Wills Wing

SPORT AT 150, 167, 180

Owner / Service Manual

TECHNICAL INFORMATION AND PLACARDED OPERATING LIMITATIONS

The Sport AT has been tested and found to comply with the HGMA Airworthiness Standards. These standards require:

1) A positive load test at root stall angle of attack at a speed of at least 65 mph for at least three seconds without failure.

2) A negative 30 degree angle of attack load test at a speed of at least 46 mph for at least 3 seconds without failure.

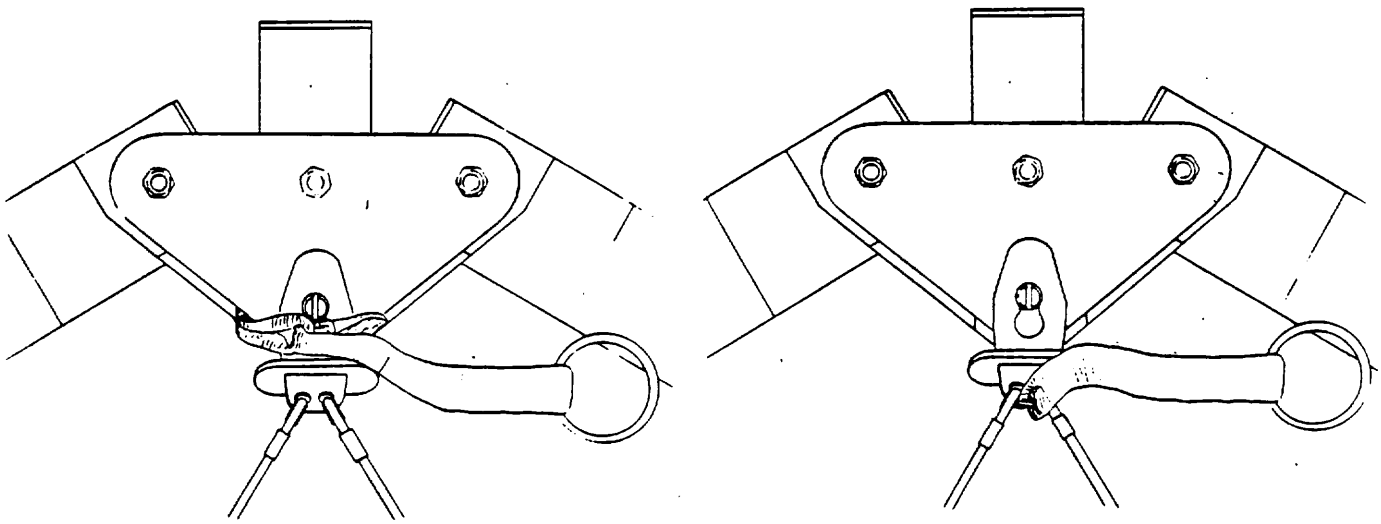
3) A negative 150 degree angle of attack load test at a speed of at least 32 mph for at least 3 seconds without failure.

4) Pitch tests at speeds of 20 mph, 30 mph and 40 mph which show the glider to be stable over a range of angles of attack from trim to negative 20 degrees at 20 mph and from trim to negative 10 degrees at 30 mph and from trim to zero lift angle of attack at 40 mph.

5) Flight maneuvers which show the glider to be adequately stable and controllable throughout the normal range of operation.

NOTE: The Sport AT has been designed for footlaunched soaring flight. It has been not designed to be motorized, tethered, or towed. It has been towed successfully using the ATOL truck towing system, and it is approved for towing in this manner **provided that all specific ATOL procedures and safeguards are followed. It is the pilot's obligation to contact ATOL directly for all recommended proceedures for using the ATOL tow system.**

In particular, please note the diagrams below showing the correct and incorrect way to attach a nose line for ATOL towing. Attaching the line incorrectly may result in the bottom front wires becoming disconnected during release from the tow vehicle resulting in loss of control of the glider.



CORRECT **WRONG - UNSAFE !**

VIEW FROM BELOW THE NOSEPLATE

Flight operation of the Sport AT 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 Sport AT will resist spinning, and 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. No attempt should ever be made to deliberately spin the glider, as loss of control, in flight inversion, and structural failure may result.

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 46 mph, which is the placarded VNE (speed never to exceed) of the glider. Depending on pilot weight, trim of the glider and harness design, a higher steady state speed may be achievable. In rough air, or when abrupt maneuvering is anticipated, the Sport AT should not be flown faster than 46 mph, as there is a potential risk of structural failure.

The stall speed of the Sport AT at maximum recommended wing loading is 25 mph. The top (steady state) speed at minimum recommended wing loading is 46 mph.

The recommended hook in pilot weight ranges for the Sport AT's are:
AT 150: 125 - 210 lbs.
AT 167: 140 - 240 lbs.
AT 180: 175 - 300 lbs.

A minimum USHGA Intermediate (III) level of pilot proficiency is required to fly the Sport AT safely. Operation of the glider by unqualified pilots may be dangerous.

Operating the Sport outside of the above limitations may result in injury and death. Flying the Sport AT 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.

Sport AT BREAKDOWN PROCEDURE FOR SHIPPING AND RE-ASSEMBLY PROCEDURE

The Sport AT can be broken down to approximately 13.5 feet by removal of the rear leading edges.

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.
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. Mark a line along the leading edge across the joint between front and rear leading edge on each leading edge. This mark will guide you in properly realigning the rear leading edges into the fronts during re-assembly.

3) If the mylar is to be removed from the mylar pocket, do so at this time. At the tip, inside the sail under the mylar pocket, make a small hole and tie or securely tape a 25' long piece of leech line to the mylar. Remove the top plastic kingpost cap and disconnect the top side wire from the kingpost. Replace the cap. Pull the top side wire through to the inside of the sail. Pull the sail back down the length of the leading edge but do not remount it to the rear. Pull the mylar out from the nose of the glider, curling it under where it exits the front of the mylar pocket to that it will fit through the opening. If the mylar sticks, work up and down the edges of the mylar along the mylar pocket, breaking the edges of the mylar away from the seamstick tape in the seams.
4) Spray silicone spray lubricant on the rear leading edge at the point where it exits from the front.
6) Remove the small safety ring and then the 3/16" clevis pin which secures the rear leading edge in the front. Pull the rear leading edge straight aft to disengage it from the front. Put tape on the sharp edges of the front end of the rear leading edge tubes, and on the rear end of the front leading edge tubes.
7) Carefully fold the rear of the sail over against the front, and replace the bag on the glider.

RE-MOUNTING THE REAR LEADING EDGES IN THE FRONT.

1) Make sure you are mounting the correct leading edge rear into the correct front (check "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 alignment of the clevis pin hole.
4) Re-install the top side wire if removed.
5) Pull the sail down the leading edge and re-intall the mylar if removed. **CAUTION: IF YOU USED TAPE TO PULL THE STRING INTO THE MYLAR POCKET, YOU WILL HAVE TO PUNCH A HOLE IN THE MYLAR AND TIE THE STRING TO THE MYLAR TO RE-INTALL IT. OTHERWISE THE STRING WILL PROBABLY COME DETACHED FROM THE MYLAR.**
6) Remount the sail to the rear leading edge, making sure to align the sail mount webbing square in the slot and attach the securing velcros.

Sport AT SET UP PROCEDURE

1) With the glider in the bag, lay the glider on the ground, zipper up with the nose into the wind.

2) Undo the zipper, remove the battens and the control bar cover bag.

3) Lift the control bar and attach the basetube to the upright, using the bolt, wingnut and safety provided.

4) Flip the glider upright on the control bar, and remove the bag and all velcro ties. If there is more than five mph of wind, turn the glider 90 degrees to the wind.

5) Spread the wings almost all the way. Lift the kingpost and set in on the kingpost base, *making sure the CG locating pin engages in one of the slots in the track.* **MAKE SURE YOU SET THE KINGPOST IN THE PROPER SLOT SO THAT YOUR CG IS THE DESIRED POSITION.** (You may see only one slot, if the other one was taped over at the factory following the test flight.) Usually, the correct trim will be obtained with the CG in one of the two middle adjustments of the four positions available. (See the diagram for an illustration of the four possible positions.) If the pin is in the forward of the two holes in the kingpost base, then the pin should be set in the forward of the two slots on top of the keel. This will give the forward middle CG adjustment. If the pin is in the aft hole in the base, the aft slot will give the aft middle CG adjusment. The forward hole in the base in combination with the aft slot on the keel gives the full aft CG adjustment, and the aft hole / forward slot gives the full forward CG adjustment.

6) Attach the top rear wire to the rear keel bolt, making sure that the bridle cables are located appropriately either inside the top rear wire or outside the top rear wire, as indicated by the position of the bridle pigtail relative to the top rear wire. *Whenever you attach a keyhole tang to its special bolt, always immediately apply the rubber safety to ensure that the tang does not slip out of proper engagement.* Attach the bridles by hooking the bridle ring into the snap clip on the pigtail.

7) Install the washout tips. This is best done by positioning the button spring on the washout tip so it points towards the aft end of the leading edge tube, and then inserting the washout tip straight into the plastic receptacle. Once the washout tip is fully engaged into the receptacle, rotate the tip slightly until you feel the button spring engage in the hole in the receptacle inside the leading edge.

8) Check the curved top surface battens for side to side symmetry and install them in the sail.

9) Spread the wings all the way and check all cables for any twisted thimbles or tangled cables.

10) Standing under the glider just in front of and facing the control bar, pass the perlon line attached to the xbar wire around the top of the downtube, back through the thimble on the crossbar wire and pull back on the perlon to pull the crossbar back. When you have the crossbar back far enough to attach the sweep wire, wrap the perlon line around the top of the downtube and temporarily tie it off. Install the crossbar sweep wire restraint bolt through the keel, attach the thimble for the sweep wire on the other side, and secure it with the wingnut and safety provided.

11) Attach the bottom front wires to the bottom of the nose.

12) Install the bottom surface battens and the plug in #1 battens.

13) Push the nose batten all the way back into the sail until the tip lies above the top of the keel.

14) Do a complete pre-flight of the assembled glider, checking all nuts, bolts, safeties, fittings, cables, battens, etc. Check that the sail mount webbing is secured properly in the slotted endcaps and that there are no tears in the sail material along the trailing edge.

15) Install the nose cone, and the plastic wing tip covers by pressing the mating velcro surfaces together.

16) Hook in to the glider and do a static hang check to check your hang position and your harness.

LAUNCHING AND FLYING THE Sport AT

1) If the wind is more than 10 mph or gusty you should have at least one assistant on your nose wires on launch. 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 Sport AT are typical of a high 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 better control.

USING WING TUFTS

Your Wills Wing glider has been equipped from the factory with 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 MSA) 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 MSA 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 unknowlingly 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 preceeding 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. MSA 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 MSA 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

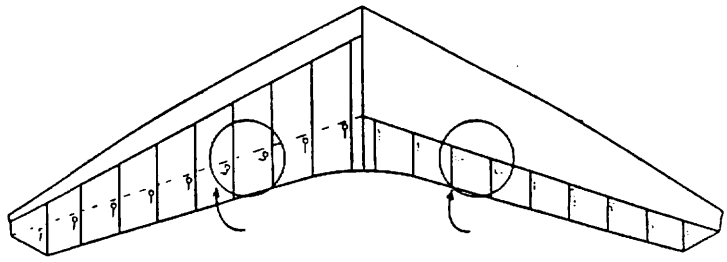
On a flex wing hang glider, the wing experiences a gradual and progressive stall, and different spanwise stations of the wing stall at different angles of attack. Contrary to popular belief, a hang glider wing does not stall first in the root or center section. It is true that because of wing twist the 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. Specifically, a flex wing hang glider stalls first somewhere in the midspan of each wing, approximately one third of the way out from the root to the tip, where your tufts are located. As the angle of attack is raised further, the stall propagates both outwards towards the tips and inwards 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.

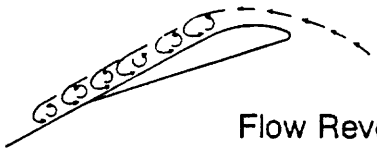
During normal flight the flow will be chordwise along the wing, and the tufts will point towards the trailing edge. When the wing stalls, the tufts will reverse direction, indicating the local flow towards the leading edge. At the first onset of stall, the tufts will indicate the impending separation by first wiggling, and then deflecting spanwise, before they fully reverse and point forward. The first onset of stall in the midspan 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.

Normal Flow

First Onset Of Midspan Stall





Flow Reversal At Stall Onset

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. 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 if you use one, 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 accesible 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 MSA 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.

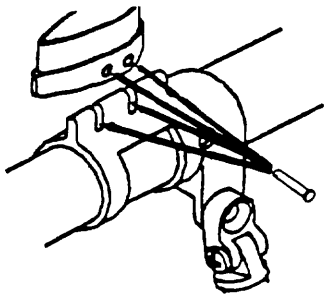
Of course in a turn, your minimum sink SPEED goes up because you are banked, and the bank effectively increases your wing loading which increases your flying SPEED for any angle of attack. But note this: THE TUFTS INDICATE ANGLE OF ATTACK, WITHOUT REGARD TO AIRSPEED! Therefore, if you practice flying 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.

Also be aware that in some thermalling situations, such as when trying to maximize climb rate in a thermal with a very strong and very small core, there may be an advantage in overall effective climb performance to flying so slowly that some portion of the inside wing is partially stalled most of the time. This is, however, an advanced and potentially dangerous technique - it is the beginning of a spin entry, and if pushed just a little too far can result in a sudden and extreme loss of control and / or altitude. In general, if the tufts are indicating flow reversal associated with the stall, you will improve both performance and controllability by pulling in and speeding up a little.

One final caution: from time to time a tuft may to stick 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. The CG on the Sport AT is adjustable in four positions; by moving the pin in the base of the kingpost to one of two holes, and by installing the pin in one of two slots in the ridge on top of the keel center bracket. If the pin is in the forward of the two holes in the kingpost base, and the pin is set in the forward of the two slots on top of the keel, this will give the forward middle CG adjustment. If the pin is in the aft hole in the base, the aft slot will give the aft middle CG adjusment. The forward hole in the base in combination with the aft slot on the keel gives the full aft CG adjustment, and the aft hole / forward slot gives the full forward CG adjustment. Each increment of adjustment is 5/8", or about two miles per hour, and the total range is 1 7/8".



The best way to set your CG is to decide first where you want to trim relative to your minimum sink speed. Some pilots like to trim at minimum sink, (because they don't like to push out all the time in thermals). Other pilots prefer to trim somewhere between minimum sink and best L/D (because they don't like to pull in against heavy bar pressure during long glides at high speed).

Once you have decided where to trim relative to minimum sink speed, use the method above to find minimum sink speed and adjust the hang point location accordingly. We recommend that you not trim your glider below MSA.

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 situtation. 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.

LANDING THE Sport AT

Landing approaches are best done with a long straight final into the wind at a speed above best L/D speed. Fly the glider down to within just a few feet of the ground, and bleed off excess speed in ground effect while keeping the wings level and the nose into the wind. Your body position should be inclined with your head and shoulders forward and your feet and legs trailing behind, with your hands at shoulder width and shoulder height on the uprights. As the glider begins to settle in a mush, give a sharp aggressive flare and allow your feet to swing under you as the glider's forward motion is arrested.

Sport AT BREAKDOWN

Breakdown is the exact reverse of assembly.

1) Remove the nose cone and plastic wing tips, the number one battens and washout tips, the bottom nose wires, and pull the nose batten out two inches past the noseplate.

2) Detach the bridles.

3) Use the perlon as you did during set up to pull the crossbar back and take the load off the sweep wires. Detach the crossbar anchor cables and detension the sail.

4) Remove all the battens.

5) Detach the top rear wire.

6) Remove the kingpost from the kingpost base and lay it down on top of the keel.

7) Fold the wings in and pull the sail over the top of the leading edges. Roll the straight battens and the washout tips in the sail, and tie the sail with the velcros provided. We recommend that you roll and tie each side of the sail separately.

8) Put the bag on the glider, flip it over and lay it down.

9) Detach the upright from the basetube, and fold up the control bar. Put the cover bag on the control bar and pull it all the way forward so that you can insert the two pads sewn to the forward end of the bag in between the control bar apex hardware and the leading edges. Put the batten bag on the battens. Lay the battens between the rear leading edges and lay the control bar against the keel. Zip up the bag.

Sport AT 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, by washout tips which are factory set at 11 degrees above the horizontal plane and are not adjustable, and by reflex support bridles running from the kingpost to the trailing edge at the number 4 and 6 battens. Correct attachment and proper adjustment of these bridles are critical to providing adequate stability at low angles of attack, particularly those below the normal operating range.

REFLEX BRIDLE ADJUSTMENT

Proper adjustment of the reflex support bridles is obtained when, in flight, under a normal one G load, the bridle cables are as tight as they can be without being so tight as to actually pull up on the trailing edge of the sail.

Adjustment of the bridles is achieved by replacing the bridle pigtail (the short wire from the kingpost top with the snap hook on the end) with one of a shorter or longer length. We recommend changing the length of this pigtail in 1/2" increments, and re-checking the bridles in flight after each change.

The proper method for checking bridle adjustment is to sight the shadow of the bridles on the sail while making shallow bank angle minimum sink rate turns. When the shadow of both bridles is visible on one wing of the sail, give the control bar a sharp, short shake and watch the shadow of the bridles. What you are looking for is a shallow catenary in the shadow of the cables that moves only a couple of inches when you shake the bar. If the bridles appear tight, like the strings on a guitar, they are adjusted too tight. If they are hanging loose, in a large, free swinging catenary that moves several inches across the sail when you shake the bar, they are too loose.

As a starting point to adjusting the bridles, the bridles should be set so that a tape measure hooked over the top front wire at the kingpost cap and extended to the intersection of the batten pocket seamed edge and the sail trailing edge measures as follows:

Sport AT 150 Inner: 69.875"
Sport AT 150 Outer: 89.5"

Sport AT 167 Inner: 70.75"
Sport AT 167 Outer: 120.25"

Sport AT 180 Inner: 85.125"
Sport AT 180 Outer: 124.0"

MAINTENANCE SCHEDULE:

Wills Wing recommends that all maintenance be performed by an authorized Wills Wing service center.
You should continually maintain your glider in a proper state of tune and repair to insure optimum performance and flight characteristics. Following any mishap that results in damage to the glider immediately have any damaged component repaired or replaced. We reommend 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 zippers on the glider with silicone spray lubricant. Also spray your battens as you install them in the glider to lubricate the insides of the batten pockets. Do not use any other type of lubricant.

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 damgage or wear. Inspect the tubes for straightness and for signs of corrosion.

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 dissassembled, flushed liberally with fresh water, dried completely, and treated for corrosion inhibition with LPS-3.

TUNING

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 assymetry in the glider. If you have a turn, first pursue symmetry in every component and adjustment on the glider.

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 (sight the height of each washout tube relative to the other by standing at the nose with the glider about level in pitch and sighting each washout tip over the high point of the nose batten).

BATTENS

Check the battens for symmetrical shape and batten string tension.

SAIL TENSION

Check for symmetrical sail tension on the leading edges (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 from inside the sail mount plugs on the rear ends of the leading edges.

SAIL PLUG ROTATIONAL ALIGNMENT

Check for symmetry in the alignment of the sail mount at the tips. (Raise the number two batten until the bottom surface at the tip just goes tight, and see how high off the washout tip the batten is.)

After you have made everything symmetrical, if you still have a turn, remove the sail mount plug from the wing away from which the glider is turning. Drill out the pop rivet that secures the slotted endcap in the plug, and twist the plug one rivet hole diameter in such a direction so as to raise the trailing edge of the sail on that wing. Install a new rivet and re-install the plug in the leading edge, and the sail onto the plug.

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 quite tight, and you will not be able when they are properly adjusted, to install then unless the crossbar is tensioned.

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. As the glider gets older and the sail stretches, you will need to add shims to maintain the proper tension.

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: SPORT AT 150
MANUFACTURED BY: Wills Wing, Inc.

All dimensions in inches, weights in lbs.
NOTE: These specifications are intended only as a guideline for determining whether or not 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 : 54 - 56
2) Leading edge dimensions:
    a) Nose plate anchor hole to:
        1) crossbar attachment hole: 131
        2) rear sail attachment point: 214.75 - 215.75
    b) Outside diameter at:
        1) Nose: 2.05
        2) Crossbar: 2.05
        3) Rear sail attachment point: 2.05
3) Crossbar dimesions:
    a) Overall pin to pin length from leading edge attachments point to hinge bolt at glider centerline: 119.9
    b) Largest outside diameter: 2.36 or 2.44
4) Keel dimensions; least and greatest allowable distances from the line joining the leading edge nose bolts to:
    a) The xbar center load bearing pin: 39.75 - 40.75
    b) The pilot hang loop: 53.75 - 55.75
5) Sail dimensions
    a) Chord lengths at
        1) 3 ft outboard of centerline: 73
        2) 3 ft inboard of tip: 44
    b) Span of sail (extreme tip to tip): 378
6) Location of information placard: keel
7) Recommended pilot weight range: 125 - 210
8) Recommended pilot proficiency: USHGA Intermediate (III)

NOTE: 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; by washout tips which are factory set at 11 degrees above the horizontal plane and cannot be adjusted, and by reflex support bridles running from the kingpost to the trailing edge at the number five and seven battens. Proper adjustment of these bridles is critical to the safety of the glider, and is described elsewhere in this manual.

HGMA COMPLIANCE VERIFICATION SPECIFICATION SHEET

GLIDER MODEL: SPORT AT 167
MANUFACTURED BY: Wills Wing, Inc.

All dimensions in inches, weights in lbs.
NOTE: These specifications are intended only as a guideline for determining whether or not 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 : 60
2) Leading edge dimensions:
    a) Nose plate anchor hole to:
        1) crossbar attachment hole: 131
        2) rear sail attachment point: 232 - 233.5
    b) Outside diameter at:
        1) Nose: 2.05
        2) Crossbar: 2.05
        3) Rear sail attachment point: 2.05
3) Crossbar dimesions:
    a) Overall pin to pin length from leading edge attachments point to hinge bolt at glider centerline: 119.9
    b) Largest outside diameter: 2.44
4) Keel dimensions; least and greatest allowable distances from the line joining the leading edge nose bolts to:
    a) The xbar center load bearing pin: 40 - 43
    b) The pilot hang loop: 58 - 60
5) Sail dimensions
    a) Chord lengths at
        1) 3 ft outboard of centerline: 76.5
        2) 3 ft inboard of tip: 45.25
    b) Span of sail (extreme tip to tip): 402
6) Location of information placard: keel
7) Recommended pilot weight range: 140 - 240
8) Recommended pilot proficiency: USHGA Intermediate (III)

NOTE: 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; by washout tips which are factory set at 11 degrees above the horizontal plane and cannot be adjusted, and by reflex support bridles running from the kingpost to the trailing edge at the number five and seven battens. Proper adjustment of these bridles is critical to the safety of the glider, and is described elsewhere in this manual.

HGMA COMPLIANCE VERIFICATION SPECIFICATION SHEET

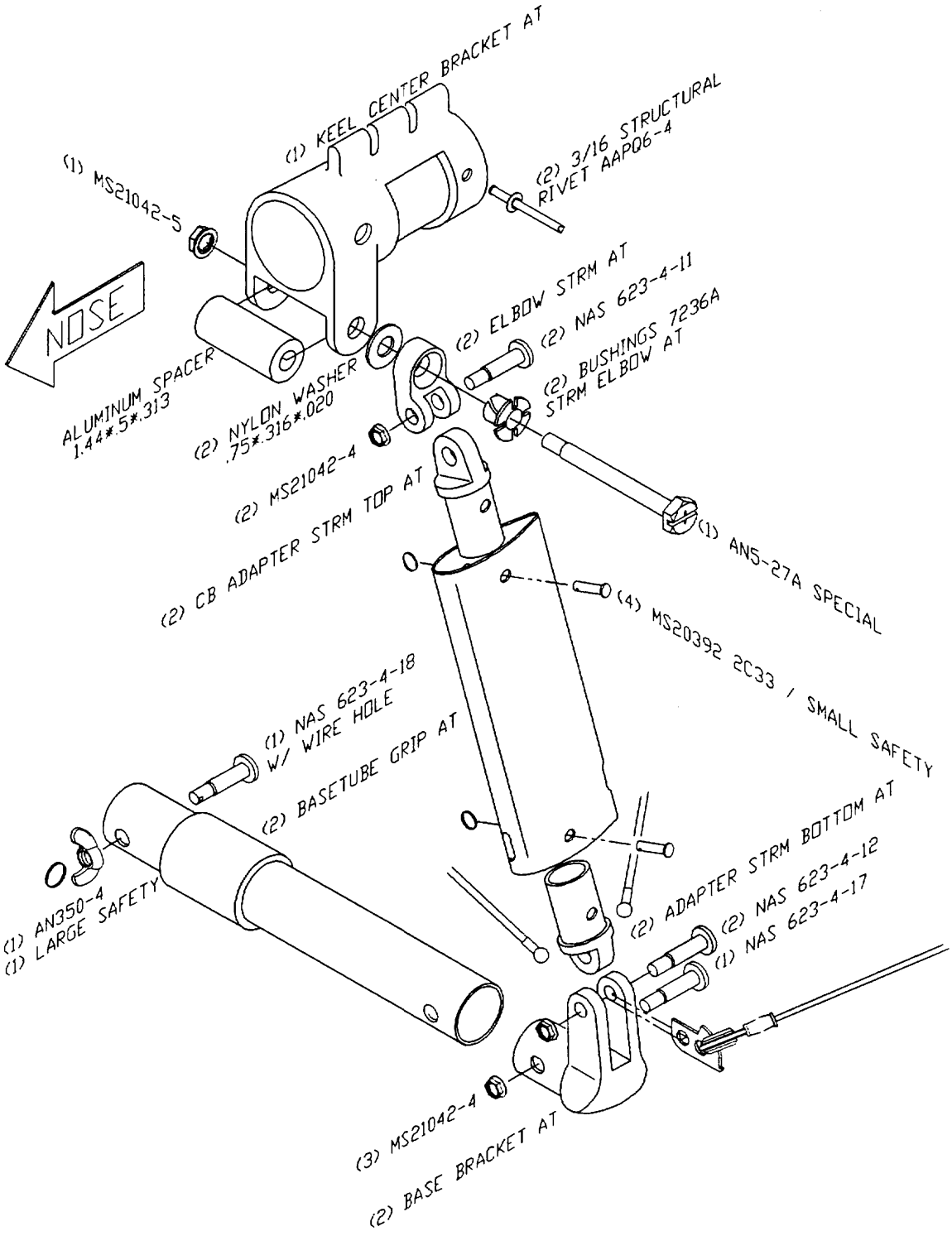
GLIDER MODEL: SPORT AT 180
MANUFACTURED BY: Wills Wing, Inc.

All dimensions in inches, weights in lbs.
NOTE: These specifications are intended only as a guideline for determining whether or not 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.

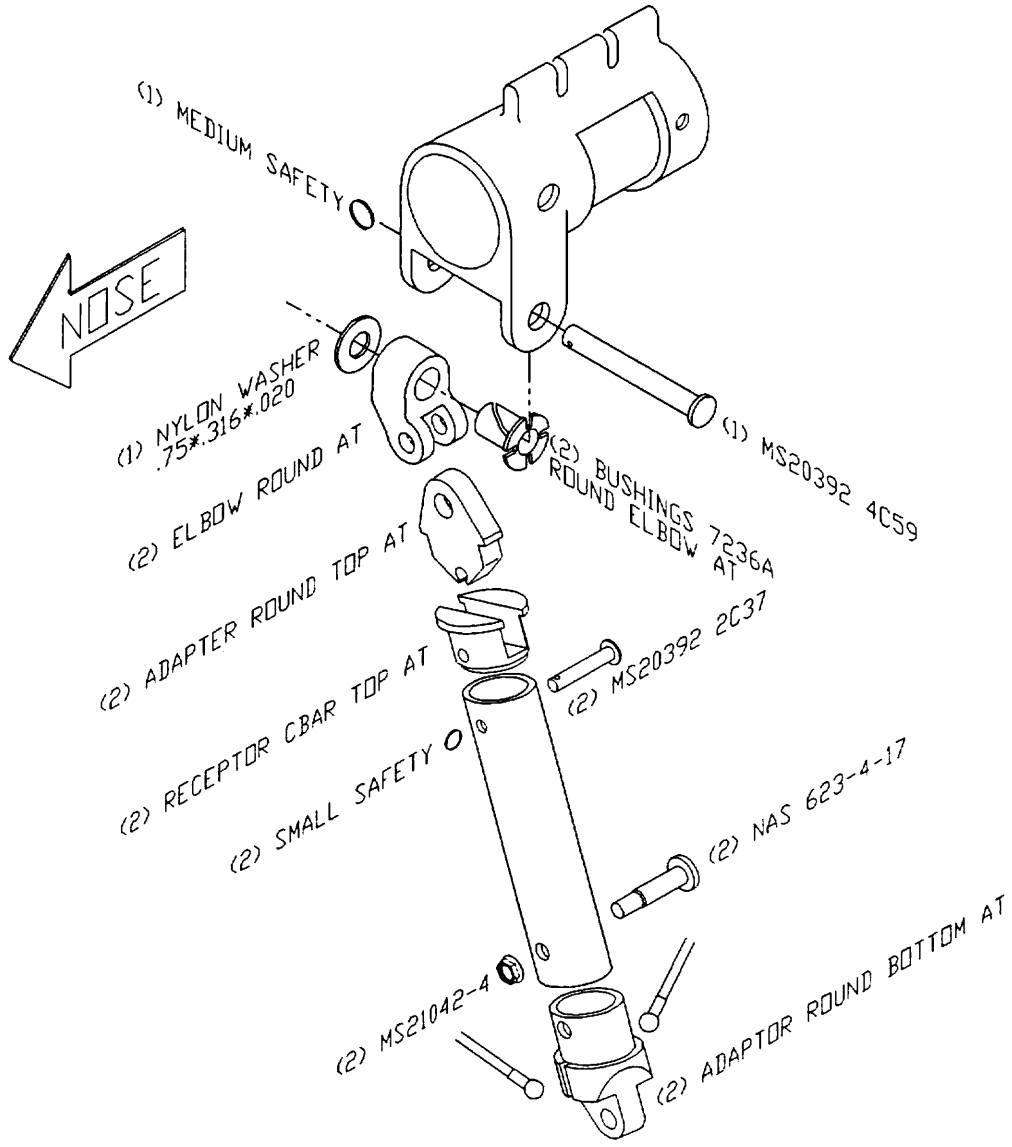
1) Weight of glider with all essential parts and without coverbags and non-essential parts : 68 - 70
2) Leading edge dimensions:
    a) Nose plate anchor hole to:
        1) crossbar attachment hole: 137
        2) rear sail attachment point: 236.9 - 238.4
    b) Outside diameter at:
        1) Nose: 2.05
        2) Crossbar: 2.05
        3) Rear sail attachment point: 2.05
3) Crossbar dimesions:
    a) Overall pin to pin length from leading edge attachments point to hinge bolt at glider centerline: 123.75
    b) Largest outside diameter: 2.5
4) Keel dimensions; least and greatest allowable distances from the line joining the leading edge nose bolts to:
    a) The xbar center load bearing pin: 49 +/- 1/2
    b) The pilot hang loop: 59.75 - 61.75
5) Sail dimensions
    a) Chord lengths at
        1) 3 ft outboard of centerline: 81
        2) 3 ft inboard of tip: 43
    b) Span of sail (extreme tip to tip): 412
6) Location of information placard: keel
7) Recommended pilot weight range: 175 - 300
8) Recommended pilot proficiency: USHGA Intermediate (III)

NOTE: 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; by washout tips which are factory set at 11 degrees above the horizontal plane and cannot be adjusted, and by reflex support bridles running from the kingpost to the trailing edge at the number five and seven battens. Proper adjustment of these bridles is critical to the safety of the glider, and is described elsewhere in this manual.

AT – REV 7/25/90

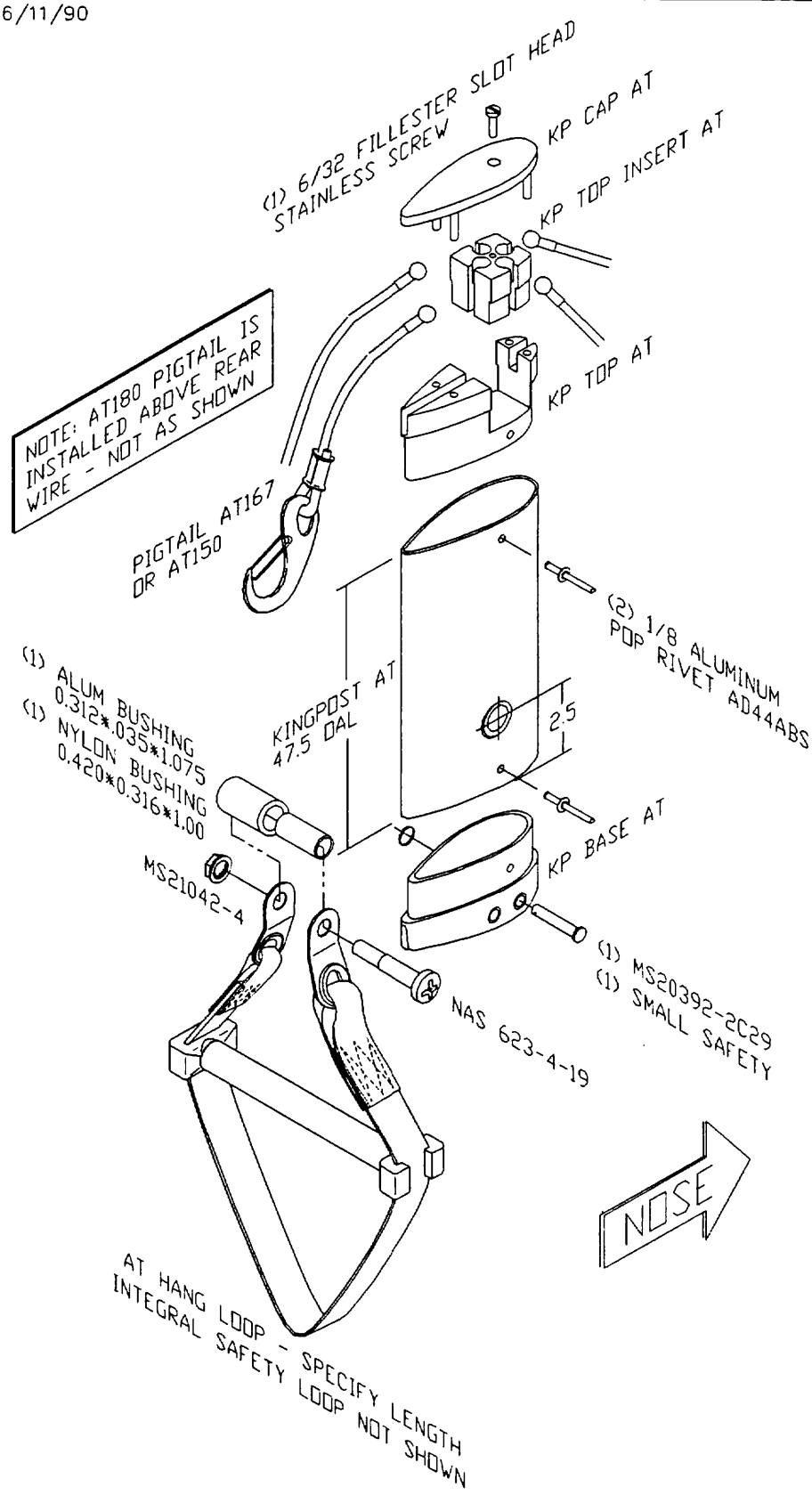


AT STREAMLINE CONTROL BAR ASSEMBLY



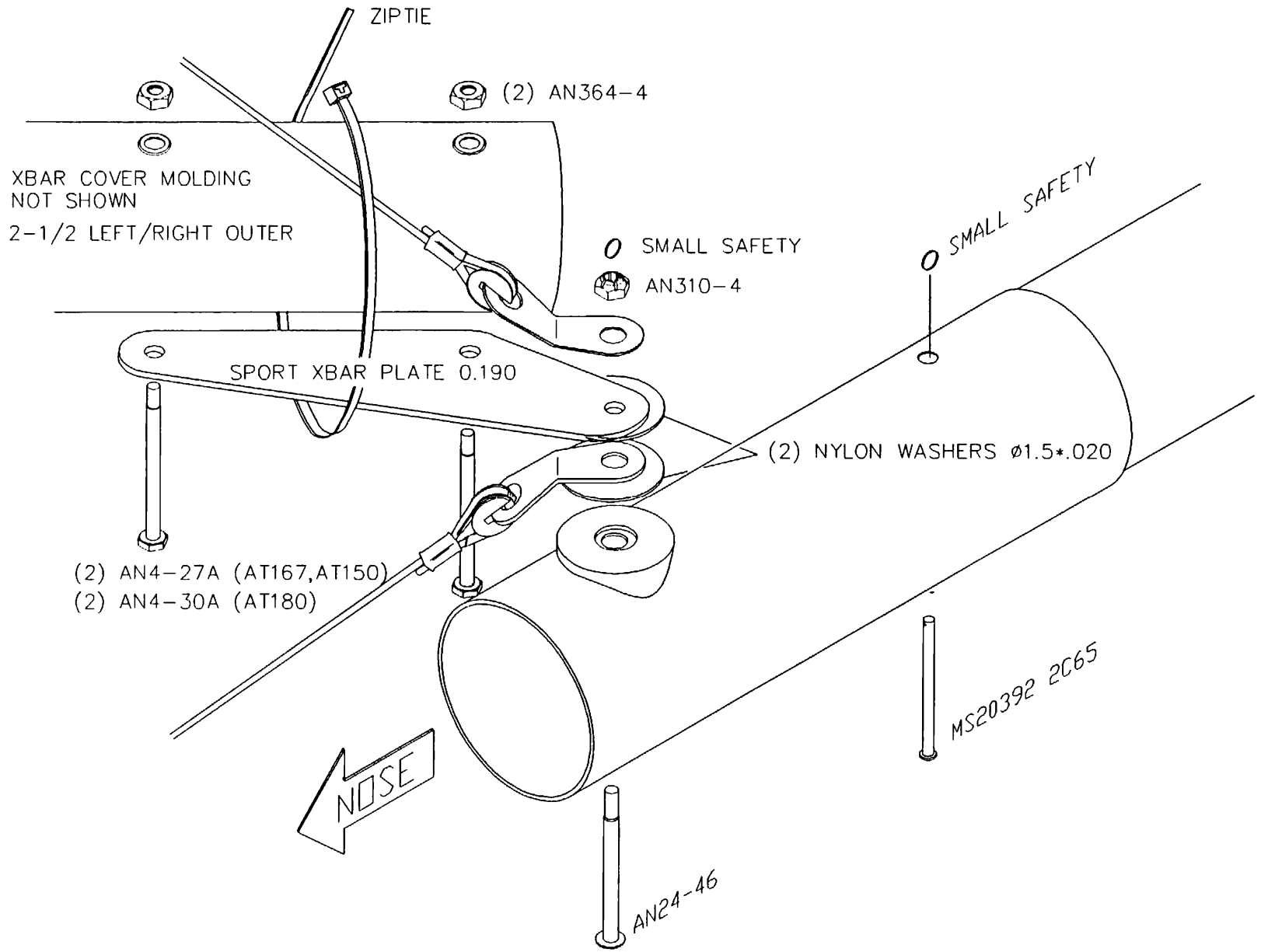
AT ROUND CONTROL BAR ASSEMBLY

SPORT AT – REV 6/11/90



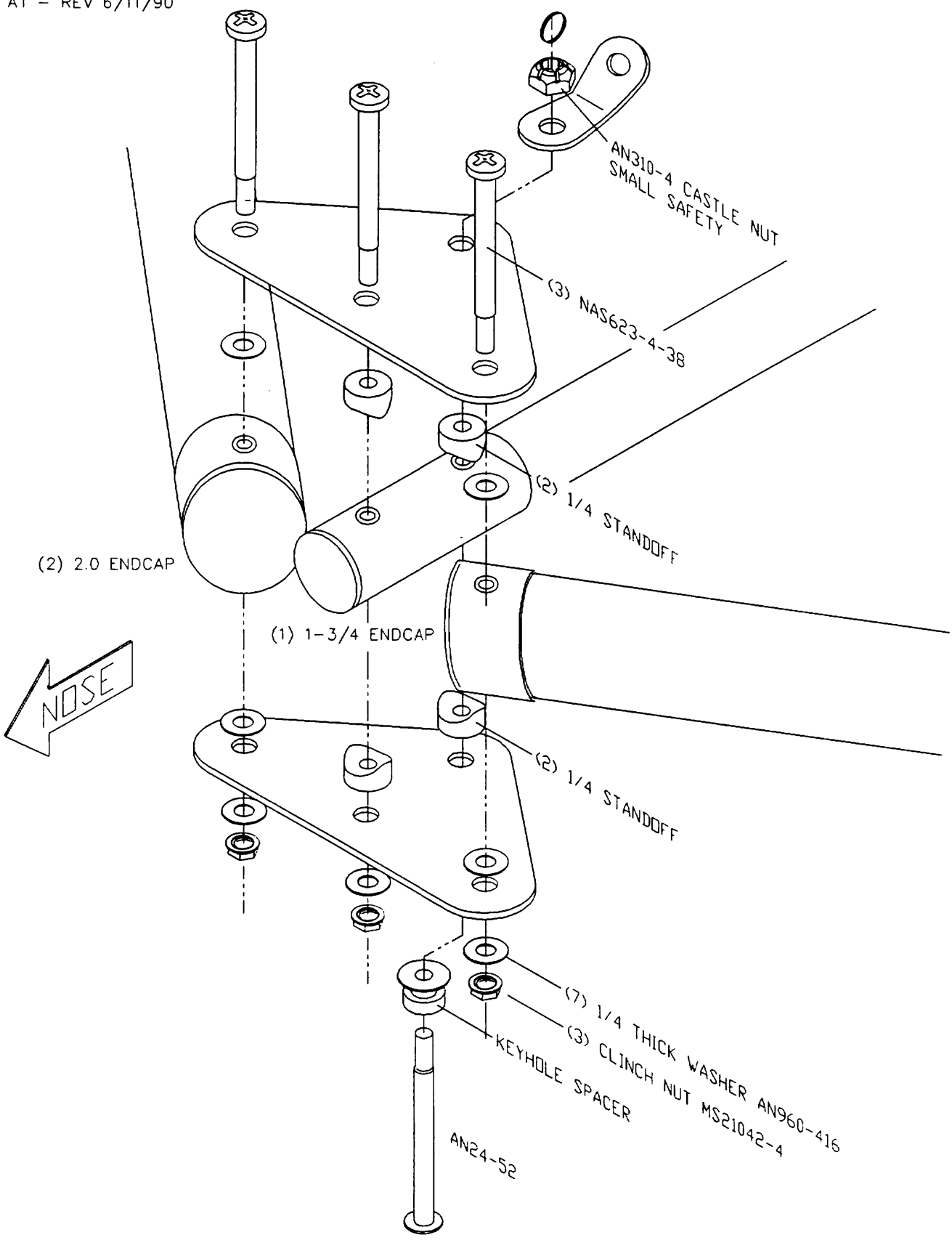
SPORT AT KINGPOST ASSEMBLY

SPORT AT – REV 6/11/90



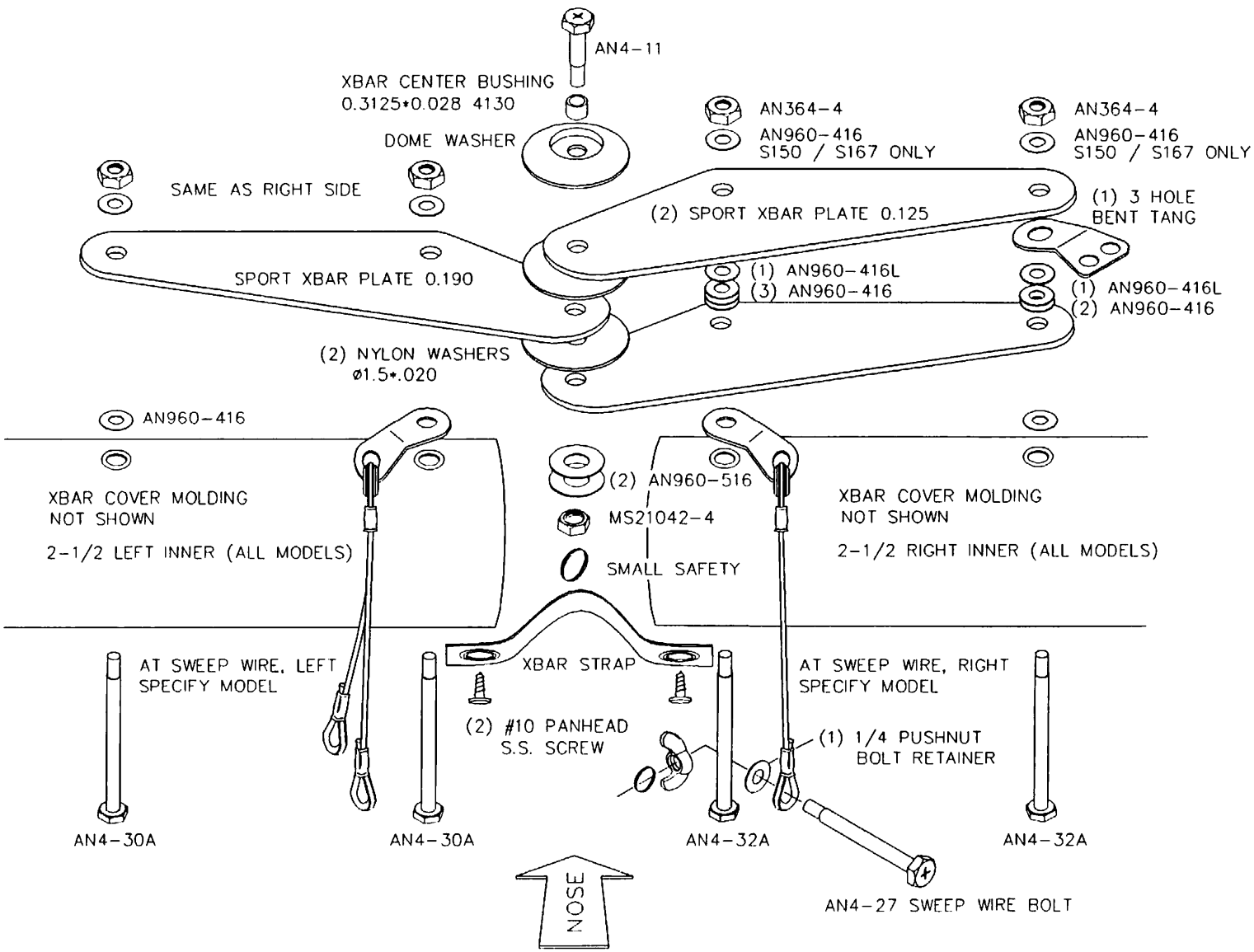
SPORT AT CROSSBAR – LEADING EDGE ASSEMBLY

SPORT AT – REV 6/11/90

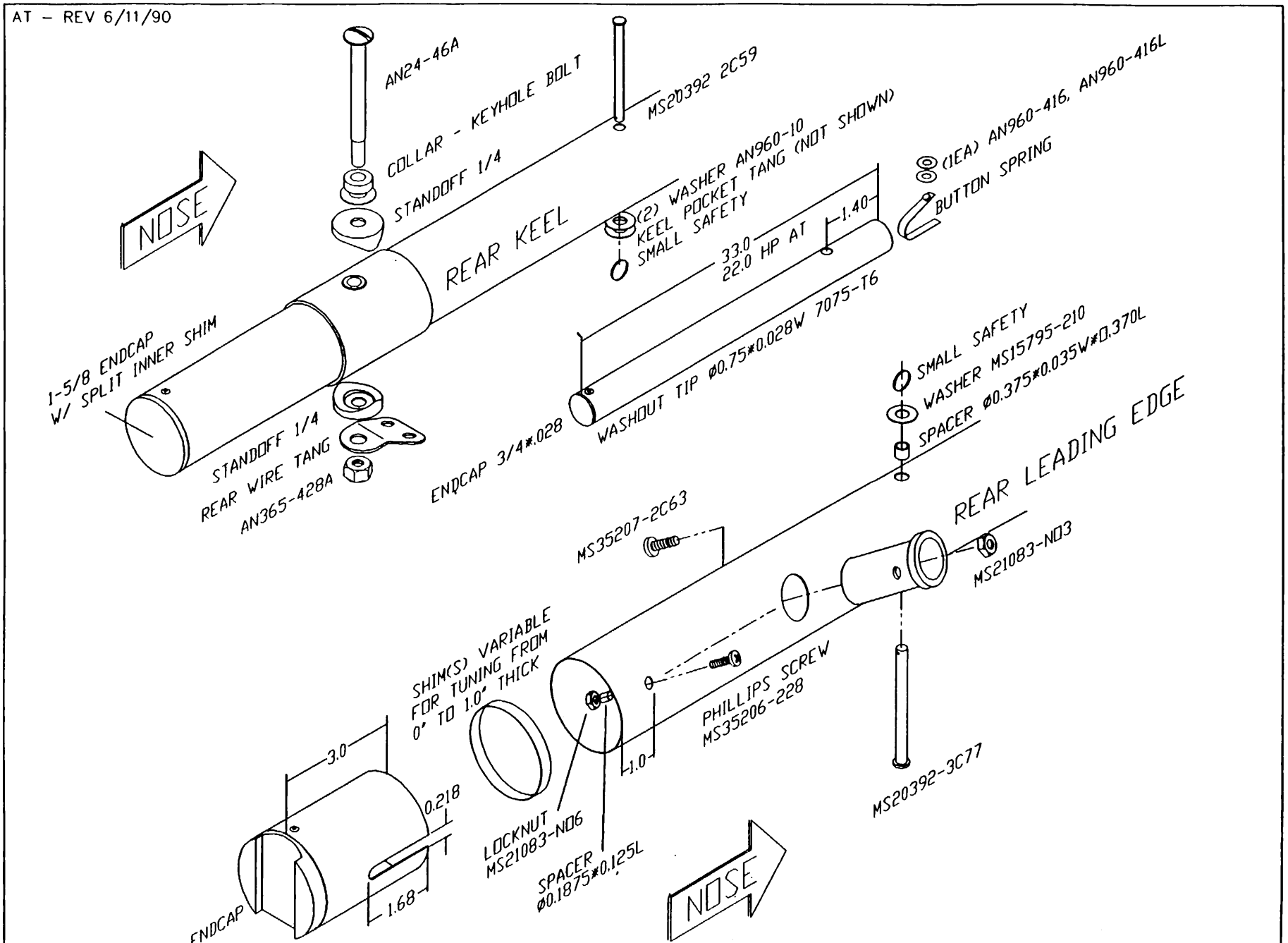


SPORT AT NOSEPLATE ASSEMBLY

SPORT AT - REV 7/25/90

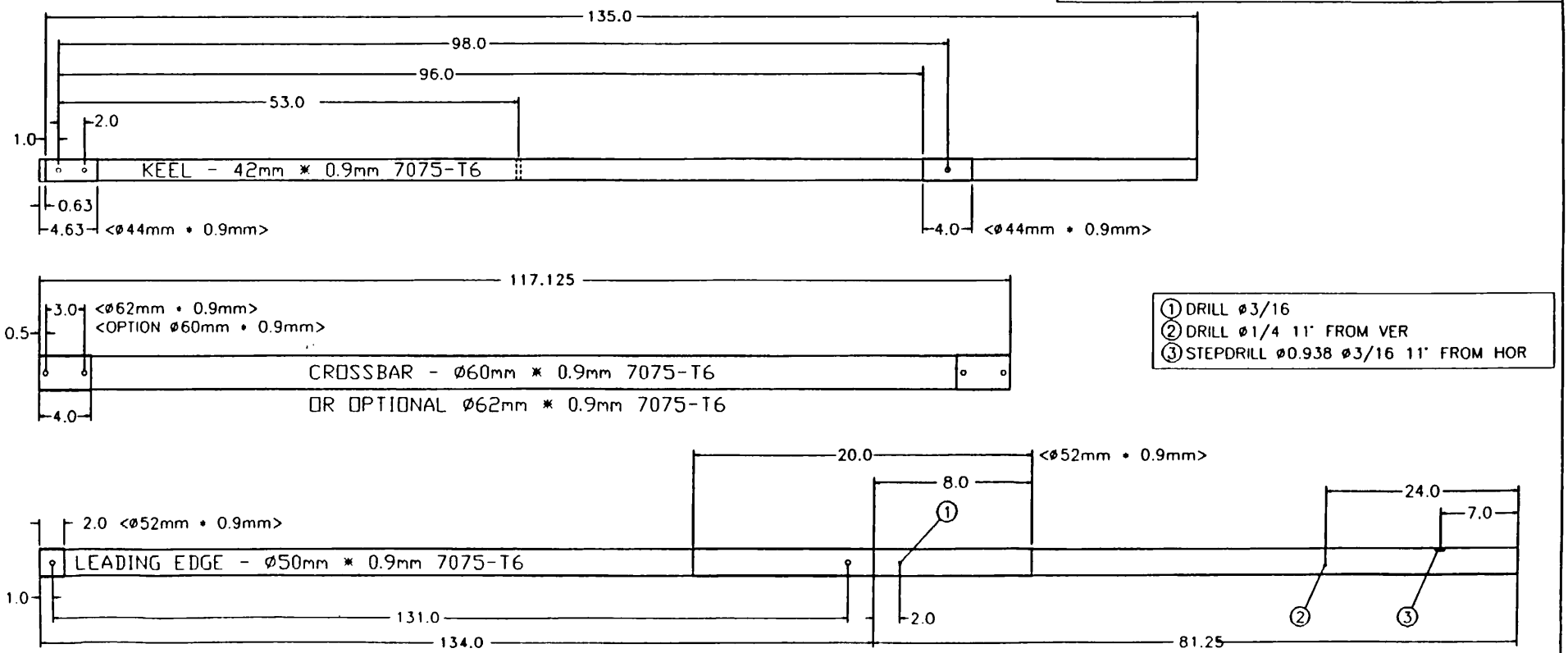


SPORT AT CROSSBAR CENTER ASSEMBLY



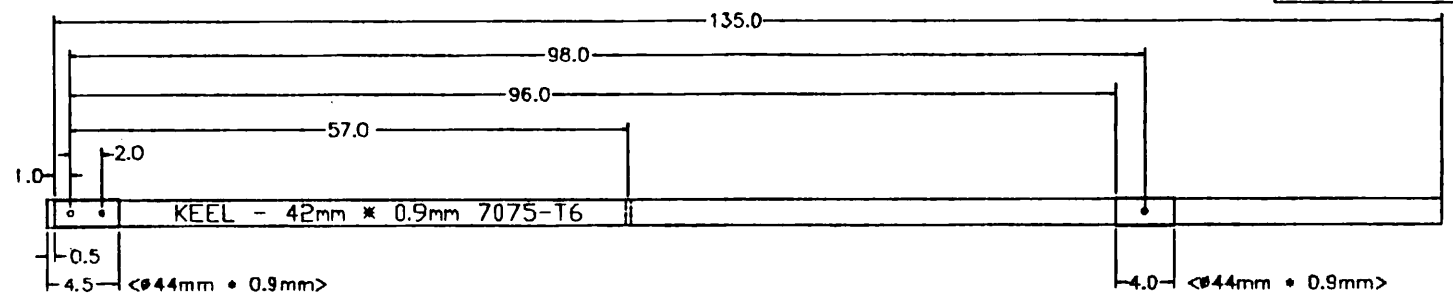
AT MISCELLANEOUS ASSEMBLIES

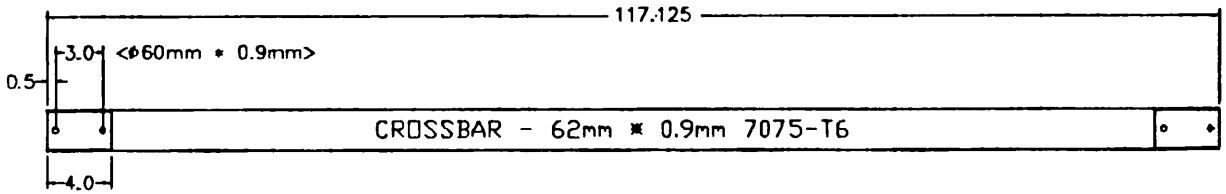
NOTES:
(1) ALL DIMENSIONS INCHES UNLESS SPECIFIED
(2) SLEEVE SPECIFICATION DENOTED < XX >
(3) SLEEVES SAME ALLOY AS PARENT UNLESS SPECIFIED
(4) ALL HOLES ø3/8 UNLESS SPECIFIED



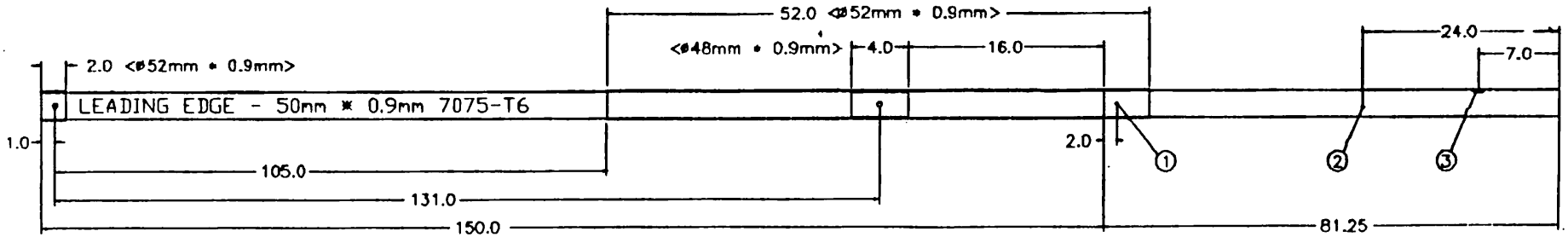
WILLS WING INC	TITLE: SPORT 150 AT FRAME PLANS	DATE: 11-27-89	DO NOT SCALE

NOTES:
(1) ALL DIMENSIONS INCHES UNLESS SPECIFIED
(2) SLEEVE SPECIFICATION DENOTED < XX >
(3) SLEEVES SAME ALLOY AS PARENT UNLESS SPECIFIED
(4) ALL HOLES ø3/8 UNLESS SPECIFIED



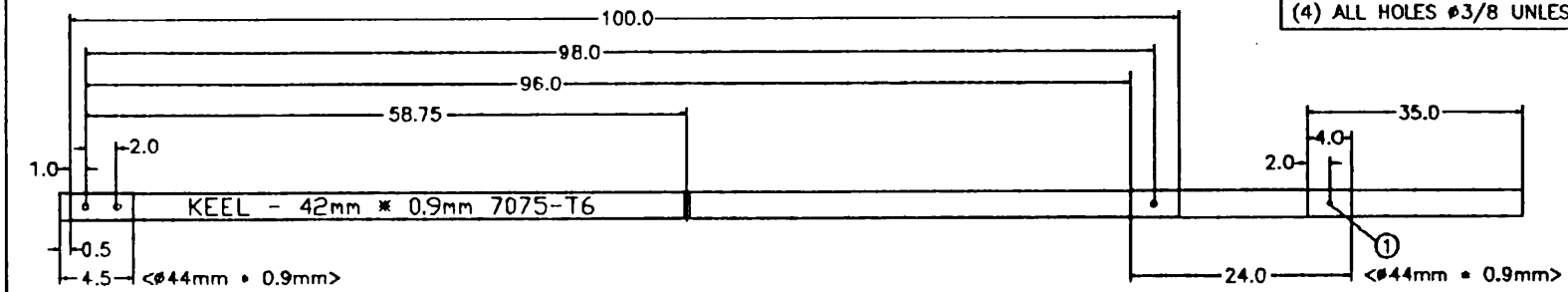


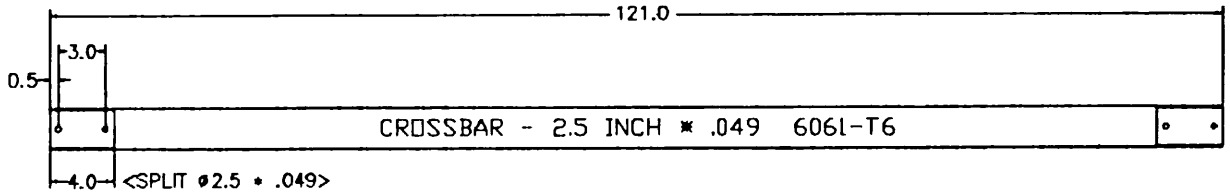
① DRILL ø3/16
② DRILL ø1/4 11° FROM VER
③ STEPDRILL ø7/8 ø3/16 11° FROM HOR



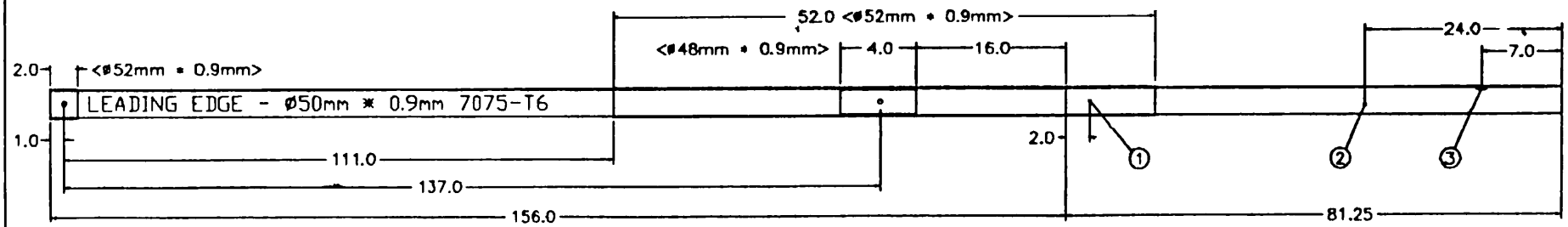
WILLS WING INC	TITLE: SPORT 167 AT FRAME PLANS	DATE: 06-26-1989	DO NOT SCALE

NOTES:
(1) ALL DIMENSIONS INCHES UNLESS SPECIFIED
(2) SLEEVE SPECIFICATION DENOTED < XX >
(3) SLEEVES SAME ALLOY AS PARENT UNLESS SPECIFIED
(4) ALL HOLES ø3/8 UNLESS SPECIFIED





① DRILL ø3/16
② DRILL ø1/4 11° FROM VER
③ STEPDRILL ø7/8 ø3/16 11° FROM HOR



WILLS WING INC	TITLE: SPORT 180 AT FRAME PLANS	DATE: 07-31-1989	DO NOT SCALE