what feels like upwards, on the control bar in an accelerating, "crescendo" flare.

Done correctly, this type of flare / run combination will bring the glider quickly to a very nose high attitude, producing a great deal of drag and quickly arresting all of your forward motion. You will feel the glider pulling you from behind, resisting your attempt to run, and as you slow down the glider will settle gently on your shoulders. Even in no wind, you should not have to take more than a few steps. If your timing is a little early, and you feel the glider start to climb, simply stop pushing out and resume the flare when the glider again begins to settle. If your timing is a little late, your feet will touch down a little sooner, but as long as you're running and flaring at the same time, the glider will stay over your head or behind you.

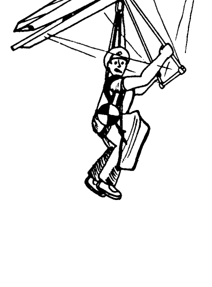
Note: Landing in a significant wind does not require a substantial landing flare; the pilot merely slows to near zero ground speed and touches down. The proper flare in light or no wind conditions is a dynamic action which causes a sudden and severe pitch up rotation of the glider. Pilots who have trouble with the flare, and with the glider nosing over during landing, usually do so because of one of the following problems:

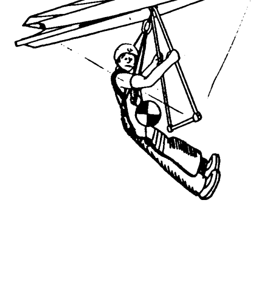
a. Harness leg straps too long / hanging too low below the glider, and / or hands too low on the control bar. This reduces pitch authority and prevents an adequate flare.





b. Improper body position - pilot leaning back, (away from the anticipated hard landing), with feet extended in front. This moves the pilot's center of mass forward ahead of his shoulders, effectively shortening the pilot's arms and reducing flare authority. The proper position is with the pilot's body inclined forward, with the shoulders out ahead of the pilot's center of mass. Thinking about pushing "up" instead of "out" when flaring may help you to maintain the proper forward inclined body position.





The Vertical Stabilizer

The use of the Wills Wing Vertical Stabilizer is optional on the Eagle. The purpose of the stabilizer is to increase yaw stability and damping, and help the pilot to minimize or eliminate problems with roll / yaw oscillations. The tendency towards oscillations of this type is present to some degree in all gliders, particularly when flying at faster speeds in turbulence, and when towing (especially aero-towing). The Eagle is naturally more resistant to these oscillations than typical high performance gliders, but without the stabilizer mounted, is somewhat more subject to them than an entry-level glider such as the Falcon. Without the stabilizer, the Eagle is almost exactly mid-way between a Falcon and an Ultra Sport in the degree of skill required to fly the glider without roll / yaw oscillations. With the stabilizer mounted, the Eagle is as easy to fly in this regard as the Falcon.

Once sufficient skill and experience are gained, the pilot can usually control or prevent such oscillations without the use of the stabilizer. Pilots who are making the transition from entry-level gliders to high performance gliders, and pilots learning new skills such as aero-towing, are often unable to adequately prevent or recover from these oscillations. In the case of aero-towing, this can be enough of a problem to be a barrier to learning this new skill. The Stabilizer is a very useful accessory in these situations.

On the Eagle, unlike on most higher performance gliders, there is no negative affect on the glider's flight characteristics when using the stabilizer. Roll /yaw coordination during thermalling flight is, if anything, enhanced.

The Stabilizer installs (and is removed and packed) easily (see the set-up section in this manual). It can be used on every flight, if desired. Alternately, the pilot can choose to use it only in some conditions, or only during the initial transition to a new glider, or trying a new skill, such as aero-towing.

Abnormal Glider Configurations
Distorted Mylar Insert And Bridle Cable Snagged Under A Batten

Background

There are two common set-up errors that, if not corrected during pre-flight inspection, can cause potentially dangerous effects on the glider's flight characteristics.

1. Distortion Of The Airfoil Caused By Folded Mylar Insert

While inserting the battens during set up of the glider, it is possible for the tip of the batten, acting through the sail, to catch the rear edge of the mylar leading edge insert, pushing it forward and folding it under in the process. This will cause a raised area of discontinuity in the mylar pocket portion of the leading edge of the wing, which in turn will cause a significant disruption of the air flow. The air flow can be affected over a wide area both inboard and outboard of the actual distortion. The result is that the affected portion of the wing will stall prematurely, at a higher airspeed and lower angle of attack than normal. Consequently, the glider will be difficult to control in the normal minimum sink airspeed range, will tend to stall repeatedly if flown in this speed range, and will tend to fall off into a diving turn towards the affected wing. The glider will exhibit delayed recovery from the stall, and the pilot will experience unusual negative pitch pressures in the control bar.

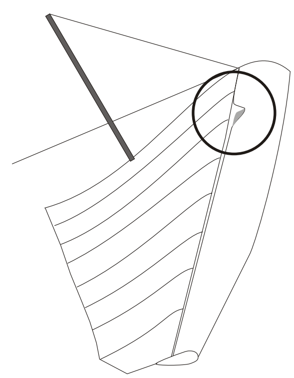
2. Bridle Cable Snagged Under A Batten

It is possible during set up that a bridle cable may end up passing underneath the rear end of the next inboard batten. Because it causes the cable to follow other than a direct route to its attachment at the kingpost, this significantly shortens the effective length of the bridle cable. If this condition is not corrected during pre-flight inspection, the cable will pull up hard on the trailing edge in flight in the vicinity of the batten under which it passes. This will cause the glider to trim slower than normal, and possibly in a stall. It will also cause a turn towards the affected wing, and it will cause the glider to be generally less responsive in roll, and more difficult to control.

Inspection / Service Requirement:

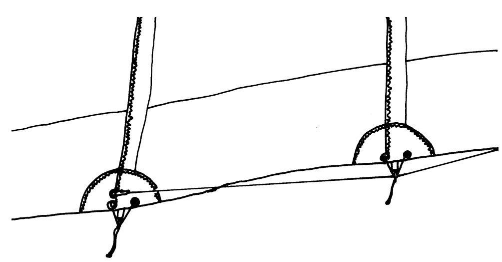
The primary and preferred solution to either of the above problems is to avoid them by always performing a proper pre-flight.

1. Folded Under Mylar:



In the case of a distortion due to folded under mylar, proper pre-flight procedure requires that you carefully sight down the entire length of the top surface of the leading edge, including the full chordwise length of the mylar pocket (the distortion described will tend to occur at the back edge of the mylar pocket, most often towards the root, as illustrated, and it may not be readily noticeable). If you notice such a distortion, de-tension the crossbar, remove the battens in the affected area, smooth down the mylar insert, and re-install the battens.

2. Bridle Under A Batten:



Your pre-flight should always include a full inspection of the glider from the trailing edge. During this inspection, you should check that the bridle balls are properly seated in the grommets, that the bridle ring has not been twisted prior to installation, and that no bridle line passes under an adjacent or farther inboard batten. Note: If for any reason you de-tension the crossbar after doing your pre-flight, you must pre-flight the bridle lines again, as this is a perfect opportunity for a bridle line to become caught under a batten.

Dealing With Configuration Abnormalities In Flight:

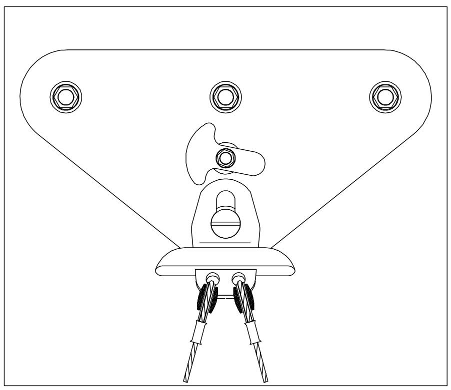
Should one of these set up errors occur, and not be discovered and corrected during pre-flight, follow the procedures below for dealing with the situation in flight.

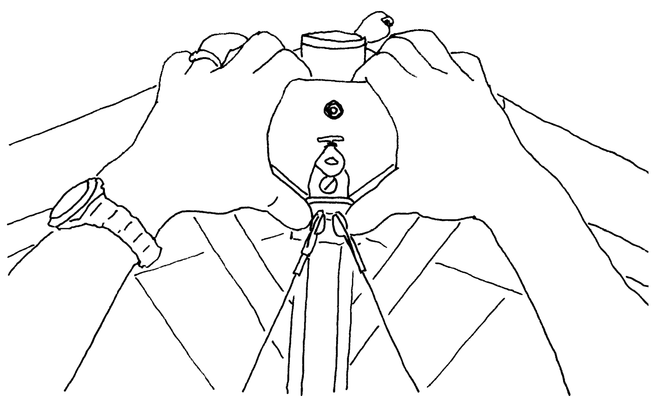
1. FLY THE GLIDER. This is the number one rule for any in flight aircraft emergency. Maintain directional control and control of airspeed and angle of attack, and maneuver away from terrain and other gliders immediately.
2. DETERMINE THE PROBLEM. While maintaining control of the glider, allow the glider to tell you what's wrong. If the glider is falling off on a wing and repeatedly pitching down, it is likely you have a folded under mylar insert. If the glider is turning one direction and trying to pitch up, it is likely that the problem is a bridle cable under a batten. While maintaining control of the glider, look up at the affected wing (the wing the glider wants to turn towards). Folded under mylar will cause an indicated stall as seen by flow reversal on the tuft on that wing, even though your airspeed is well above the normal stall speed. At the same time, you will feel negative pitch pressure in the control bar if flying near minimum sink airpseed. A bridle cable under a batten will be visible to you as you look along the trailing edge. It can also affect the local flow and therefore the wing tufts, but will usually cause a pitch up tendency, felt as positive pitch pressure in the control bar.
3. CHOOSE AN APPROPRIATE FLYING SPEED. If the problem is folded under mylar, fly faster – 30-35 mph. At a higher speed, no part of the wing will be stalled, and the glider will be relatively easy to control and will fly almost normally. If the problem is a bridle cable under a batten, you are better off to fly more slowly, at 22-25 mph, as the turn induced by the batten being pulled up is less at lower speeds. Do not allow the glider to stall, however, as this will compromise your directional control.
4. CONFIGURE THE GLIDER FOR BEST CONTROL. If the glider is equipped with variable geometry, set it to full loose. This will afford maximum control authority, and put the most slack in the bridle cables.
5. FLY TO A SAFE LANDING AREA AND LAND. If you have a choice, select the largest, easiest landing area. If you have a choice, fly an aircraft pattern away from the turn in the glider. (If the glider is trying to turn right, fly a pattern with all left turns). If possible, go to full upright position with hands on the downtubes early in the approach, so you don't have to change positions at low altitude. Maintain the pre-selected flying speed for best control throughout the pattern, for as long as possible. Do not dive your approach, or slip any of your turns. Instead vary the flight path to control you touchdown point. As you slow down on final, apply an appropriate amount of opposite roll control against the turn as necessary to maintain straight flight. (This will be a continuously increasing amount in the case of folded under mylar.) When flaring to land, apply pitch up control and roll control against the turn simultaneously, and run out the landing.

Eagle Breakdown

Breakdown of the glider is the reverse of assembly.

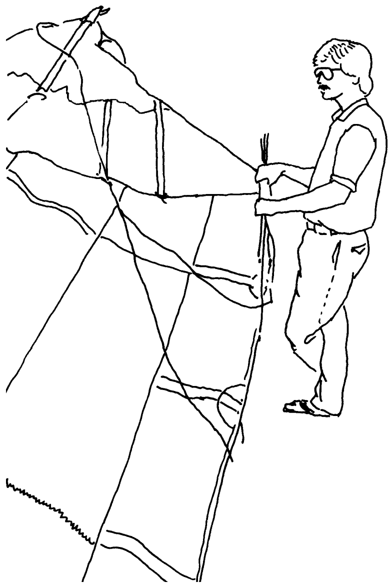
1. Set the glider at 90 degrees to the wind direction. Dismount the nose batten, and pull it out about 2" past the noseplate. Remove the #1 battens and 2 shortest cambered battens, roll the sail under at the tips, and install the tip cover bags.
2. Rotate the keyhole tang on the bottom of the noseplate to allow the keyhole tang to be disengaged. Disengage the tang by pulling down on the nose of the glider while pushing up with your thumbs on the plastic tang handle.

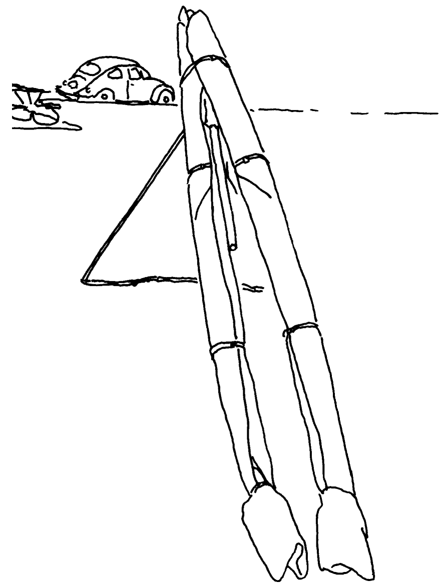




3. Pull back on the crossbar sweep wire and disengage the sweep wire, de-tensioning the crossbar.
4. Remove the rest of the battens.
5. Fold the wings together, pulling the sail up over the top of the leading edges.
6. Lay the kingpost down forward against the keel.
7. Detach the bridles and stow the bridle ring at the kingpost base. One method is to tuck it under the kingpost base cover sock, over the nut which secures the hang loop bolt.

8. Roll the sail on each side around the number 1 batten and the bottom surface battens.





9. Secure the sail with the Velcro sail ties provided.

The wide, long Velcro strap is installed by passing it OVER THE TOP of the keel tube just forward of the kingpost base, and then installing it around the glider leading edges. This will require that you partly un-zip the bottom surface center zipper. This holds the leading edges up away from the control bar apex hardware.

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10. Place the glider bag on the glider, and flip the glider over onto the ground.
11. Detach the basetube, fold the control bar, and install the control bar bag and keel protective covers.
12. Stow the battens in the rear of the glider between the rear leading edges, and zip up the bag.

Eagle Stability Systems

Stability in pitch is provided by reflex in the root section, which is determined by the lengths of the kingpost, control bar, and front to rear top and bottom wires, and by the shape of the root battens, and by reflex support bridles running from the kingpost to the trailing edge at the number four, five, and six battens. Correct attachment and proper adjustment of the bridles are critical to providing adequate stability at low angles of attack, particularly those below the normal operating range.

Reflex bridle adjustment

The glider must be fully assembled to measure the bridles. String a lightweight piece of thread tautly across from the rear tip of each bridle batten to the corresponding batten on the other side. Measure the height of this string above the top of the keel tube. The miminum height of the string should be:

Model	Btn #6	Btn #5	Btn #4
145	3 7/8"	6 1/2"	6 7/8"
164	6 7/8"	8"	8 1/2"
180	7 1/4"		9 3/4"

Adjustment of the bridles requires replacing the bridle pigtail with one of a shorter (to tighten) or longer (to loosen) length, or placing tubular shims under the sail to shorten individual bridle lines. Improper adjustment of the bridles will affect the glider's pitch stability and flight characteristics in the following ways:

Bridles Too Loose

If the bridles are adjusted too loose, it will not affect the glider in normal flight as the bridles are always slack in this range anyway. At angles of attack below normal flight, there will be a reduction in pitch stability proportional to the amount by which the bridles are looser than they are supposed to be. This stability reduction could increase the probability of a turbulence induced tumble or other in-flight stability related loss of control.

Bridles Too Tight

If the bridles are adjusted too tight, it will compromise the flight characteristics of the glider. The effects of too tight bridles are to increase roll control pressures and reduce roll rate in circumstances where maximum control input is applied.

Other factors of glider geometry which affect bridle adjustment and effectiveness

The effective adjustment of the bridles is also affected by other aspects of the glider geometry. For example, if the bottom side wires are too long, it will allow the wings to rise and slacken the bridles in normal flight. If they are too short, it will pull the wings down, and tighten the bridles in normal flight.

If the top side wires are too short, it will reduce the amount the wings can "fold" downwards as the glider unloads at low angles of attack, thereby reducing the effectiveness of the bridles.

Changes from proper length to the top or bottom side wires will also change the relative adjustment of the inner, middle, and outer bridles to each other, and change the way they operate. Finally, normal shrinkage of the sail over time, by reducing the spanwise distance to the bridle attachment station, will loosen the bridle adjustment, and this should be corrected.

Maintenance Schedule

You should continually maintain your glider in a proper state of tune and repair to insure optimum airworthiness, performance and flight characteristics. Failure to properly maintain your glider may lead to a dangerous loss of strength, stability or control responsiveness of the glider. Following any mishap that results in damage to the glider immediately have any damaged component repaired or replaced. We recommend that you have all such maintenance work done by your Wills Wing dealer. In addition, please follow the following maintenance schedule:

Every month

1. Spray all battens with silicone spray lubricant as you install them in the glider to lubricate the insides of the batten pockets. Do not use any other type of lubricant. Wipe off any excess silicone so that it does not attract dirt. If you fly in a dusty or sandy environment, it will help to prolong the life of your batten pockets if you wipe each batten with a rag before you install it in the sail.
2. Check your battens on a flat level floor against the batten diagram provided, and correct any that deviate from the pattern by more than 1/4".

Every six months

1. Have a complete inspection performed on the glider and replace any suspension system component that shows any wear, and any cable that shows any kinks, wear, damage, corrosion, etc.
2. Inspect all bolts for tightness, all safeties for proper installation and possible damage. Inspect plates and fittings for damage, holes in tubes for elongation.
3. Inspect the sail for wear, tears, UV damage, loose stitching, etc.

Every year

1. Have the sail completely removed from the frame, and disassemble all frame components. Inspect every part of the glider for any damage or wear. Inspect the tubes for straightness and for signs of corrosion. Anytime you have the sail off the frame inspect all of the batten pockets and batten pocket terminations.
2. Replace bottom side wires and hang loops.

Special circumstances

1. Any time you suffer a crash or extremely hard landing you should have an “annual” inspection done on your glider to insure that you find all damaged parts.
2. If your glider is ever exposed to salt water you will need to have the glider completely disassembled in accordance with the recommended annual inspection procedure. All frame parts will need to be disassembled, including the removal of all sleeves, flushed liberally with fresh water, dried completely, and treated for corrosion inhibition with LPS-3 or other suitable agent.

3. Cleaning Your Sail - Keeping your sail clean will extend the life of the cloth. When cleaning the entire sail you should generally use only water and a soft brush. You may clean small spots or stains with any commercial spot remover that is labeled for use on polyester. Such cleaning agents are available at the supermarket or drug store, or you may order a cleaning solution from Wills Wing through your dealer.

A Note About Cables and Cable Maintenance:

The cables which support the glider's airframe are critical components of the glider's structure, and must be maintained in an air worthy condition. It is a general practice in the design of aircraft structures to design to an ultimate strength of 1.5 times the highest expected load in normal service. Hang glider cables, like other structural components on the glider, are typically designed with a structural safety factor of only about 50% above the expected maximum load. No significant loss in cable strength can be tolerated.

A cable with even a single broken strand must be replaced before the glider is flown again. A cable which has been bent sharply enough to have taken a permanent set (will not lie flat in a straight line when all tension is removed) must also be replaced immediately. If it is not, subsequent tensioning and de-tensioning of the cable will induce fatigue, and the cable will fail. In tests we have conducted, a cable bent one time to 90 degrees, and then loaded to the equivalent of a normal flight load 100 times (corresponding to 100 or fewer flights), failed at only 56% of its original strength.

Some degree of fatigue due to repeated bending of cables is almost unavoidable in an aircraft that is assembled and disassembled with every flight. Bottom side wires are subject to the highest loads in flight, and are therefore the most critical. This is why we recommend that these wires be replaced annually, even if there is no known damage. The requirement for immediate replacement of a cable known to have been bent or otherwise damaged supercedes this annual replacement requirement.

Replacement cables should always be obtained from the factory, or, if not from the factory, from a reliable source known to use proper fabrication procedures. An improperly made cable may appear perfectly OK on visual inspection, but could fail in flight at a load much below the intended design strength of the cable.

Removing The Sail From The Airframe And Reinstalling

Many maintenance and repair procedures will require the removal of the sail from the frame. Please follow these instructions when removing and reinstalling the sail. Please read all the instructions for each operation before beginning.

Sail removal

You will need an unobstructed area six feet by thirty feet. Make sure the surface is clean. If it is abrasive, like rough concrete, you should either put down a protective tarp or be extremely careful not to scrape your sail.

1. Lay the glider on its back, unzip and remove the glider bag and put the battens aside. Remove the control bar bag.
2. Remove the tangs that secure the sail at the nose from the bolts to which they are attached. Spread the wings slightly, undo the Velcro tabs inside the rear ends of the leading edges and then dismount the sail from the rear leading edges.
3. Unbolt the bottom side wires from the control bar. Remove the clevis pin or bolt which secures the control top elbows to the apex bracket. Unbolt the bottom rear flying wires from the rear keel. Reassemble the hardware removed onto the bolts in the original order so that it doesn't get lost. All disassembled assemblies on the glider must be reassembled in the proper order and orientation. Use the exploded parts diagrams in this manual to help you. On the bottom rear wire, the relative position of the washers, saddles and tangs affects the front to rear wire tension.
4. Set the control bar aside.
5. Turn the glider over. Unroll the sail until you can reach the bridle attachments at the trailing edge. Remove the plastic bridle retainer balls and disconnect the bridles from the sail.
6. Remove the screw that holds the kingpost top cap in place and carefully remove the cap. Remove the top front and top side wires from the kingpost top. Reinstall the cap. Unbolt the kingpost from the keel. Set the kingpost aside.
7. Feed the top and bottom side wires into the sail through the holes in the sail. Turn the glider over onto its back again. Unzip the bottom surface center zipper all the way and remove the plastic wire tie that joins the sail at the nose. Slide the frame towards the nose and out through the opening of the bottom surface of the glider. If you encounter resistance, stop and find out what is hanging up.

9. If you need to send the sail into the factory for repair, remove the mylar inserts from the sail, fold and package the sail carefully. Be sure to include written instructions of what you want done, your name and a phone number where you can be reached during the day.

Reinstalling the sail on the frame

1. Position the sail on the floor with the keel pocket up and the wings folded over so that the leading edges lie along the length of the root line, with the top of the leading edge lying on top.
2. Prepare the frame, making sure that the side wires are pulled forward from the crossbar leading edge junction and are not wrapped around the frame.
3. Position the frame with the bottom of the noseplate facing up and with the rear end of the leading edges at the nose of the sail. Slide the frame into the nose of the sail, making sure that the leading edges of the frame and the crossbar halves pass properly into the leading edge pockets of the sail and don't get caught at the rear of the bottom surface near the root. As you feed the frame slowly into the sail, check periodically to see that none of the hardware is snagging on the sail. Make sure the keel feeds into the keel pocket.
4. After the frame is fully installed, mount the webbing anchor loops over the rear leading edge endcaps. Make sure you mount the inner webbing loops in the endcap slots, not the outer "handle" loops! Make sure that the webbing lies flat and smooth in the slot, and that the sail is properly aligned when mounted. Secure the Velcro retainer tabs.
5. Working through the zipper access in the bottom surface at the leading edge crossbar junction, insert the top wires through the holes in the sail, making sure that no cable is wrapped around a leading edge or crossbar, and that no thimbles are cocked or twisted. Pull the bottom side wires out through the bottom side wire hole.
6. Bolt the bottom rear wires to the rear of the keel attaching the rear sail mount at the same time. Install the control bar onto the apex bracket, and attach the bottom side wires to the control bar corners.
7. Flip the glider up onto the control bar. Working through the nose, insert the top front wire up through the hole in the sail.
8. Reinstall all the top wires onto the kingpost.
9. Spread the wings slowly and carefully, making sure that the sail rides forward as necessary at the nose without catching. Be careful: you can easily tear the sail open at the nose at this point. Reinstall the nose tangs after the sail is fully spread.
10. Attach the kingpost base bracket to the keel. Connect the top rear wire, and the bottom front wires. Connect the bridles to the sail.
11. Finish the assembly of the glider completely according to normal assembly procedures.
12. Do a very careful and complete preflight of the glider according to the normal preflight procedure as explained earlier in this manual.

Tuning

Dismounting and remounting the sail at the tip

A number of tuning procedures require you to dismount the sail at the rear leading edge. This can be most easily accomplished by using a large, flat bladed screw driver to pry the sail mount webbing off of the end of the leading edge. The same technique can be used to reinstall the sail. Take care not to damage the sail mount webbing, and when remounting the sail, be sure to mount the inner webbing in the slot, not the outer handle webbing, and be sure that the webbing seats squarely in the slot.

CG adjustment

has already been covered in the section of this manual on using your wing tufts. Wills Wing recommends that tuning other than CG adjustment be performed by your Wills Wing dealer.

Turn trim

Turns are caused by an asymmetry in the glider. If you have a turn, first try to make the glider symmetrical in every way.

Airframe

Check the leading edges for possible bent tubes. Check that the keel is not bent to one side.

Check for symmetrical twist in the leading edges by checking for symmetry in the alignment of the sail mount plugs.

Battens

Check the battens for symmetrical shape and batten string tension.

Sail mount plugs - adjusting sail tension and rotational alignment

The molded plastic sail mount plug fits directly into the rear leading edge and is secured against rotation by a sliding wedge which is forced out against the inside of the tube as the allen screw is tightened. The proper installation procedure for this plug is to engage the allen screw three turns into the sliding wedge, install the plug into the rear leading edge, set the desired alignment, and then tighten the allen screw 15 additional turns.

Shims are added to the plug by sliding them over the end of the plug before the plug is inserted into the leading edge. The shims are thus visible with the plug installed.

Once the allen plug is installed, the rotational alignment can be changed by loosening the allen screw to relieve the pressure of the wedge against the inside of the leading edge tube until the sail mount plug is free enough that it can be rotated.

If you loosen the screw too much, the wedge will fall off inside the leading edge tube, and you will have to dismount the sail to retrieve it.

Sail tension

Check for symmetrical sail tension on the leading edges. In order to check this, sight the hem of the sail at the bottom of the leading edge tube relative to the noseplate on each side. Sail tension is adjusted by adding or removing shims in 1/8" or 1/4" increments to or from the sail mount plugs on the rear ends of the leading edges. See the discussion above about how shims are added or removed.

To remove or add shims from the sail mount plug, first dismount the sail mount webbing by pulling it free and then to the outside of the leading edge. You can use a flat bladed screwdriver to pry the webbing off, but take care not to damage the webbing. After dismounting the sail, to remove the plug, first check and record the rotational alignment by noting the position of the scribe mark on the plug relative to the scale on the leading edge tube. Use the allen wrench provided in your spare parts kit to loosen the allen screw until you can remove the plug. Add or remove shims as necessary, and then reinstall the plug, making sure the alignment is correct. Fifteen turns of the allen screw after installation of the plug will secure the plug in place.

Twisting a tip

After you have made everything symmetrical, if you still have a turn, you will correct it by rotating one or both sail mount plugs. A left turn is corrected by twisting the left sail plug clockwise (twisting the sail down at the trailing edge) or twisting the right sail plug clockwise (twisting the sail up at the trailing edge) or both. Twist counter clockwise on either or both plugs to correct a right turn.

To rotate the sail plug, use the allen wrench provided in your spare parts kit to loosen the allen screw thus pushing the wedge forward and releasing the plug.

If you loosen the screw too much, the wedge will fall off the end of the screw inside the leading edge, and you will have to dismount the sail to retrieve it. Start by loosening the screw ten turns, and then check to see if you can rotate it. If not, loosen it one turn at a time until it can be rotated.

After rotating the plug in the desired amount in the desired direction, (see above) tighten the screw to secure the plug against rotation. When the screw is properly tightened, there will be a slight bulge (less than or equal to the wall thickness of the tube) in the rear leading edge tube adjacent to the screw.

Adjusting batten tension

All battens are tensioned by looping the batten string over the notched end of the batten twice. The inboard batten strings should be slightly on the loose side, and the outboard batten strings should be progressively tighter. The number one batten strings should be fairly tight, but not so tight as to slacken the sail mount webbing which mounts the sail at the tip.

Leading edge sail tension

The tension in the leading edge of the sail, adjustable by shimming as described above, will influence the performance and handling of the glider. If the sail is mounted too loose, the performance will deteriorate noticeably. If the sail is mounted too tight, the glider will handle poorly; it will be stiff and slow in roll response with excessive adverse yaw and an increased tendency to spin in a stalled turn. As the glider gets older and the sail stretches, you will need to add shims to maintain the proper tension.

Car Top Mounting And Transport

Improper or careless transport of your glider can cause significant damage. You should transport your glider on a rack which has at least three support points which span at least 13' of the length of the glider. These should be well padded and at least four inches wide to distribute the load. Your glider should be mounted on your rack with the control bar facing up. It should be securely tied down with webbing straps which are at least 1/2" wide If you drive on rough roads where the glider receives impact loads, you should take extra care to pad your glider internally when you pack it up. One special area to pay attention to is the forward area of the glider where the crossbar center section bears against the top of the leading edge tubes, and the kingpost sits on top of the keel. Some extra padding inserted in this area will save wear on your airframe and sail.

In Closing

With proper care and maintenance, your glider will retain a high level of airworthiness for some years. Because of the relatively short history of hang gliding, and the rapid advances in new designs, we do not have a lot of information about the ultimate service life of a hang glider. We do know that ultraviolet (UV) damage to the sail from sunlight is probably the limiting factor in the life of your sail. Try to avoid exposing your sail to sunlight any time you are not actually flying it.

We also know that there are forces in nature which can be so violent that they can result in fatal accidents regardless of the airworthiness of your aircraft. Ultimately your safety is your responsibility. Know the limitations of your knowledge, skill and experience, and know the limitations of your aircraft. Fly within those limitations.

Have fun.

See you in the sky!

Wills Wing, Inc.

HGMA COMPLIANCE VERIFICATION SPECIFICATION SHEET

GLIDER MODEL Eagle 145
MANUFACTURED BY Wills Wing Inc.
All dimensions in inches; weights in pounds.

NOTE: These specifications are intended only as a guideline for determining whether a given glider is a certified model and whether it is in the certified configuration.

Be aware, however, that no set of specifications, however detailed, can guarantee the ability to determine whether a glider is the same model, or is in the same configuration as was certified, or has those performance, stability, and structural characteristics required by the certification standards. An owner's manual is required to be delivered with each HGMA certified glider, and it is required that it contain additional airworthiness information.

1) Weight of glider with all essential parts and without coverbags and non-essential parts: 52.5 lbs
2) Leading Edge Dimensions
   a) Nose plate anchor hole to:
      1) Crossbar attachment hole 121
      2) Rear sail attachment point 210.88
   b) Outside diameter at:
      1) Nose 2.05
      2) Crossbar 2.05
      3) Rear sail attachment point 1.97
3) Crossbar Dimensions
   a) Overall pin to pin length from leading edge attachment point to center of ball at glider centerline. 109
   b) Largest outside diameter 2
4) Keel dimensions; least and greatest allowable distances, whether variable through tuning or through in-flight variable geometry, from the line joining the leading edge nose bolts to:
   a) The center of the xbar center load bearing ball 41.75
   b) The pilot hang loop 52.75 - 55.25
5) Sail Dimensions
   a) Chord lengths at:
      1) 3 ft outboard of centerline 74.9
      2) 3 ft inboard of tip 41.3
   b) Span (extreme tip to tip) 359.5
6) Location of Information Placard Keel
   Location of Test Fly Sticker Keel
7) Recommended Pilot Weight Range 130 - 200
8) Recommended Pilot Proficiency USHGA Novice

HGMA COMPLIANCE VERIFICATION SPECIFICATION SHEET

GLIDER MODEL Eagle 164
MANUFACTURED BY Wills Wing Inc.
All dimensions in inches; weights in pounds.

NOTE: These specifications are intended only as a guideline for determining whether a given glider is a certified model and whether it is in the certified configuration.

Be aware, however, that no set of specifications, however detailed, can guarantee the ability to determine whether a glider is the same model, or is in the same configuration as was certified, or has those performance, stability, and structural characteristics required by the certification standards. An owner's manual is required to be delivered with each HGMA certified glider, and it is required that it contain additional airworthiness information.

1) Weight of glider with all essential parts and without coverbags and non-essential parts: 59 lbs
2) Leading Edge Dimensions
   a) Nose plate anchor hole to:
      1) Crossbar attachment hole 128
      2) Rear sail attachment point 217.75
   b) Outside diameter at:
      1) Nose 2.05
      2) Crossbar 2.05
      3) Rear sail attachment point 1.97
3) Crossbar Dimensions
   a) Overall pin to pin length from leading edge attachment point to center of ball at glider centerline. 115.88
   b) Largest outside diameter 2.25
4) Keel dimensions; least and greatest allowable distances, whether variable through tuning or through in-flight variable geometry, from the line joining the leading edge nose bolts to:
   a) The center of the xbar center load bearing ball 43.0
   b) The pilot hang loop 54.5 - 57.0
5) Sail Dimensions
   a) Chord lengths at:
      1) 3 ft outboard of centerline 79
      2) 3 ft inboard of tip 41
   b) Span (extreme tip to tip) 380
6) Location of Information Placard Keel
   Location of Test Fly Sticker Keel
7) Recommended Pilot Weight Range 150 - 250
8) Recommended Pilot Proficiency USHGA Novice

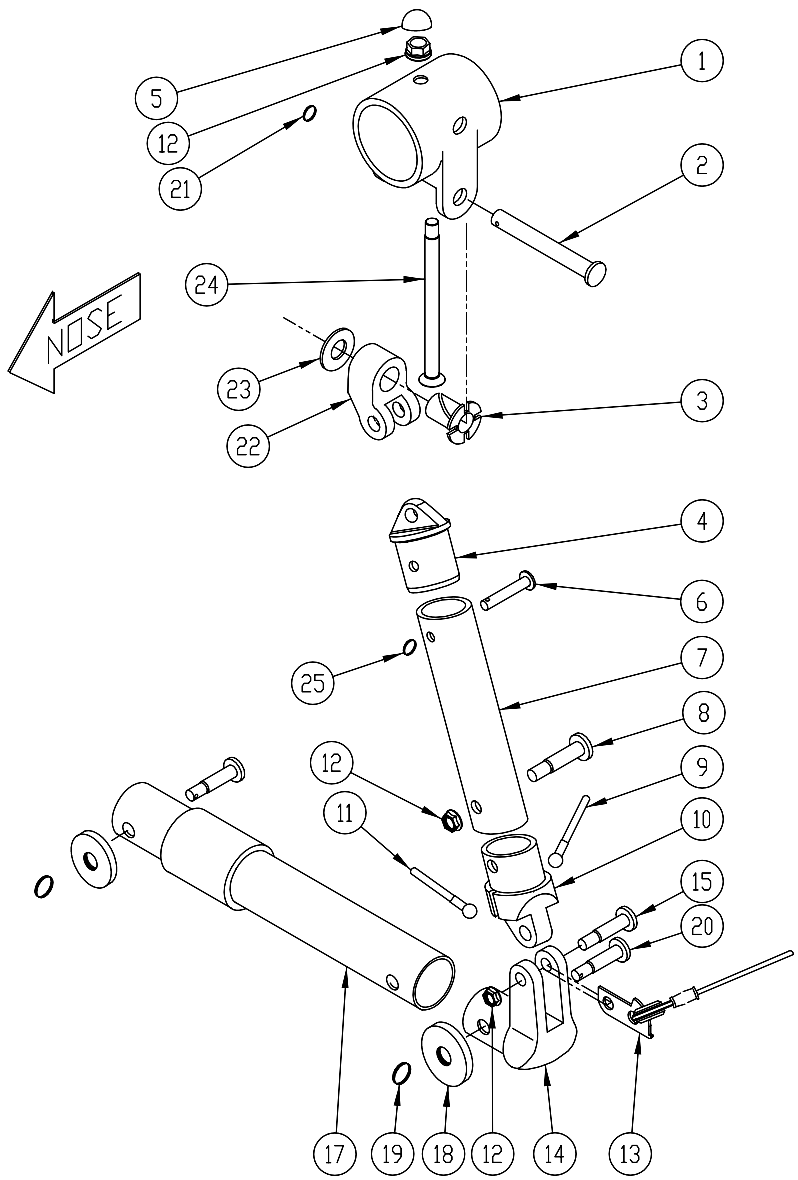
HGMA COMPLIANCE VERIFICATION SPECIFICATION SHEET

GLIDER MODEL Eagle 180
MANUFACTURED BY Wills Wing Inc.
All dimensions in inches; weights in pounds.

NOTE: These specifications are intended only as a guideline for determining whether a given glider is a certified model and whether it is in the certified configuration.

Be aware, however, that no set of specifications, however detailed, can guarantee the ability to determine whether a glider is the same model, or is in the same configuration as was certified, or has those performance, stability, and structural characteristics required by the certification standards. An owner's manual is required to be delivered with each HGMA certified glider, and it is required that it contain additional airworthiness information.

1) Weight of glider with all essential parts and without coverbags and non-essential parts: 62.5 lbs
2) Leading Edge Dimensions
   a) Nose plate anchor hole to:
      1) Crossbar attachment hole 133
      2) Rear sail attachment point 227.88
   b) Outside diameter at:
      1) Nose 2.05
      2) Crossbar 2.05
      3) Rear sail attachment point 1.97
3) Crossbar Dimensions
   a) Overall pin to pin length from leading edge attachment point to center of ball at glider centerline. 120.38
   b) Largest outside diameter 2.25
4) Keel dimensions; least and greatest allowable distances, whether variable through tuning or through in-flight variable geometry, from the line joining the leading edge nose bolts to:
   a) The center of the xbar center load bearing ball 42.75
   b) The pilot hang loop 57.75 - 60.25
5) Sail Dimensions
   a) Chord lengths at:
      1) 3 ft outboard of centerline 84.6
      2) 3 ft inboard of tip 43.1
   b) Span (extreme tip to tip) 399.5
6) Location of Information Placard Keel
   Location of Test Fly Sticker Keel
7) Recommended Pilot Weight Range 175 - 275
8) Recommended Pilot Proficiency USHGA Novice



ID	Part No	Description	QTY	Model
1	20G-1612	BRACKET KEEL CNTR FALCON 44MM	1	
2	10G-3590	CLEVIS PIN MS20392-4C59	1	
3	10T-5114	BUSH SPLIT HEADED AT CB LONG	2	
4	20G-1412	CBAR PLUG AT LEG TOP ROUND	2	
5	15A-1001	FRICTION CAP 1/4 X 1/4	1	
6	10G-1370	CLEVIS PIN MS20392-2C37	2	
7	40G-1220	LEG AT 62 .065 ROUND	2	145
7	40G-1230	LEG AT 65 .065 ROUND	2	164
7	40G-1240	LEG AT 68 .065 ROUND W/ SLEEVE	2	180
8	10C-5171	BOLT NAS 623-4-17	2	
9	40P-3301	WIRE SET BOTTOM REAR BALL SWDG	1	
10	20G-1402	CBAR PLUG AT LEG BOTM ROUND 95	2	
11	40P-3201	WIRE SET BOTTM FRONT BALL SWDG	1	
12	10N-1740	CLINCH NUT 1/4 MS21042-4	5	
13	40P-3103	WIRE BOTTOM SIDE 3/32 AT STYLE	2	
14	20G-1801	CBAR BRACKET AT BASETUBE END	2	
15	10C-5131	BOLT NAS 623-4-13	2	
17	40F-1320	BASETUBE AT 62 STRAIGHT	Option	145
17	40F-1321	BASETUBE AT 62 SPEEDBAR	1	145
17	40F-1330	BASETUBE AT 65 STRAIGHT	Option	164
17	40F-1331	BASETUBE AT 65 SPEEDBAR	1	164
17	40F-1340	BASETUBE AT 68 STRAIGHT	Option	180
17	40F-1341	BASETUBE AT 68 SPEEDBAR	1	180
18	10N-1445	SPEEDNUT 1/4 X 28	2	
19	10P-1200	SAFETY RING AN R2 LARGE	2	
20	10C-5181	BOLT NAS 623-4-18	2	
21	10P-1300	SAFETY RING MEDIUM THICK	1	
22	20G-1701	CBAR ELBOW AT TOP ROUND	2	
23	10U-5125	WASHER NYLON .75 * .316 * .020	2	
24	10C-2291	BOLT NAS 517-4-29	1	
25	10P-1100	SAFETY RING AN 9491 SMALL	2	

WILLS WING

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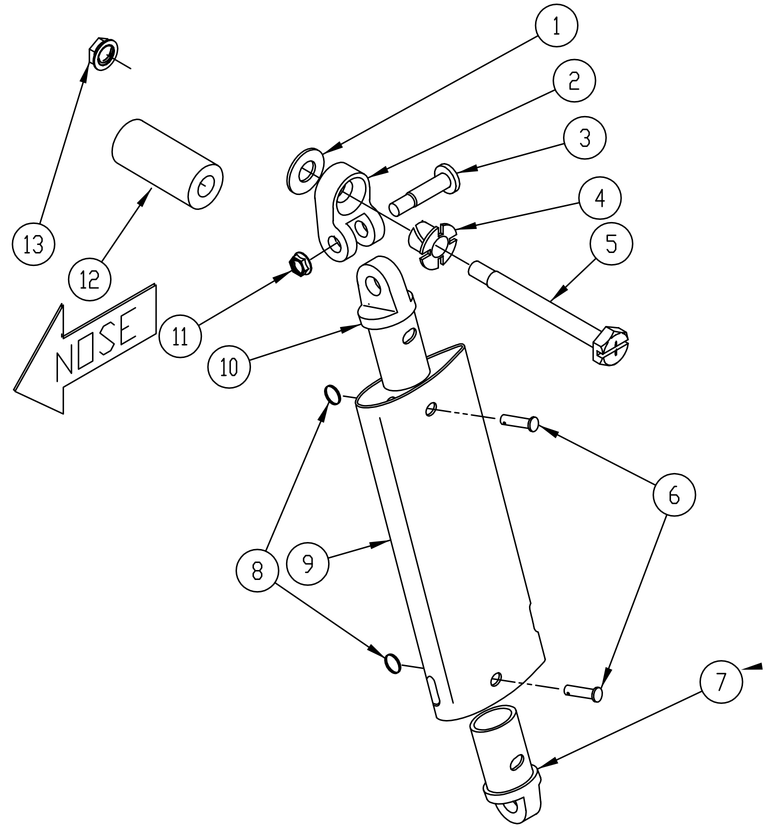
TITLE: Round Control Bar

PART NO:	DWG ID:	DOCUMENT ID:	MATERIAL:	DRAWN:	SCALE:
NA	Iso Eagle.dwg	NA	NA	03-11-2002 mm	NA



ID	Part No	Description	QTY	Model
1	10U-5125	WASHER NYLON .75 * .316 * .020	2	
2	20G-1711	CBAR ELBOW AT TOP STREAM	2	
3	10C-5111	BOLT NAS 623-4-11	2	
4	10T-5113	BUSH SPLIT HEADED AT CB SHORT	2	
5	10A-3272	BOLT AN5-27A GROUND & SLOTTED	1	
6	10G-1330	CLEVIS PIN MS20392-2C33	4	
7	20G-1425	CBAR PLUG AT LEG BOT STR 97 LEFT	1	
7	20G-1426	CBAR PLUG AT LEG BOT STR 97 RGHT	1	
8	10P-1100	SAFETY RING AN 9491 SMALL	4	
9	40G-1320	LEG AT 62 STREAMLINE	2	145
9	40G-1335	LEG AT 65 STREAMLINE	2	164
9	40G-1345	LEG AT 68 STREAMLINE	2	180
10	20G-1433	CBAR PLUG AT LEG TOP STR TOEIN	2	
11	10N-1740	CLINCH NUT 1/4 MS21042-4	2	
12	10T-1133	SPACER AL .5 * .095 * 1.42	1	
13	10N-1750	CLINCH NUT 5/16 MS21042-5	1	

WILLS WING

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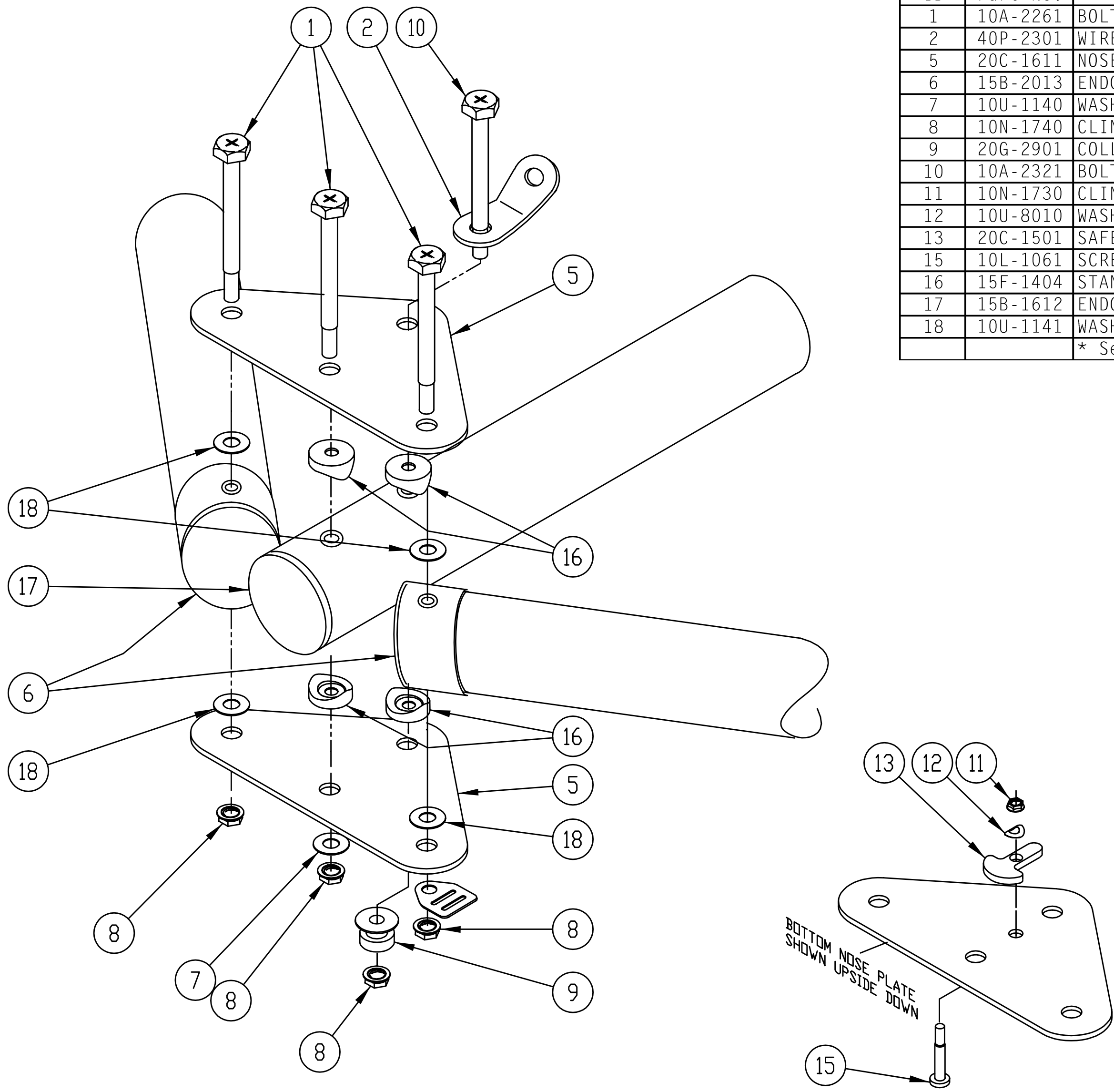
TITLE: Streamlined Control Bar

PART NO:	DWG ID:	DOCUMENT ID:	MATERIAL:	DRAWN:	SCALE:
NA	NA	NA	NA	03-11-2002 mm	NA

ID	Part No.	Description	QTY
1	10A-2261	BOLT AN4-26A	3
2	40P-2301	WIRE TOP FRONT BALL SWEDG 3/32	*
5	20C-1611	NOSEPLATE HARRIER THRU CURRENT	2
6	15B-2013	ENDCAP 2" MULTIGAUGE	2
7	10U-1140	WASHER STEEL AN960-416	1
8	10N-1740	CLINCH NUT 1/4 MS21042-4	4
9	20G-2901	COLLAR KEYHOLE TANG BOLT	1
10	10A-2321	BOLT AN4-32A	1
11	10N-1730	CLINCH NUT 3/16 MS20142-3	1
12	10U-8010	WASHER WAVE KEYHOLE ANCHOR	1
13	20C-1501	SAFETY ALUM KEYHOLE ANCHOR	1
15	10L-1061	SCREW PAN 3/16 MS35207-263	1
16	15F-1404	STAND-OFF 1/4	4
17	15B-1612	ENDCAP 1 3/4 .049	1
18	10U-1141	WASHER STEEL AN960-416L	4
		* See Kingpost Top	

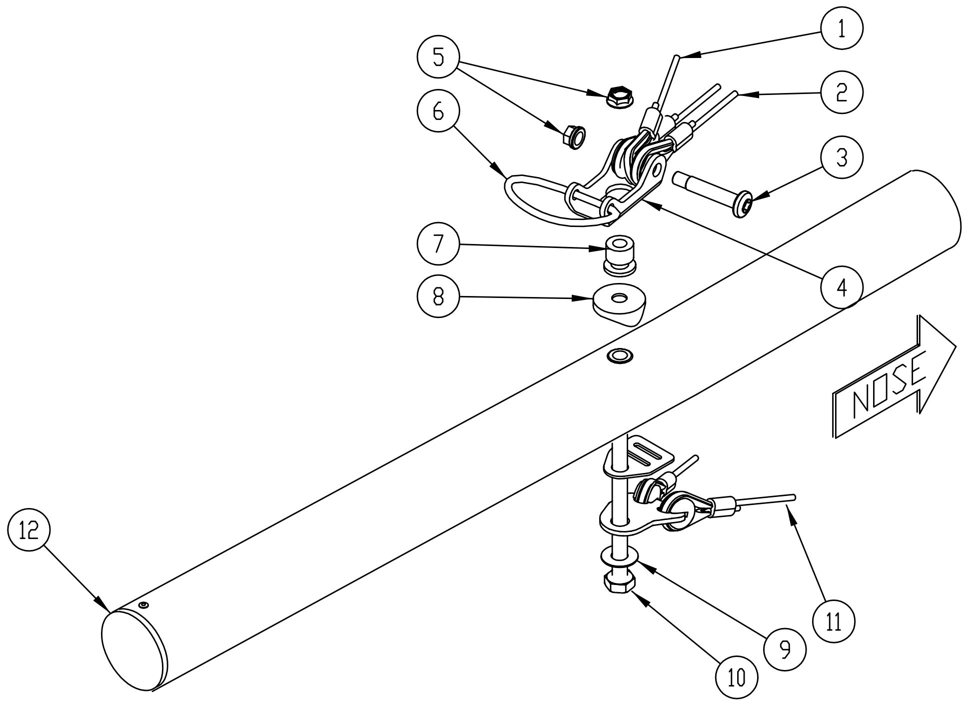


WILLS WING
500 BLUERIDGE AVE · ORANGE · CA · 92665 · PH/FAX (714) 998-6359 / 998-0647

TITLE: Eagle Noseplate

PART NO:	DWG ID:	DOCUMENT ID:	MATERIAL:	DRAWN:	SCALE:
NA	Iso Eagle.dwg	NA	NA	03-11-2002 mm	NA

ID	Part No	Description	QTY
1	40P-2401	WIRE TOP REAR BALL SWEDG 3/32	*
2	40P-4204	WIRE XBAR SWEEP CNTR HINGE SET	**
3	10C-5131	BOLT NAS 623-4-13	1
4	20A-1601	BRACKET, KEYHOLE TYPE LAYFLAT	1
5	10N-1740	CLINCH NUT 1/4 MS21042-4	2
6	30J-3101	CORD - 4mm ACCESSORY PER FOOT	1
7	20G-2901	COLLAR KEYHOLE TANG BOLT	1
8	15F-1602	STAND-OFF 1/8	1
9	10U-1141	WASHER STEEL AN960-416L	1
10	10A-2271	BOLT AN4-27A	1
11	40P-3301	WIRE SET BOTTOM REAR BALL SWDG	***
12	15C-4209	ENDCAP 42mm OD 40.2 ID	
		* see King Post	
		** see Crossbar Center	
		** see Control Bar	



WILLS WING

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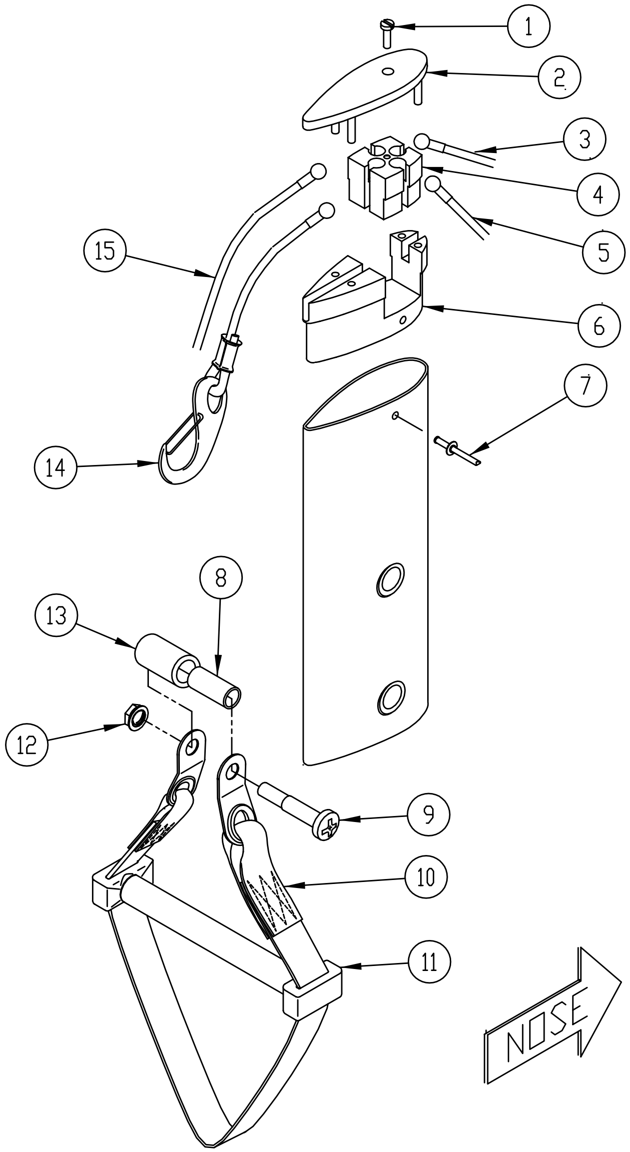
TITLE: Rear Keel

PART NO:	DWG ID:	DOCUMENT ID:	MATERIAL:	DRAWN:	SCALE:
NA	Iso Eagle.dwg	NA	NA	03-11-2002 mm	NA



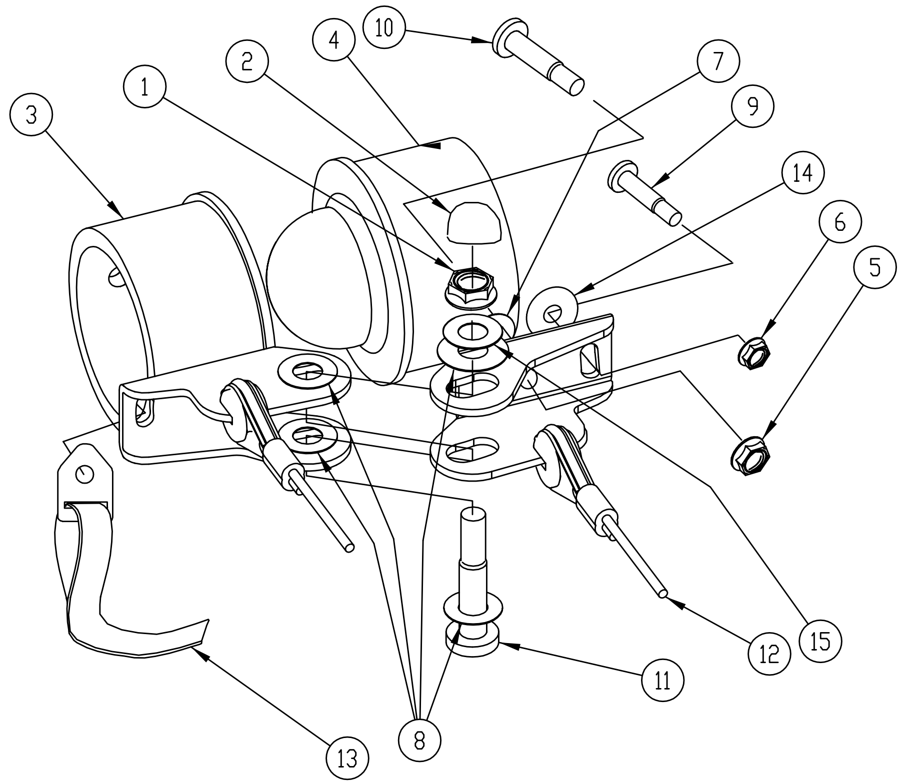
ID	Part No	Description	QTY
1	10M-1361	SCREW 6/32 FLSTR MACH HEAD SS	1
2	15J-1501	CAP AT KINGPOST TOP POLYCARB	1
3	40P-2301	WIRE TOP FRONT BALL SWEDG 3/32	1
4	20G-2323	KINGPOST TOP INSERT AT ALUM	1
5	40P-2202	WIRE TOP SIDE BALL SWEDGE 3/32	2
6	15J-1502	TOP AT KINGPOST POLYCARB	1
7	10R-0342	RIVET AL 1/8 * .25	2
8	10T-1121	SPACER AL .313 * .028 * 1.140	1
9	10C-5191	BOLT NAS 623-4-19	1
10	45J-1401	HANG LOOP SET - KINGPOST STK	1
11	20G-2812	SPREADR BAR XC & LATER KP HANG	1
12	10N-1740	CLINCH NUT 1/4 MS21042-4	1
13	10T-5132	BUSH FGLASS .414 * .337 * 1.0	1
14	40P-4101	WIRE BRIDLE PIGTAIL	1
15	40P-2401	WIRE TOP REAR BALL SWEDG 3/32	1

WILLS WING

500 BLUERIDGE AVE · ORANGE · CA · 92665 · PH/FAX (714) 998-6359 / 998-0647

TITLE: Kingpost					
PART NO: NA	DWG ID: Iso Eagle.dwg	DOCUMENT ID: NA	MATERIAL: NA	DRAWN: 03-11-2002 mm	SCALE: NA

ID	Part No	Description	QTY	Model
1	10N-1750	CLINCH NUT 5/16 MS21042-5	1	
2	15A-1103	NUT CAP SHALLOW	1	
3	15J-2116	SOCKET XBAR CNTR BALL JNT 2.25	1	164/180
3	15J-2112	SOCKET XBAR CNTR BALL JNT 52	1	145
4	15J-2126	BALL XBAR CNTR BALL JOINT 2.25	1	164/180
4	15J-2122	BALL XBAR CNTR BALL JOINT 52	1	145
5	10N-1740	CLINCH NUT 1/4 MS21042-4	2	
6	10N-1730	CLINCH NUT 3/16 MS20142-3	2	
7	10U-1140	WASHER STEEL AN960-416	3	
8	10U-5125	WASHER NYLON .75 * .316 * .020	4	
9	10C-4081	BOLT NAS 623-3-8	2	
10	10C-5071	BOLT NAS 623-4-7	2	
11	10C-6171	BOLT NAS 623-5-17	1	
12	40P-4204	WIRE XBAR SWEEP CNTR HINGE SET	1	
13	45K-1310	XBAR STRAP HOLD DOWN 154	1	
14	10U-5093	WASHER NYLON .560 *.192 *.015	2	
15	10U-1151	WASHER STEEL AN960-516L	1	

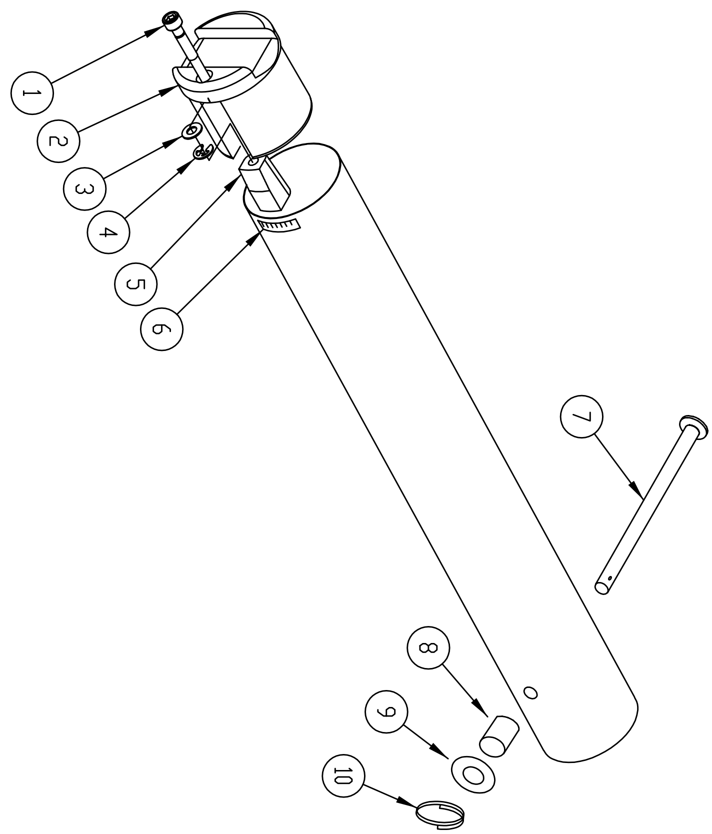


WILLS WING

500 BLUERIDGE AVE · ORANGE · CA · 92665 · PH/FAX (714) 998-6359 / 998-0647

TITLE: Crossbar Center

PART NO:	DWG ID:	DOCUMENT ID:	MATERIAL:	DRAWN:	SCALE:
NA	Iso Eagle.dwg	NA	NA	03-11-2002 mm	NA



ID	Part No	Description	QTY
1	10K-2026	SCREW SOCKET CAP 10-32*1.75 SS	2
2	15J-1911	ENDCAP SAIL MOUNT ADJUSTABLE	2
3	10U-1130	WASHER STEEL AN960-10	2
4	10S-1101	C-CLIP SAIL ADJUSTER CAP SCREW	2
5	15J-1912	LOCKING SLIDE ADJUST ENDCAP	2
6	70G-4019	PLACARD - SAIL ADJUSTER ALIGN	2
7	10G-2770	CLEVIS PIN MS20392-3C77	2
8	10T-1111	SPACER AL .375 * .035 * .375	2
9	10U-1400	WASHER MS 15795-210	2
10	10P-1100	SAFETY RING AN 9491 SMALL	2

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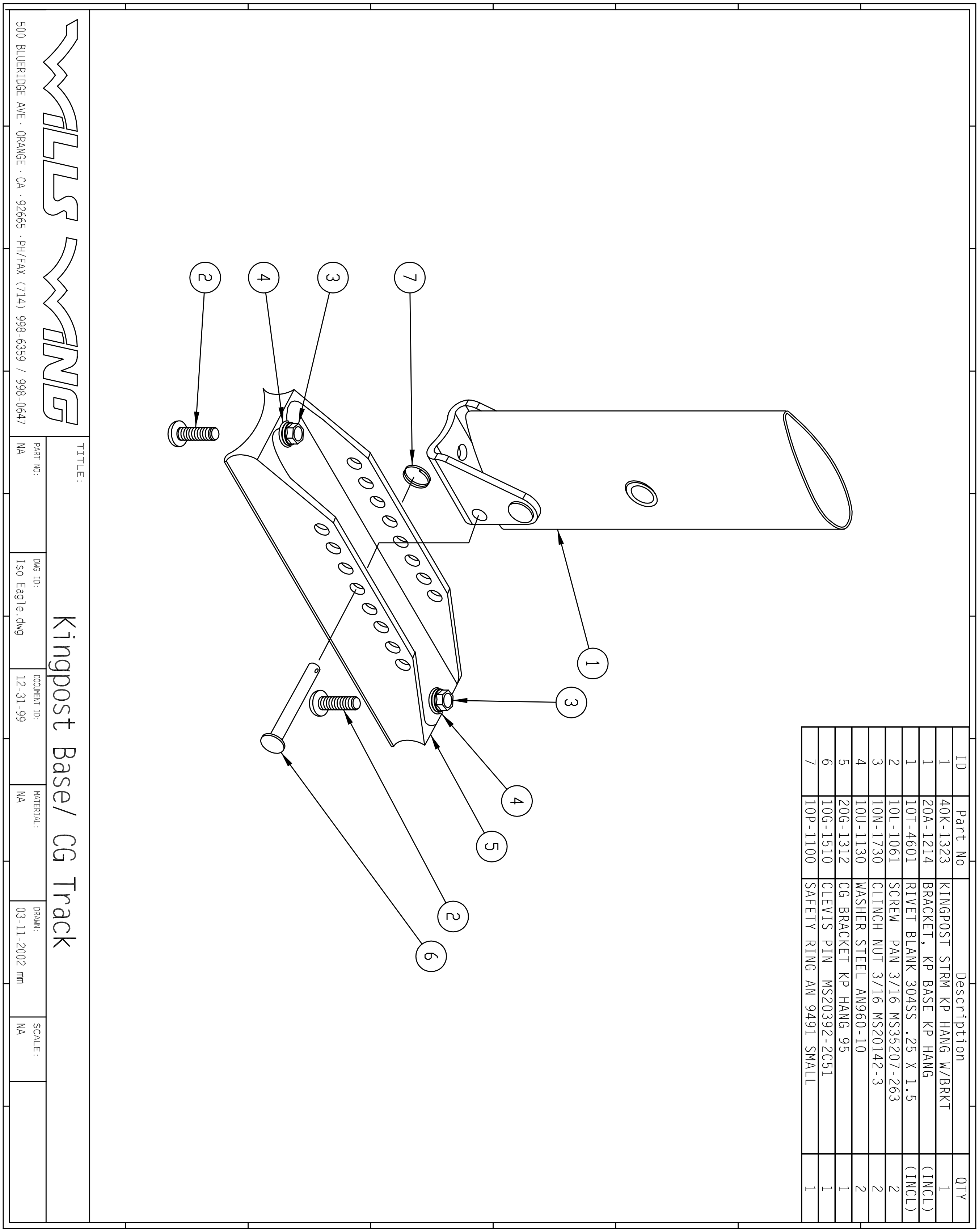
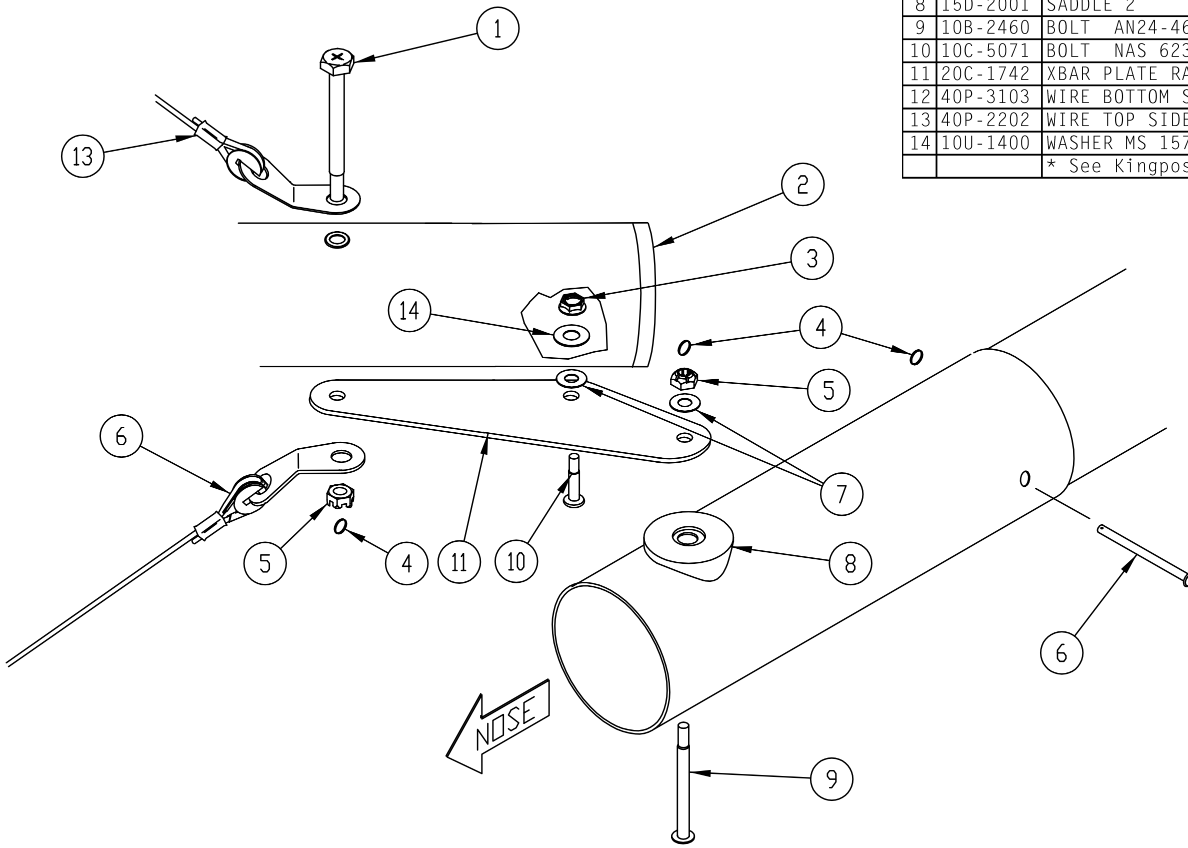
TITLE: Sail Adjuster

PART NO:	DWG ID:	DOCUMENT ID:	MATERIAL:	DRAWN:	SCALE:
NA	Iso Eagle.dwg	NA	NA	03-11-2002 mm	NA



ID	Part No	Description	QTY
1	40K-1323	KINGPOST STRM KP HANG W/BRKT	1
1	20A-1214	BRACKET, KP BASE KP HANG	(INCL)
1	10T-4601	RIVET BLANK 304SS .25 X 1.5	(INCL)
2	10L-1061	SCREW PAN 3/16 MS35207-263	2
3	10N-1730	CLINCH NUT 3/16 MS20142-3	2
4	10U-1130	WASHER STEEL AN960-10	2
5	20G-1312	CG BRACKET KP HANG 95	1
6	10G-1510	CLEVIS PIN MS20392-2C51	1
7	10P-1100	SAFETY RING AN 9491 SMALL	1

ID	Part No	Description	QTY	Model
1	10A-2310	BOLT AN4-31	2	164/180
1	10A-2270	BOLT AN4-27	2	145
2	15B-2213	ENDCAP 2.25" MULTIGAUGE	2	164/180
2	15B-2013	ENDCAP 2 MULTIGAUGE	2	145
3	10N-1740	CLINCH NUT 1/4 MS21042-4	2	
4	10P-1100	SAFETY RING AN 9491 SMALL	6	
5	10N-1340	CASTLENUT 1/4 AN310-4	4	
6	10G-1650	CLEVIS PIN MS20392-2C65	2	
7	10U-1140	WASHER STEEL AN960-416	4	
8	15D-2001	SADDLE 2	2	
9	10B-2460	BOLT AN24-46	2	
10	10C-5071	BOLT NAS 623-4-7	2	
11	20C-1742	XBAR PLATE RAMAIR .250	2	
12	40P-3103	WIRE BOTTOM SIDE 3/32 AT STYLE	*	
13	40P-2202	WIRE TOP SIDE BALL SWEDGE 3/32	*	
14	10U-1400	WASHER MS 15795-210	2	
		* See Kingpost Top		

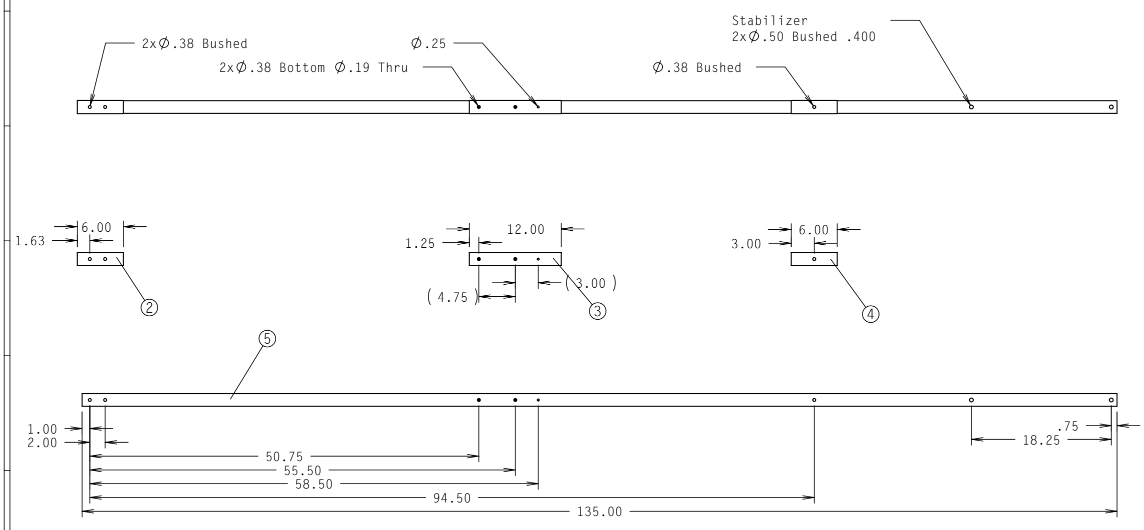


WILLS WING
500 BLUERIDGE AVE · ORANGE · CA · 92665 · PH/FAX (714) 998-6359 / 998-0647

TITLE: Xbar - Leading Edge

PART NO:	DWG ID:	DOCUMENT ID:	MATERIAL:	DRAWN:	SCALE:
NA	Iso Eagle.dwg	NA	NA	03-11--2002 sp	NA

ITEM NO.	QTY.	PART NO.	DESCRIPTION
2	1	Eagle 164 Keel front slv	44mm x 0.9mm 7075-T6
3	1	Eagle 164 Keel middle slv	44mm x 0.9mm 7075-T6
4	1	Eagle 164 Keel rear slv	44mm x 0.9mm 7075-T6
5	1	Eagle 145 Keel tube	42mm x 0.9mm 7075-T6

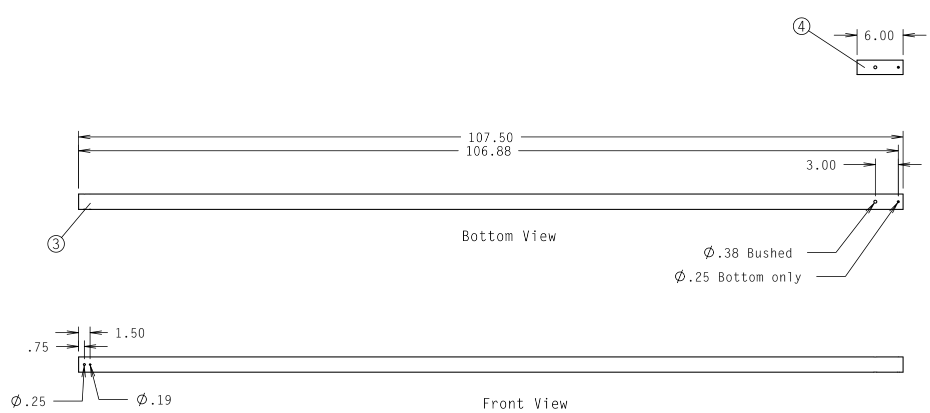


2.875 lb

WILLS WING
500 BLUERIDGE AVE ORANGE, CA 92865 PH/FAX (714) 998-6359 / 998-0647

TITLE: Eagle 145 Keel			PART NO: 40B-1201		REVISION: A	T.U.S. .X ± .05 .XX ± .015 .XXX ± .003 .XXXX ± .0005 ANGLES ± 1/2°
SLDDWF ID: Eagle 145 Airframe	MATERIAL: NA	DRAWN: 01-22-02	REVISED: NA	STATUS: Released	BY: PEARSON	

ITEM NO.	QTY.	PART NO.	DESCRIPTION
3	1	Eagle 145 Crossbar tube	2.00in x .049in 6061-T6
4	1	Eagle 145 Crossbar slv	1.88in x .049in 6061-T6

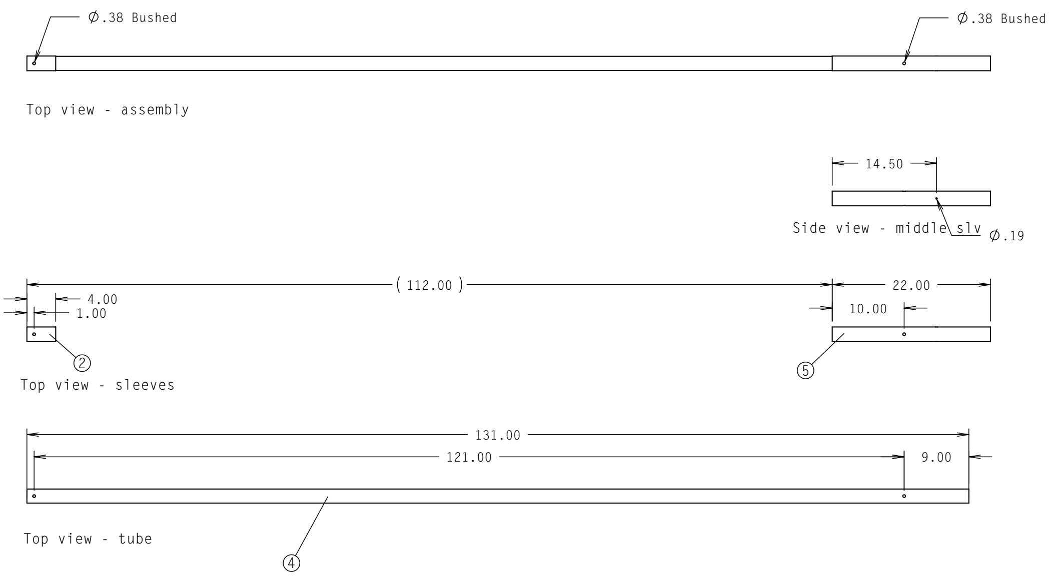


3.394 lb

WILLS WING
500 BLUERIDGE AVE ORANGE, CA 92865 PH/FAX (714) 998-6359 / 998-0647

TITLE: Eagle 145 Crossbar			PART NO: 40D-2100		REVISION: A	T.U.S. .X ± .05 .XX ± .015 .XXX ± .003 .XXXX ± .0005 ANGLES ± 1/2°
SLDDWF ID: Eagle 145 Airframe	MATERIAL: NA	DRAWN: 01-22-02	REVISED: NA	STATUS: Released	BY: PEARSON	

ITEM NO.	QTY.	PART NO.	DESCRIPTION
2	1	Eagle 164 Front LE front slv	52mm x 0.9mm 7075-T6
4	1	Eagle 145 Front LE tube	50mm x 0.9mm 7075-T6
5	1	Eagle 145 Front LE middle slv	52mm x 0.9mm 7075-T6



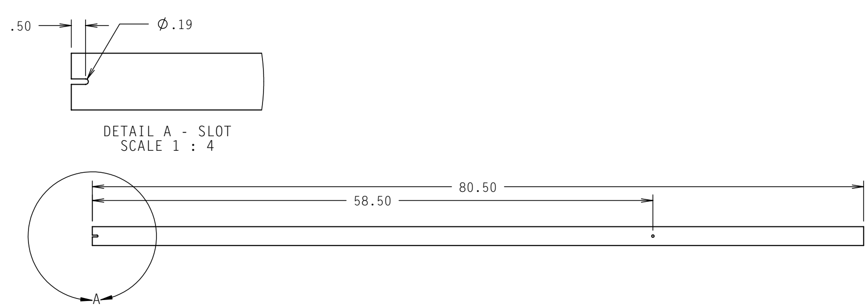
3.398 lb

500 BLUERIDGE AVE ORANGE, CA 92865 PH/FAX (714) 998-6359 / 998-0647

TITLE:	PART NO:	REVISION:	SLDDWF ID:	MATERIAL:	DRAWN:	REVISED:	STATUS:	BY:
Eagle 145 Front LE	40C-2200	A	Eagle 145 Airframe	NA	01-22-02	NA	Released	PEARSON

T.U.S. .X ± .05 .XX ± .015 .XXX ± .003 .XXXX ± .0005 ANGLES ± 1/2°

ITEM NO.	QTY.	PART NO.	DESCRIPTION
1	1	Eagle 164 Rear LE tube	50mm x 0.9mm 7075-T6



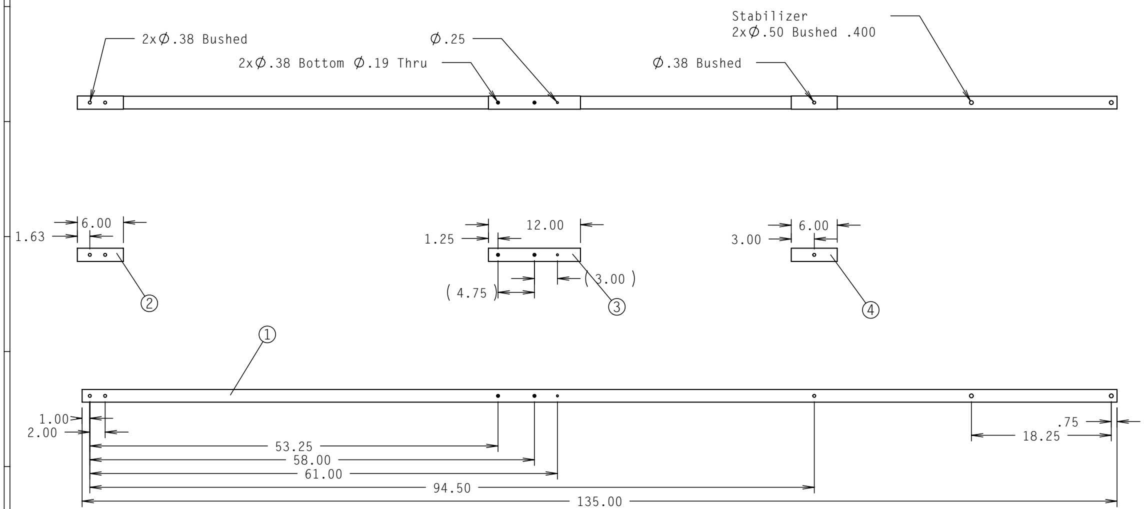
1.731 lb

500 BLUERIDGE AVE ORANGE, CA 92865 PH/FAX (714) 998-6359 / 998-0647

TITLE:	PART NO:	REVISION:	SLDDWF ID:	MATERIAL:	DRAWN:	REVISED:	STATUS:	BY:
Eagle 145/164/180 Rear LE	40C-3200	A	Eagle 145 Airframe	NA	01-22-02	NA	Released	PEARSON

T.U.S. .X ± .05 .XX ± .015 .XXX ± .003 .XXXX ± .0005 ANGLES ± 1/2°

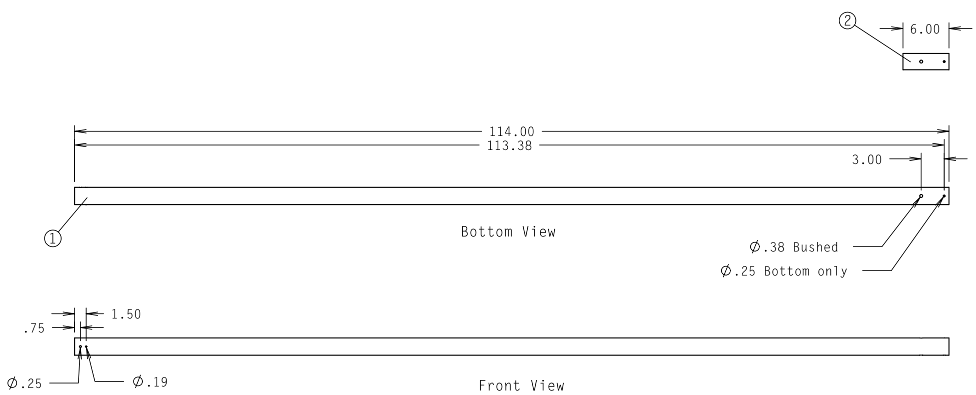
ITEM NO.	QTY.	PART NO.	DESCRIPTION
1	1	Eagle 164 Keel tube	42mm x 0.9mm 7075-T6
2	1	Eagle 164 Keel front slv	44mm x 0.9mm 7075-T6
3	1	Eagle 164 Keel middle slv	44mm x 0.9mm 7075-T6
4	1	Eagle 164 Keel rear slv	44mm x 0.9mm 7075-T6



2.875 lb

WILLS WING 500 BLUERIDGE AVE ORANGE, CA 92865 PH/FAX (714) 998-6359 / 998-0647	TITLE: Eagle 164 Keel		PART NO: 40B-1201		REVISION: A	T.U.S. .X ± .05 .XX ± .015 .XXX ± .003 .XXXX ± .0005 ANGLES ± 1/2°
	SLDDWF ID: Eagle Airframe	MATERIAL: NA	DRAWN: NA	REVISED: 1-22-02	STATUS: Released	BY: PEARSON

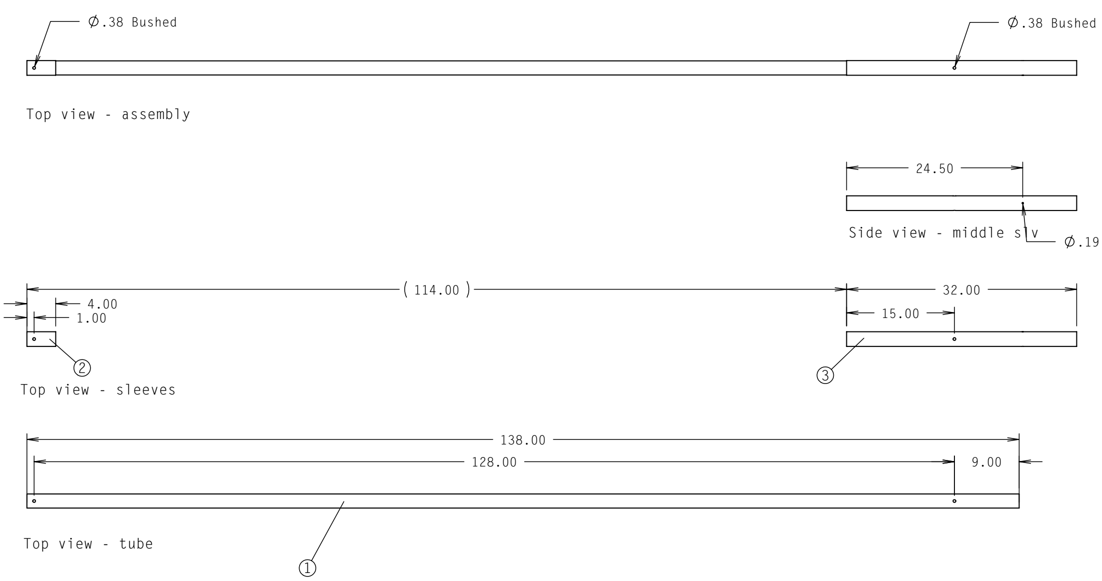
ITEM NO.	QTY.	PART NO.	DESCRIPTION
1	1	Eagle 164 Crossbar tube	2.25in x .049in 6061-T6
2	1	Eagle 164 Crossbar slv	2.25in x .049in 6061-T6 split internal sleeve



4.051 lb

WILLS WING 500 BLUERIDGE AVE ORANGE, CA 92865 PH/FAX (714) 998-6359 / 998-0647	TITLE: Eagle 164 Xbar		PART NO: 40D-2100		REVISION: A	T.U.S. .X ± .05 .XX ± .015 .XXX ± .003 .XXXX ± .0005 ANGLES ± 1/2°
	SLDDWF ID: Eagle Airframe	MATERIAL: NA	DRAWN: 01-22-02	REVISED: NA	STATUS: Released	BY: PEARSON

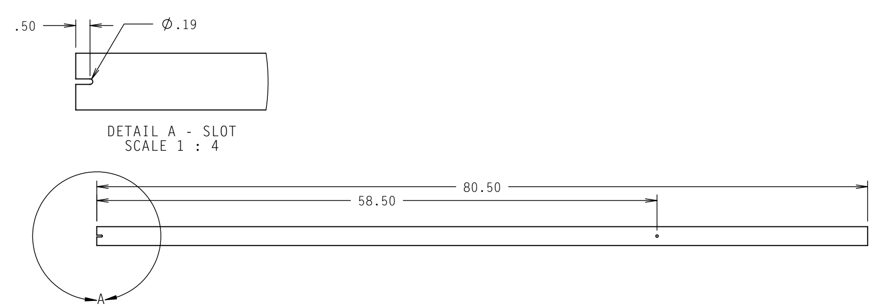
ITEM NO.	QTY.	PART NO.	DESCRIPTION
1	1	Eagle 164 Front LE tube	50mm x 0.9mm 7075-T6
2	1	Eagle 164 Front LE front slv	52mm x 0.9mm 7075-T6
3	1	Eagle 164 Front LE middle slv	52mm x 0.9mm 7075-T6



3.772 lb

WILLS WING 500 BLUERIDGE AVE ORANGE, CA 92865 PH/FAX (714) 998-6359 / 998-0647	TITLE: Eagle 164 Front LE			PART NO: 40C-2200		REVISION: A	T.U.S. .X ± .05 .XX ± .015 .XXX ± .003 .XXXX ± .0005 ANGLES ± 1/2°
	SLDDWF ID: Eagle Airframe	MATERIAL: NA	DRAWN: 01-22-02	REVISED: NA	STATUS: Released	BY: PEARSON	

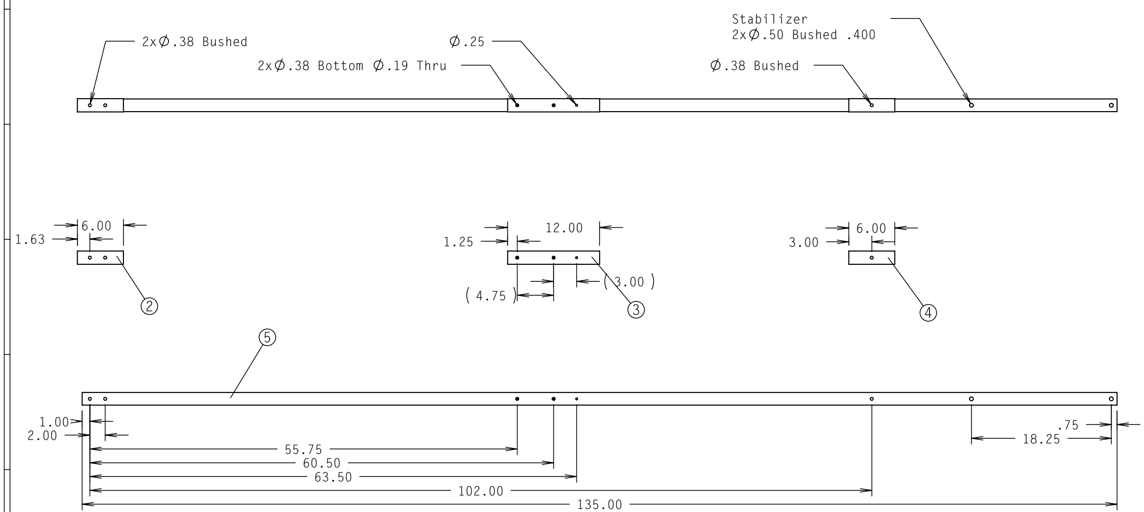
ITEM NO.	QTY.	PART NO.	DESCRIPTION
1	1	Eagle 164 Rear LE tube	50mm x 0.9mm 7075-T6



1.731 lb

WILLS WING 500 BLUERIDGE AVE ORANGE, CA 92865 PH/FAX (714) 998-6359 / 998-0647	TITLE: Eagle 145/164/180 Rear LE			PART NO: 40C-3200		REVISION: A	T.U.S. .X ± .05 .XX ± .015 .XXX ± .003 .XXXX ± .0005 ANGLES ± 1/2°
	SLDDWF ID: Eagle Airframe	MATERIAL: NA	DRAWN: 01-22-02	REVISED: NA	STATUS: Released	BY: PEARSON	

ITEM NO.	QTY.	PART NO.	DESCRIPTION
2	1	Eagle 164 Keel front slv	44mm x 0.9mm 7075-T6
3	1	Eagle 164 Keel middle slv	44mm x 0.9mm 7075-T6
4	1	Eagle 164 Keel rear slv	44mm x 0.9mm 7075-T6
5	1	Eagle 180 Keel tube	42mm x 0.9mm 7075-T6



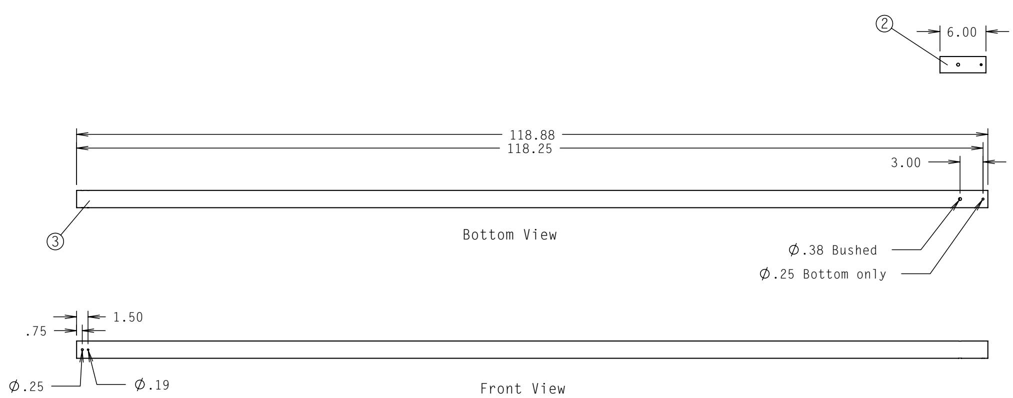
2.875

500 BLUERIDGE AVE ORANGE, CA 92865 PH/FAX (714) 998-6359 / 998-0647

TITLE:	PART NO:	REVISION:	T.U.S.
Eagle 180 Keel	40B-1201	A	.X ± .05 .XX ± .015 .XXX ± .003 .XXXX ± .0005 ANGLES ± 1/2°

SLDDWF ID:	MATERIAL:	DRAWN:	REVISED:	STATUS:	BY:
Eagle 180 Airframe	NA	01-22-02	NA	Released	PEARSON

ITEM NO.	QTY.	PART NO.	DESCRIPTION
2	1	Eagle 164 Crossbar slv	2.25in x .049in 6061-T6 split internal sleeve
3	1	Eagle 180 Crossbar tube	2.25in x .049in 6061-T6



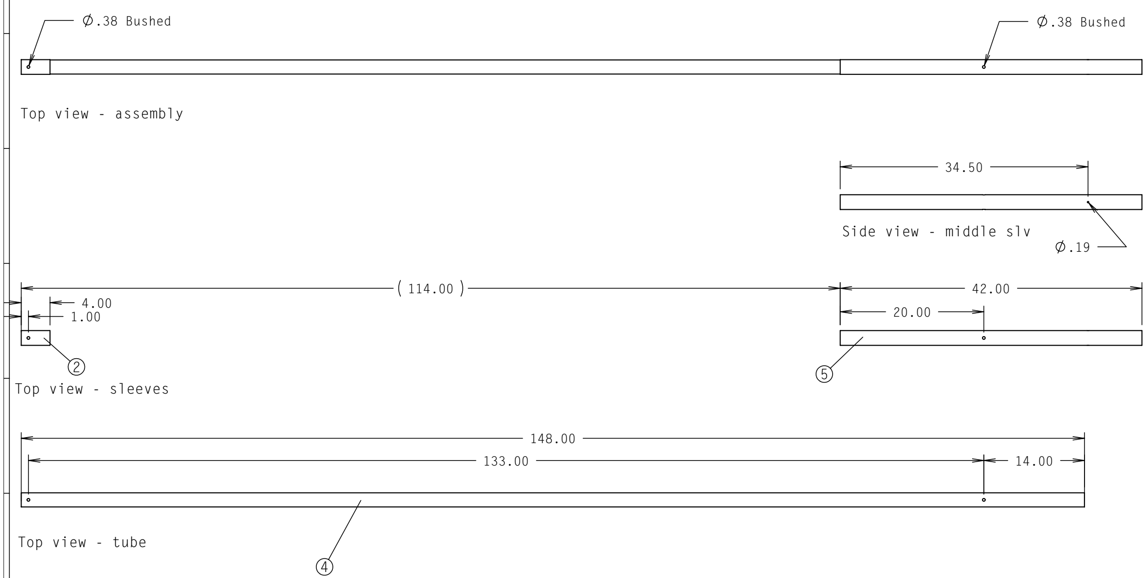
4.216

500 BLUERIDGE AVE ORANGE, CA 92865 PH/FAX (714) 998-6359 / 998-0647

TITLE:	PART NO:	REVISION:	T.U.S.
Eagle 180 Crossbar	40D-2100	A	.X ± .05 .XX ± .015 .XXX ± .003 .XXXX ± .0005 ANGLES ± 1/2°

SLDDWF ID:	MATERIAL:	DRAWN:	REVISED:	STATUS:	BY:
Eagle 180 Airframe	NA	01-22-02	NA	Released	PEARSON

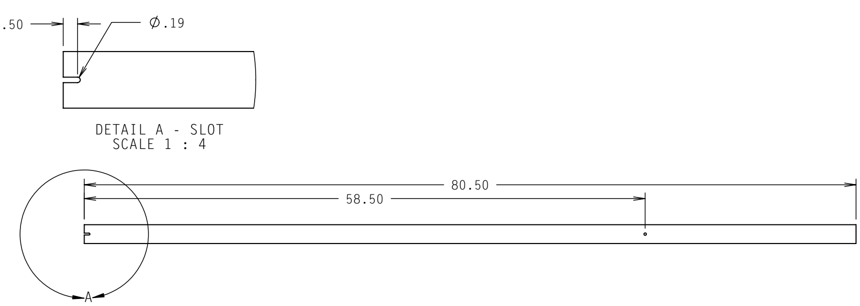
ITEM NO.	QTY.	PART NO.	DESCRIPTION
2	1	Eagle 164 Front LE front slv	52mm x 0.9mm 7075-T6
4	1	Eagle 180 Front LE tube	50mm x 0.9mm 7075-T6
5	1	Eagle 180 Front LE middle slv	52mm x 0.9mm 7075-T6



0.000 lb

WILLS WING 500 BLUERIDGE AVE ORANGE, CA 92865 PH/FAX (714) 998-6359 / 998-0647	TITLE: Eagle 180 Front LE			PART NO: 40C-2202	REVISION: A	T.U.S. .X ± .05 .XX ± .015 .XXX ± .003 .XXXX ± .0005 ANGLES ± 1/2°
	SLDDWF ID: Eagle 180 Airframe	MATERIAL: NA	DRAWN: 01-22-02	REVISED: NA	STATUS: Released	BY: PEARSON

ITEM NO.	QTY.	PART NO.	DESCRIPTION
1	1	Eagle 164 Rear LE tube	50mm x 0.9mm 7075-T6



1.731 lb

WILLS WING 500 BLUERIDGE AVE ORANGE, CA 92865 PH/FAX (714) 998-6359 / 998-0647	TITLE: Eagle 145/164/180 Rear LE			PART NO: 40C-3200	REVISION: A	T.U.S. .X ± .05 .XX ± .015 .XXX ± .003 .XXXX ± .0005 ANGLES ± 1/2°
	SLDDWF ID: Eagle 180 Airframe	MATERIAL: NA	DRAWN: 01-22-02	REVISED: NA	STATUS: Released	BY: PEARSON