MANUAL

FOR

MOYES DELTA GLIDERS

MARS 170

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INTRODUCTION

Thank you for buying a MOYES MARS. If after reading the manual there is anything you would like clarified, please notify your nearest dealer or the MOYES factory direct. We will be pleased to answer any queries.

Your MARS has been designed primarily as a training glider. We have concentrated on good static balance, ease of ground handling, light weight, low stall speed, gentle stall and very light roll response so you can easily and safely progress through your initial stages of hang gliding.

The design team at the MOYES factory have put their 55 years of collective hang gliding experience into the concept and refinement of the MARS. It has a very competitive sink rate and excels in all conditions. It is very safe and very stable and has undergone severe load testing and pitch testing on our test vehicle. It has no strange quirks or idosyncracies. In our opinion it is the best training and intermediate glider in the world today.

.... but any hang glider is only as good as the pilot flying it. So please fly safely, carefully and conscientiously.

Safe soaring and happy landing.

DESCRIPTION OF DESIGN

The Mars is a single surface flex-wing hang glider. Designed especially for the first day pilot to give him the advantage of the most up-to-date technologically designed hang glider. The modern designs are safer in pitch stability than the older flexible batten gliders.

The Mars was designed to allow pilots to start their first day on a glider that can carry them through their first 18 months in hang gliding without having to go to the expense of purchasing an up-to-date glider with improved performance, because the sink rate on the Mars is equal to the best performing glider on the market.

A combination of stainless steel reflex bridles and fixed washout struts gives the Mars excellent pitch stability and dire recovery. However, careful test vehicle work was necessary to determine bridle lengths and washout angles, so altering those overall dimensions will decrease the grade of your gliders pitch positive.

Basic Specifications

Area	:	172ft^2
Span	:	31ft
Nose Angle	:	125^o
Aspect Ratio	:	5.58
Weight	:	62lb (without bag), 64lb (with bag)

OPERATING LIMITATIONS

Utility Class Glider

Flight operation should be limited to non-aerobatic maneuvers, i.e., those in which the pitch angle will not exceed either 30^o nose up or down of the horizon and in which the bank angle will not exceed 60^o. The Mars is not capable of spins (which is not an approved maneuver).

Additional Parameters

Stall speed @ max. recommended loading	:	26 mph
Max. speed @ min. recommended loading	:	42 mph
Recommended pilot weight range	:	125-240lb
U.S.H.G.A. required rating (or equiv.)	:	Beginner Hang I or above

Static Aero dynamic Load Tests

+30° @ 65 mph
-30° @ 46 mph
-150° @ 32 mph

This glider should not be flown in excess of V.N.E. = 46 mph.

This glider is certified for towing. The glider must be fitted with a certified tow bar with upper release. Floats must be used over water.

DISCLAIMERS

WARNING: The owner and operator must understand that due to the inherent risk involved in flying such a unique vehicle, no warrenty is made or implied of any kind against accidents, bodily injury or death. Operations such as aerobatic maneuvers or erratic pilot technique may ultimately produce equipment failure and are specifically excluded from the warrenty.

TOWING

WARNING: Towing adds further hazards to hang gliding. It should not be pracised without an expert crew and pilot. Towing without the correct conditions, equipment and personnel is dangerous.

The Mars is a sucessful tow glider. Pilots tow Mars gliders at Cypress Gardens every day. This glider is stressed for high positive loads that can be imposed by the line and can be further stressed by additional sleeving if required.

The art of towing demands skill and experience from all involved. That is the pilot, the driver and the throttle-release man. The pilot must be experienced enough to be able to recognize the source of the forces being experienced by the glider and to signal the towing crew for changes in speed as necessary. Also, to control the pitch and direction of the glider during the towed period of the flight. He must avoid any situation that may cause a sudden release during a steep and fast climb. A combination of all these, that is:

1 steep climb
2 high speed
3 sudden release, will cause a pitch over and loss of control.

The boat driver must be familiar with meteorology. He must understand the problems that will be encountered with wind gradients, wind shear and wind direction. Changes in wind direction, both in the horizontal and vertical components. The throttle-release man must be seated in the boat in such a position as to be able to keep his eye on the pilot and glider during the towed period of the flight.

He must be able to vary the speed of the boat to agree with:

1 pilot signals
2 changes in angle of attack of the glider
3 changes in air speed.

The air speed experienced by the glider will change during the towed period of the flight. Due to either the meterological reasons or acceleration due to the position of the glider during the climb. The throttle-release man has the most responsible duties of the trio and must also operate the quick-release in case of an aborted take-off or other reason for an emergency.

The towing of hang gliders has developed by boat towing over water. It is the safest method.

WINCH AND CAR TOWS

The use of the mechanized winches and land operated vehicles is possible however, the tow crew must be familiar with their above duties and the operation of the mechanics on the system of intended use. The added hazards of high tension wires, trees, obstacles and uneven terrain to operate a vehicle pose problems. An aborted flight with a hard landing is harder on land than on water.

The use of today's high powered vehicles as a tow source can and has caused structural failure in the glider or equipment simply by the use of a fraction of an inch of extra throttle. In general, land towing, though not impossible, has so many hazards that it is not advisable.

RECOMMENDED SET-UP PROCEDURE

1. Lay glider on the ground, zip uppermost and nose into the wind. Assemble control bar with bolt, casellated nut and safety pin located on one end of control bar side tube. Make sure the flying wires are outside the control bar.

2. Flip the glider over and remove bag and sail ties. Raise the kingpost and attach the carabiner on the end of the top back wire to the tang at the back of the keel. Attach the carabiner on the dive lines to the thimble at the top of the kingpost. Make sure the dive lines are not twisted.

3. Fit the keel post (at the end of the keel pocket) vertically into the hole on top of the keel.

4. Spread the wings by walking each one out as far as possible. (It is not possible to spread the wings of the Mars 175 out completely at this stage.)

5. Take the battens out of their bag and push Nos. 1-4 gently into the sail. Red is left, green is right. Secure with bungee cords on the trailing edge. At this stage do not insert 5, 6 and keel battens as they will not fit until the sail is tight.

6. Insert the aluminium dive sticks fully onto their stainless steel spigots.

7. Lift up the nose of the glider until you can pull the control bar up to its flying position, using the front flying wires. Then connect the front wires by pacing the hook shaped plastic unit onto the back bolt in the nose-plate channel, pushing the front of the unit into the channel and securing it by inserting the push pin through the front hole.

8. With the rear of the keel on the ground, push the control bar and plastic sliding unit back to the kingpost stop. The bolt, castellated nut and safety pin that secured the sliding unit to the keel, also secures the the main hang strap via a short strap with a grommet at either end. <u>For a detailed picture look at the suspension system further on.</u>

   Note: a. It is easier to slide the plastic unit down the keel if one person is holding a wing bar a couple of inches off the ground and gently pulling the wing out.
   b. The plastic unit may jam if the keel and wing bars are not on the same plane.
   c. If the plastic unit won't slide down to the kingpost stop, check for wires caught under the control bar.

9. Battens 5 and 6 locate in plastic units on the leading edge. Push battens Nos. 5 and 6 into their respective pockets and secure with the double bungees. Check that they are correctly installed by looking up into the double surface from the tip end of the leading edge.

10. Walk to front of glider and insert keel battens together. Secure them by putting nipples on the leading edges through the holes in the batten fronts.

11. Clip your harness into the main hang loop and safety loop. Make sure your harness is the correct height above the base bar.

PRE-FLIGHT CHECKS

You should have a regular check system that you go through before every flight. The best system is to start at the centre of the glider, i.e., the top of the control bar (bolts, hang straps etc) move out to the nose of the glider (nose catch, nose battens) and then walk around the glider (tips, elastics) check the end of keel(stingpost, dive lines); around the other wing to the front(check front again) and to the centre of the glider where you started (check hang straps, control bar, harness again).

Check List, before every flight

1. Check bolt through the plastic sliding unit and strap securing the main hang loop are secured with nut and safety pin.
2. Check hang loop and safety loop are in correct position and harness is properly connected and at the right height.
3. Check bolt in bottom of control bar is secure with castle nut and pin.
4. Check for kinked or twisted wires at each end of control bar.
5. Check front wires are correctly attached at the nose plate and push pin is fully inserted through channel and the hook shaped plastic unit.
6. Check the wing bar/cross bar connectionis secure. Check the side wires are not twisted.
7. Check sail attachment screws at the end of the wing bar.
8. Look up the sail and check that battens NOs. 5 and 6 are properly located in their plastic stops and tensioned by the bungees.
9. Make sure the dive sticks are fully inserted onto their stainless steel spigots.
10. Check all battens are correctly bungeed.
11. Check dive lines are not caught under the ends of battens 1 and 2, are properly connected at the kingpost and not twisted.
12. Check keel post is properly inserted.
13. Check carabiner connecting top back wires is correctly fitted.
14. Check the screws attaching the keel pocket to the keel.
15. Make sure that both sides of your glider have been thoroughly checked.

Get into your harness. Don't forget the leg loops. Do a harness check by walking forward until the harness gets tight. Look back and check your harness ropes for twists, check your carabiner is secure and both your main loop and safety loop are clipped in and untwisted. Lie down to check the harness height and fit.

This few minutes before your flight does three things:-

1. It checks the glider and your equiptment.
2. It calms you and mentally prepares you for the flight.
3. It gives you confidence in the air knowing your Mars is correctly set-up and structurally perfect.

Before you take off you will naturally,

1. Know where the landing area is (this is not as stupid as it sounds)
2. Know where there is likely to be bad or turbulent air.
3. Have a flight plan organised.

O.K. Now you are ready to go. Wait until the wind, you and the glider are stable. Take off-sky out-and have a thoroughly enjoyable flight.

BREAKDOWN PROCEDURE

This is more or less the reverse of set-up. These few hints will make your break down easier. If it is over 15 m.p.h. don't leave the glider unattended with the nose down into the wind. The reflex from the dive sticks, dive lines and keel pocket may lift the nose and flip the glider over. Detach the front wires and lay the glider down on the ground. If very windy detach the dive lines from the kingpost and pull out the dive sticks.

1. Pull out nose battens.

2. Undo bolt from plastic sliding unit. With the keel and wing tips on the ground, pull the plastic sliding unit forward a foot or so. In one action and still keeping the keel and wing tips on the ground, pull the nose of the glider forward (not down), allowing the plastic unit to slide fully up the keel until the glider is lying on the ground.

IMPORTANT: If you try to slide the cross bar (i.e. the plastic unit) forward when the glider is horizontal the weight of the leading edges will jam the unit three feet from the kingpost and possibly kink the keel, so be careful.

3. Pull the battens out and fit, camber first, and all simultaneously, into the batten bag.

N.B. Don't lift up No. 5 batten to pull out as you may break off its plastic tip.

4. Pull out keel post.

5. Undo dive lines.

6. Stand astride the keel facing forwards at the end of the keel pocket; bend down and pick up the trailing edge of the sail as far as you can on each side. By lifting the trailing edge above your head you will pull in the wing bars. Repeating this will bring the wing bars in parallel with the keel. Roll the sail neatly and secure with ties.

7. Unclip carabiner on top back wires and lay kingpost forward.

8. Put glider bag over the glider with the zip down.

9. Flip glider over so control bar is on top.

10. Undo control bar bolt.

11. Secure battens to the glider with the camber to the back.

12. Put the padded compartment inside the bag between the control bar ends and the sail. Zip up the bag and that's it.

13. Make sure you have sufficient padding on your roof racks and be sure to tie the glider on securely.

FLYING

After performing the preflight inspection and harness hang check, you're ready for the first flight. The Mars launches well, requiring no special techniques, simply hold the wing nose down at flying attitude and just accelerate smoothly and run hard until the ship lifts you off the ground.

Once in the air, relax your grip and the glider will fly straight and level. Once turned off course, the glider needs only light bar pressures and small control movements by the pilot to bring the glider back on course.

A beginner pilot should choose a slope with a large landing area and gentle slope with no obstacles and fly in conditions that allow a straight flight path.

In flight, the glider is responsive to lift. The Mars' low stall speed and good glide at normal flying speed coupled with superb maneuverability offers you the best of all worlds. The glider will stall nose first, not tending to drop a wing. 360° turns co-ordinate best with little pitch pressure.

Landings are easy as well. The glider will parachute if you are over-shooting the landing area, but if within 30' of the ground, you should always fly 5mph above stall speed and be aware of the effects of wind gradient and ground effect. The flair on a Mars is one of its main advantages because the glider is slightly tail heavy and the control bar is short. So when you push out on the uprights, the glider will land nose up.

TUNING INSTRUCTIONS

Roll

The glider should fly straight and not produce a tendancy to roll either right or left. If the glider has a tendancy to roll to the left hand side, the problem is that the lift generated on the right wing is more than that on the left wing. To adjust this problem, increase the sail tension down the left hand leading edge by removing the two screws in the webbing at the tip. Pull the sail ½" further down towards the tip and mount the screws and webbing in the new holes. Adjust the sail tension either increasing or decreasing till the glider flies straight.

Variations in bank. The glider bank pressures should be even. Fly your glider on a 20° bank to the left for a 360° turn. If there should be a tendancy for the glider to increase the bank on either side, either one or two of the battens in No 6 or No 5 may be out of shape. Check the battens for damage. If no damage is evident, you must increase the camber approximately ½" on the side that the bank increases. This will cause the tip area to generate more lift at lower speed when that tip is inside the turn. Don't over camber or it will cause the same problem on the other side. This is a delicate adjustment and should be carried out by an experienced person.

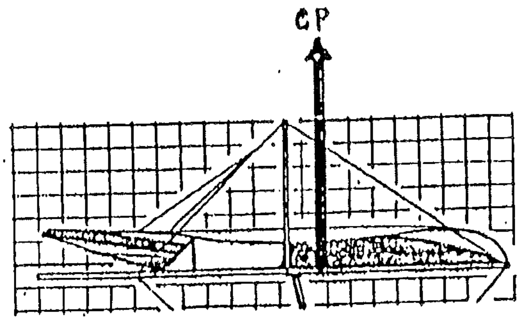
Under no circumstances should the reflex bridles or tip washout angles be altered from original specifications!

TUNING INSTRUCTIONS

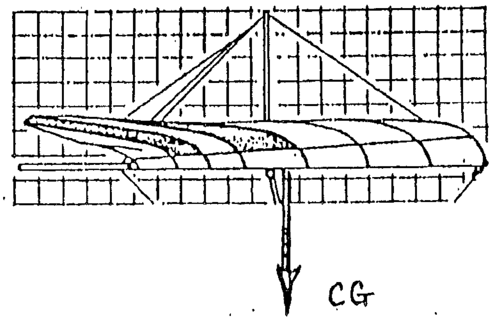
First, a few general principles concerning air flow and trim on hang gliders affecting pitch and roll.

PITCH

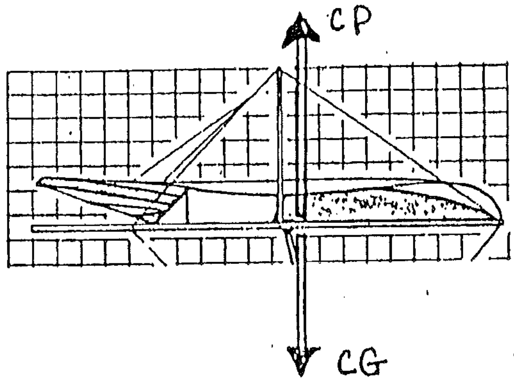
1 **The Centre of Pressure**
is the position on an airfoil where the sum of the dynamic air pressures on the airfoil are centred.



2 **The Centre of Gravity (C.G.)**
is the position on the glider where the sum of the gravitational forces are centred.

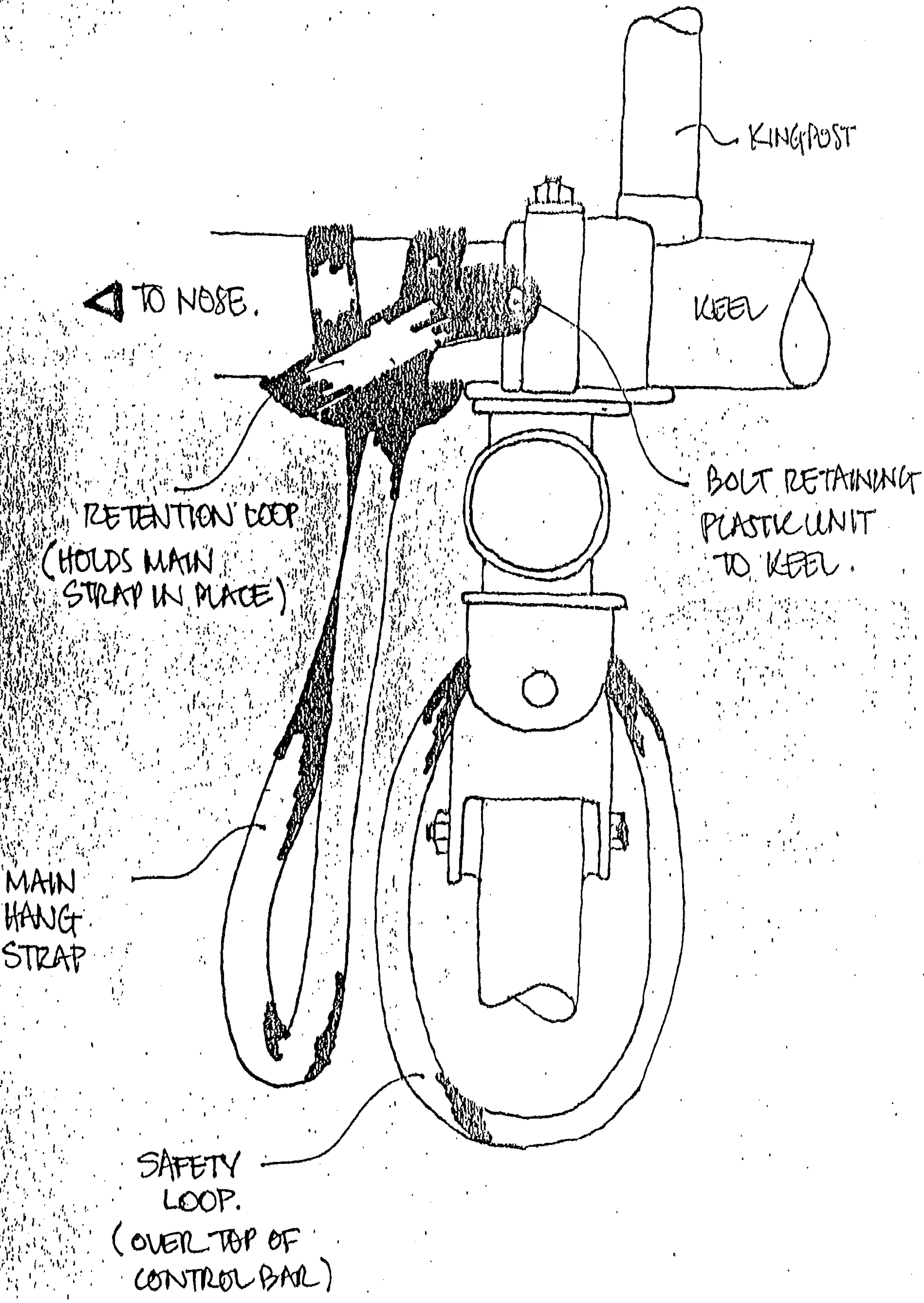


3 **Trim**
A glider in trim is one when the C.P. and the C.G. are centred together, placing no resulting bar pressure on the pilot.



4 Trim speed is the speed at which a glider will fly placing the C.P. at the same point as the C.G. with no pilot input. This speed should be 2.5 mph above stall speed. A glider of good design and in good condition will produce bar pressure to return the glider to trim speed.

MARS 175 SUSPENSION POINTS.



MAINTENANCE SCHEDULE

EVERY 10 HOURS

* Check top and bottom surface ribs against airfoil maintenance blueprint.

EVERY 50 HOURS

* Inspect all cross tube support cable components (carabiner, pins, nuts and bolts, cross tube plates and cable itself).
* Inspect trailing edge lines support strap.
* Inspect all batten bungie cords.
* Check all tubing for possible wear damage which could occur during set-up, fold-down or transportation.
* Inspect sail mounting.

EVERY 100 HOURS

* A complete inspection of your glider is recommended, including all rigging and components, replacement of any worn or bent bolts or lock nuts connecting two moving parts together (i.e., cross tube plates junction bolt, cross tube leading edge junction bolt, etc.).
* If badly scratched, dinged or damaged, the control bar base tube should also be replaced.
* Critical sail tears should be mended by a professional sailmaker.

** Please contact your dealer for a complete and professional sailmaker.

*** AND REMEMBER: Your care will always pay off in the future. What you're giving yourself by following this schedule faithfully is many hours of anxiety-free flying.

INSTRUMENTATION AND CALIBRATION

The following instruments were used in flight tests, pitch tests and load tests.

Cameras and Recording Equipment	Application
JVC compact video system with HR-C3 recorder and GZ-S3 camera (weights: recorder 6.5lb camera 3.0lb)	Vehicle footage
Elmo Super-8 movie camera, Album 3600	In-flight onboard footage
Elmo Super-8 movie camera, 1012S-XL	Ground based

Measuring Equipment	
Inclinometer: Rieker Instr. Co., ball in fluid type	Vehicle and onboard work
Site level, Micro no. 800-RL	Vehicle and onboard alignment
Spring Guage, Type 120, Chatillon, N.Y.	Pitch tests
Casio TS1000 Quartz Digital Watch	Timing sequences

Test Vehicle	
Mark West Consulting Rig., Dodge Powerwagon	Free airstream as documented and accepted on previous package use.

Airspeed Indicator	
SR Mariner, WS-1, Serial No. 2267 SR Instruments Inc., N Tonowanda, N.Y. Cup Annomometer	All documented airspeed footage

ASI Calibration

The SR Mariner was cross referenced and calibrated against a FAA checked Kollsman- pitot tube ASI, SAE spec. AS 391, Caa-TSO-C2, and against the calibrated speedometer of the MW Test Rig. The annomometer proved to be extremely smooth and accurate. There was no noticeable, (less than 1 mph), variation in the readings during these tests and therefore all airspeeds may be read directly. See also Test Rig Calibration on the following page.

The SR Mariner reads in knots. The conversion factor from knots to miles per hour is 1.1515 x knots = MPH.

COMPLIANCE VERIFICATION

SPECIFICATION SHEET

MARS 170

1 Weight - 62 lb (without bag), 64 (with bag)

2 Tube Dimensions (in inches)

* Leading Edge	:	Diameter 1 7/8", Length 217" Holes at 3/4, $125\frac{1}{2}$, $129\frac{1}{2}$, $196\frac{1}{2}$"
* Cross bar	:	Diameter 50mm, Length 111 3/4" Holes at 1, 1 5/8, 111 1/8"
* Keel	:	Diameter 44mm, Length 143" Holes at $1\frac{1}{4}$, 3, 62, 64 3/8, $66\frac{1}{2}$, 101, $117\frac{1}{4}$"
* Washout Strut	:	Diameter 20mm, Length 25"
* Kingpost	:	Diameter 28mm, Length 41 1/16"
* Control Bar Base	:	Diameter 28mm, Length 54" Holes at 5/8, 53 3/8"
* Control Bar Down Tube	:	Diameter 28mm, Length 61 1/16" Holes at 5/8, 60 7/16"

3 With Keel at 0 deg:

a) Washout tip (tip strut) angle 20^{o}.
b) Control Bar angle (fwd. sweep) 84^{o}.

4 Sail to Cross bar at mid-point of Cross bar - $13\frac{1}{2}$".

5 Sail to Keel at mid-point of nose and CG - 10".

6 Bridle Dimension, Kingpost top to sail eyelet.

a) 73"
b) $103\frac{1}{2}$"

7 Chord Lengths

* 3ft from root $86\frac{1}{2}$"
* 3ft from tip 44"

8 Span - 31' 0"

9 Bow in tubes, end to end $\pm\frac{1}{2}$".

* Leading Edge : N/A sail preload approx. $3\frac{1}{2}$"
* Cross bar half : 0
* Keel : 0

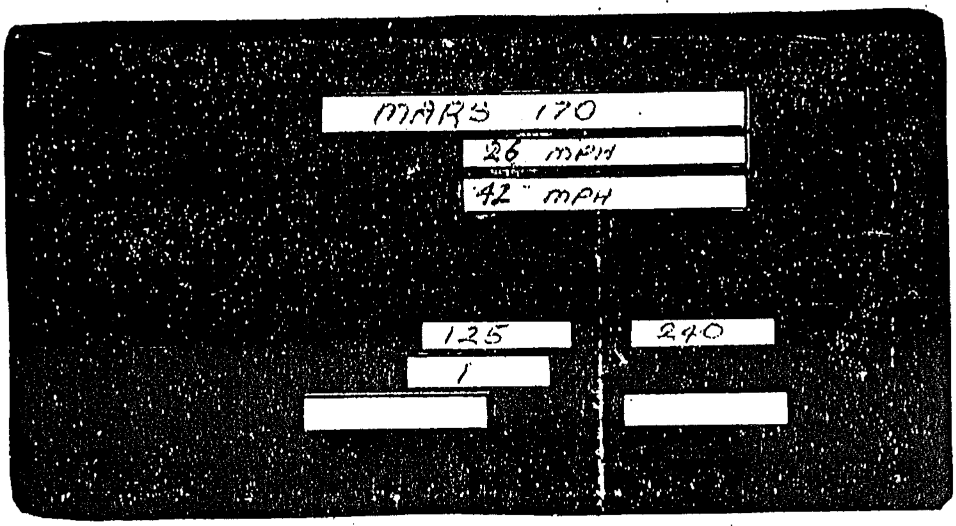
10 The plackard is located on the cross bar on the port cross bar half. The test fly sticker is located on the cross bar next to the plackard.

11 Recommended pilot range, with gear, 125-240lb. Recommended pilot proficiency is beginner Hang I or above.

PLACARDS

The placards are located on the keel on the right hand side near the control bar bracket.

OPERATIONS PLACARD



TEST FLIGHT STICKER

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TRIM ANGLE COMPARISON MARS 170

AN INCLINOMETER WAS INSTALLED ON THE INSTRUMENT CONSOLE FOR IN-FLIGHT TESTS, AND ARRANGED TO INDICATE ROOT ANGLE OF ATTACK. AT AN INDICATED TRIM SPEED OF 26MPH (A 5MPH CORRECTION FACTOR) A CORRESPONDING TRIM ANGLE OF 14° WAS OBSERVED. (ON BOARD FOOTAGE)

A VEHICLE TRIM OF 20° AT 26MPH WHICH WOULD LEAVE A DIFFERENCE 6°, AND CORRESPOND TO A GLIDE ANGLE AT TRIM OF APPROX 9 TO 1

THIS WOULD SEEM TO BE A REASONABLE FIGURE, AND WITHIN COMPARATIVE LIMITS

MOYES "MARS 170"

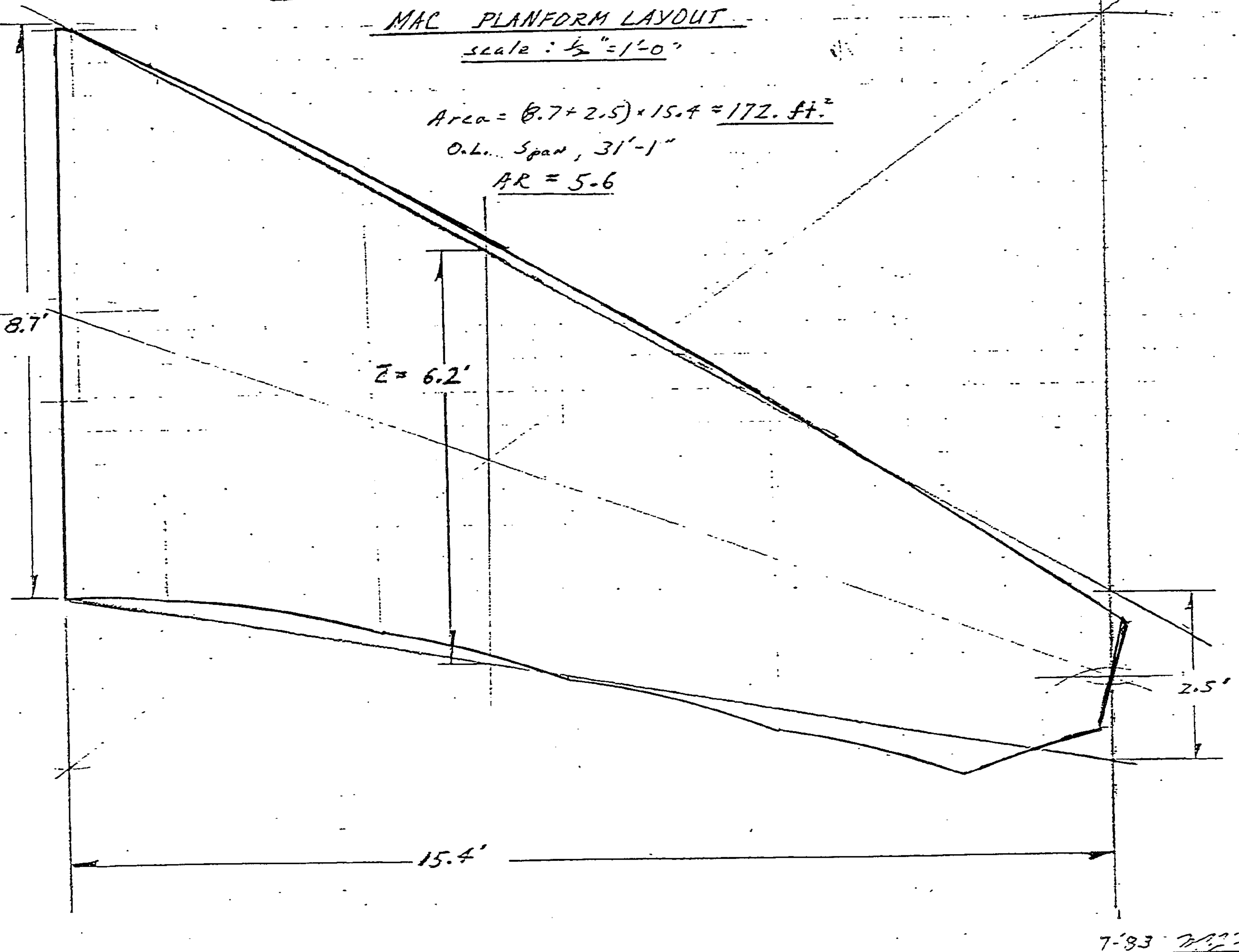
MAC PLANFORM LAYOUT

scale : ½" = 1'-0"

Area = (8.7 + 2.5) × 15.4 = 172. ft²

O.L. Span, 31'-1"

AR = 5.6



MW	Pitching Moment Data	25 July '83	1/2

Crew: Steve Moyes, Mark West

When + Where: Whiteman Airport, Sun Valley Ca., 25 July '83.

Equipment: MW Test Rig, S.R. Mariner A.S.I., Chatillon Spring Gauge, Reicher level Gauge. Zero lift determined by loose mounting hole.

Glider: MARS 170 - Moyes -

Variables → $S = 172$, $\bar{c} = 6.2'$, $l = 5.1'$

Equations → $C_m = \frac{M}{qS\bar{c}} = \frac{F \times l}{(\frac{1}{2}\rho V^2) S\bar{c}}$ @ $\rho = .0024$ slugs/ft³

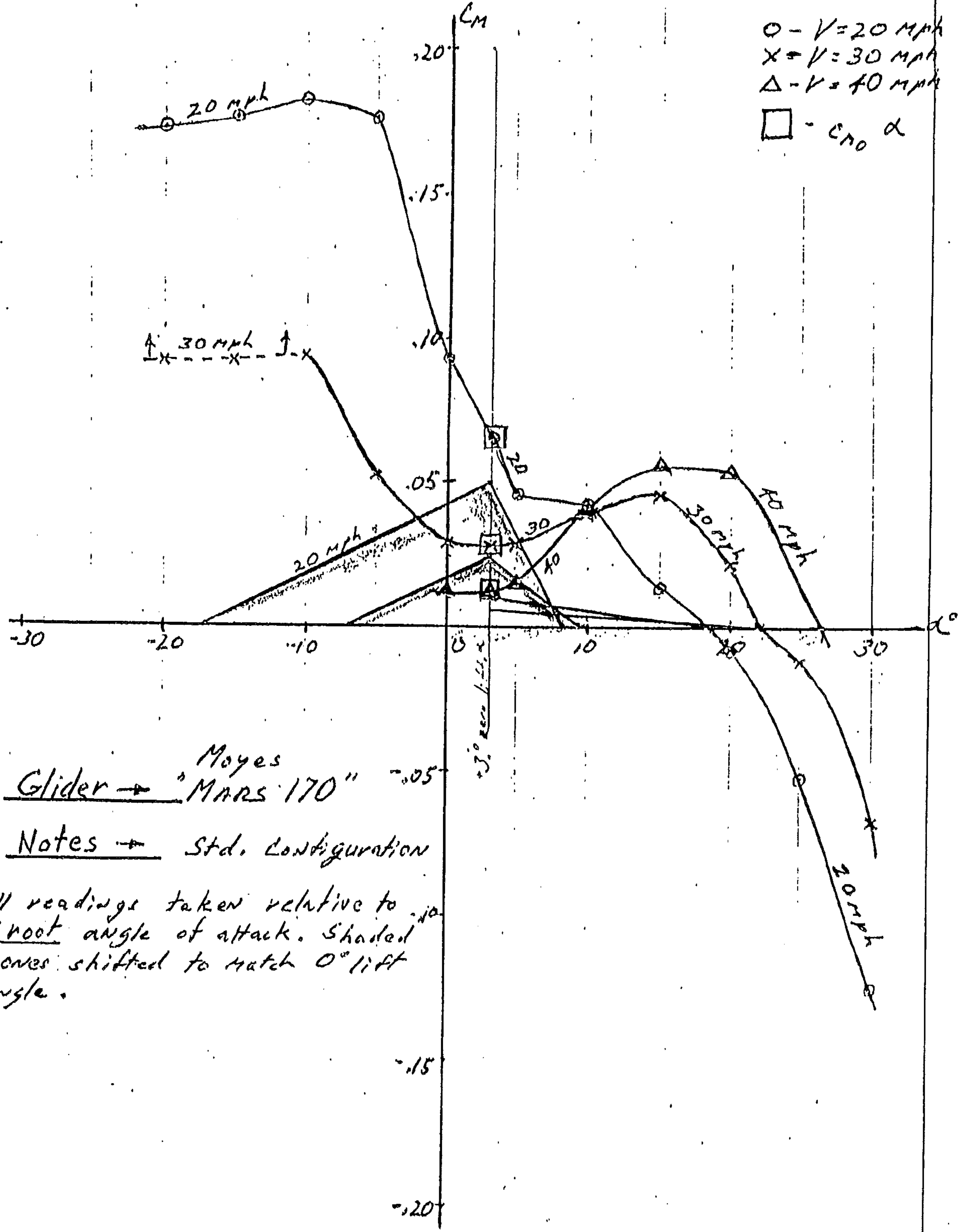
$$C_{m\,20\,mph} = \frac{F \times l}{(\frac{1}{2} \cdot .0024 \cdot (29.33\ ft/sec)^2) S\bar{c}} = \frac{F \times l}{1.032 \cdot S\bar{c}} = F \times .00463,$$

@ .05 min, $F \doteq 10.8$#, say 11.#

$$C_{m\,30\,mph} = \frac{F \times l}{2.32 \cdot S\bar{c}} = .00206\,F, \quad @ .025 \text{ min}, \quad F \doteq 12.1\#$$

$$C_{m\,40\,mph} = \frac{F \times l}{4.13 \cdot S\bar{c}} = .00116\,F, \quad F \geq 0\#$$

α° Root angle of attach	F # @ 0 mph	F @ 20 Static + Dyn.	20 MPH F dyn. tot-st.	Cm Dynamic	F @ 30 Static + Dyn.	30 MPH F dyn. tot-st.	Cm Dyn.	F @ 40 Static + Dyn.	40 MPH F dyn. tot-st.	Cm dyn.
-30	↓									
-25										
-20	6	43	37	.171	>50	>44	>.091			
-15	6	44	38	.176	>50	>44	>.091			
-10	5	44	39	.181	>50	>45	>.093			
-5	5	43	38	.176	30	25	.051			
-0-	4	24	20	.093	17	13	.027	15	11	.013
5	4	14	10	.046	18	14	.029	20	16	.019
10	3	12	9	.042	22	19	.039	38	35	.041
15	2	5	3	.014	24	22	.045	>50	>48	.056
20	2	trim	-2	-.009	12	10	.021	48	46	.053
25	1	-10	-11	-.051	-7	-8	-.016			
30	1	-26	-27	-.125	-32	-33	-.068			
Notes - Trim, Cm, α	Tail heavy	trim 20° @ +3° 18#- 4 = 14 Cm = .065			Trim 22°, @ +3° 17#- 4 = 13# Cm = .027			Trim @ 27° @ +3°: 15#- 4 = 11# Cm = .013		



Glider → Moyes "Mars 170"

Notes → Std. configuration

All readings taken relative to 0° root angle of attack. Shaded zones shifted to match 0° lift angle.