AMERICAN AERONAUTICS
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INTRODUCTION

Thank you for purchasing our weight and balance system. We know you will find it a fast and convienent method to complete an all too often neglected factor in flying safety. Page 1 of these instructions deals with some general principles common to all aircraft. Page 2 presents specific instructions for your model aircraft. Page 3 is an example, and page 4 gives some ideas for extending the utility of your weight and balance plotter. Please take time to understand the directions thoroughly, and then save them for future reference.

A weight and balance diagram consists of a series of vectors (line segments) drawn head to tail to form a vector sum. The theory is identical to a wind triangle, where two vectors (True airspeed and wind velocity) are summed (drawn head to tail) to obtain ground velocity (ground speed and direction). In a weight and balance diagram the vectors represent payload elements (front row passengers, aft row, baggage, fuel, etc.). When the vectors are summed the result is total weight and moment. The vertical component is the elements weight, the horizontal component is the elements moment (arm x weight). The plotter is used to draw the vectors, it has a scale for each payload element, the scales are calibrated to give the vectors the proper length and orientation. When the vectors are drawn on a graph with the proper scaling, the division of moment by weight is accomplished automatically and cg is displayed. On our graphs the cg envelope is displayed so the pilot can tell if the loading is within limits. As an added convienence, Maximum Ramp, Maximum zero fuel weight, and Maximum landing weights are also displayed for those aircraft having those limitations. The vertical scale of the graph is calibrated in weight and the horizontal scale is calibrated in inches aft of datum (small aircraft) or percent of MAC (Mean Aerodynamic Chord) for large aircraft.

The cg-weight limits are set by the manufacturer and approved by the FAA. They exist to insure adequate handling characteristics, structural integrity, and performance. Maximum Takeoff Gross Weight is a structural limitation (but sometimes climb performance or takeoff performance), Maximum zero fuel weight is to protect the wing root structure, Maximum landing weight protects the landing gear and their attach structure, Maximum Ramp weight allows the operator to load on extra fuel above maximum takeoff weight for taxi and ground delays. Exceeding these limits can fatigue important structural elements and cause failure (usually at a later date). The straightline portion of the forward cg limit insures adequate low speed pitch control, violating it guarantees a difficult (if not impossible) takeoff and a hard or worse landing. The curved portion of the forward cg limit insures adequate climb performance, it is vital to multiengine operators desiring any single engine climb performance. The aft limit guarantees static stability for the aircraft, violating it invites a stall spin accident.

INSTRUCTIONS: MOONEY M20 F,G,J,K

IT IS IMPORTANT THAT THE TOP OR BOTTOM EDGE OF THE PLOTTER IS PARALLEL TO THE HORIZONTAL LINES ON THE GRAPH WHEN DRAWING ANY SEGMENT OF A WEIGHT AND BALANCE DIAGRAM, THIS ASSURES ACCURACY.

1) Plot the point on the graph where your BEW (Basic Empty Weight) and the basic empty cg intersect. The example shows 1700 lbs. and 44.0" aft of datum. This point should be plotted as accurately as possible, as any error here will be carried through the problem. On laminated graphs, permanently mark this point to facilitate future problems.

2) Place the zero tick mark of the CREW scale on the BEW point and draw upscale to the combined weight of the cockpit occupants. Place the zero tick mark of the 2ND ROW scale on that point and draw upscale to the combined weight of the second row passengers. The example shows 300 lbs. in both rows.

3) Place the zero tick mark of the BAGS scale on the last point plotted and draw upscale to the weight of baggage in the aft area. The example shows 100 lbs. here. If the hatshelf is loaded draw a segment for this area (10 lbs. maximum). This is the zero fuel point, insure that it within the cg envelope. For baggage placed on the rear seat, use the 2ND ROW scale. For baggage placed between the front and second rows, assume half the weight to be in the front row and half the weight to be in the second row. This will yield the correct answer.

4) Place the zero tick mark of the FUEL scale on the zero fuel point and draw upscale to the gallons of fuel in the mains at liftoff. This point is the takeoff cg and weight. Back down the fuel segment to landing fuel, this point is the landing cg and weight. The example shows 50 gallons at takeoff and 10 gals. at landing. It is important that the entire fuel segment is within the cg-weight envelope, as this represents the cg-weight travel from liftoff to touchdown.

MOMENT ARMS ARE SHOWN ON THE PLOTTER AFTER THE SCALE TITLE

Note: On laminated graphs use broad or medium tip ballpoint pens or fine tip markers (nylon tip). Wipe clean with rag. Water helps clean with stubborn inks. Do not use grease pencils, as these will gum up the plotter scales.

ACCURACY

Just as a chain is only as strong as its weakest link, a calculation is only as accurate as its least accurate data. The plotter and graph system are accurate to the width of a pencil or pen line over eight inches, or well under 1% error. The data used for the weight and balance calculation, therefore will dictate the accuracy of the final answer. The BEW (Basic Empty Weight) provided in your Flight Manual should be accurate within 1% provided it is corrected for items normally carried in the aircraft but not in it during weighing , e.g. charts and case, flashlights, engine covers, emergency kit, etc. Similarly, the BOW, or Basic operating weight, used with large aircraft, should be corrected to actual crew weights, charts, and the actual amount of stores, not estimated. The reason for using actual crew weights and charts together is that they are located far forward in the aircraft, and hence even a small amount of weight has a large effect on the cg.

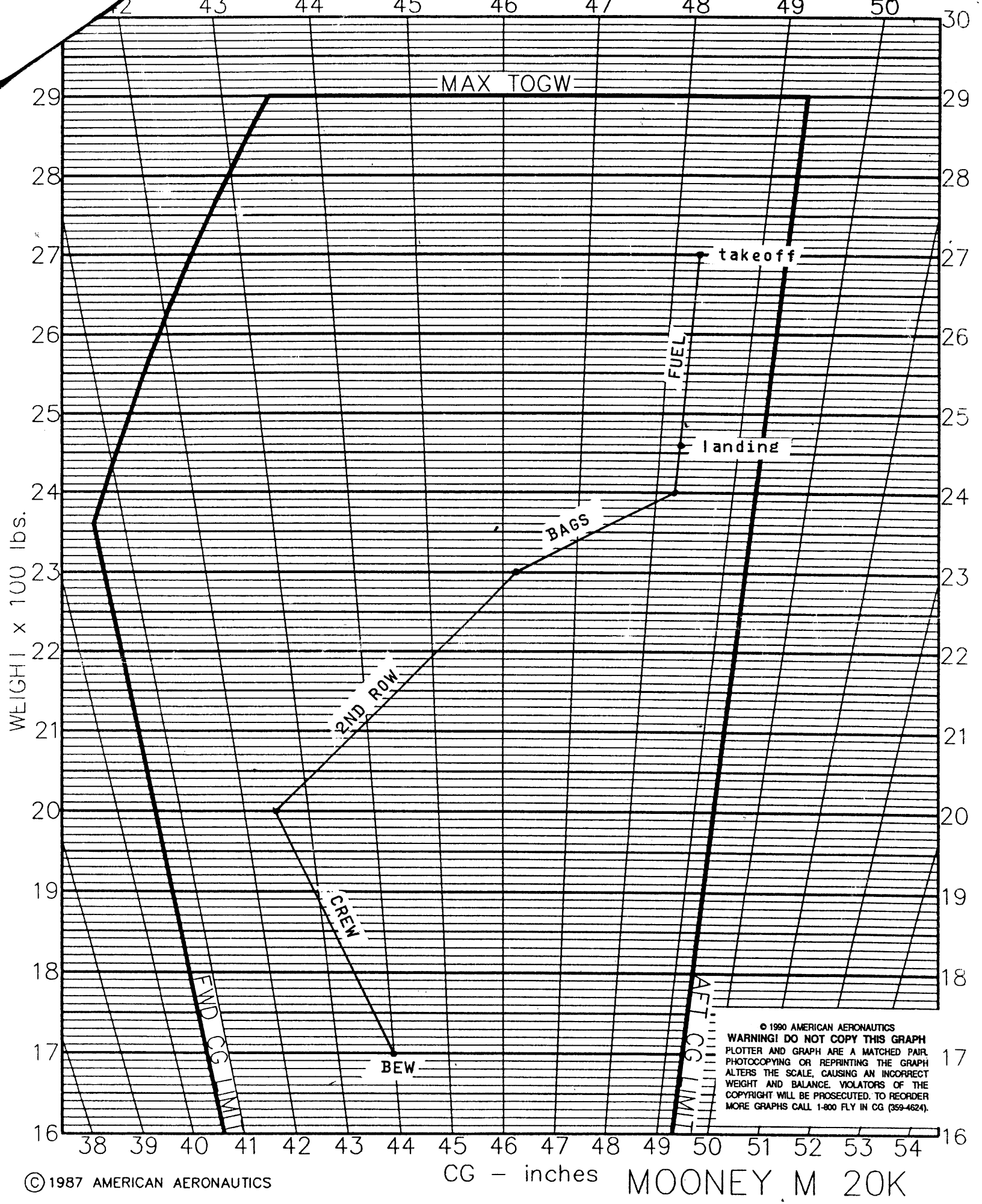
In light aircraft, assuming standard passengers is dangerous, as this can introduce an error of as much as 40%. A good estimate is preferable, (error 10%), but a discrete inquiry is best (add 5lbs. in summer and 10 lbs. in winter), this will yield an error generally less than 5%. Weighing passengers is usually impossible though best. Baggage should be weighed; estimating,for most people, introduces at least a 10% error. Finally, fuel estimates are accurate only if the aircraft is full or empty. In between non-capacitance fuel gauges are seldom within 10%. Capacitance fuel gauges, properly calibrated, are good for about 2%. For large aircraft, standard passengers are allowed by the FAA because a 200 lb. error in a 20,000 lb. aircraft is only 1%. The cg will be off more than the weight. The bottom line is this, if everything is done right, the best accuracy your data can have is 2%, a far larger error than the approximately 1/4% introduced by the graphic system. Even crunching your data through a calculator with eight place accuracy still yields an answer with at least 2% error. One advantage of the graphic system is that the problem can be solved when all the passengers are there and seated, thus eliminating errors due to whom is seated where.

ORDERING SEGMENTS

Although the answer will be the same irregardless of the order of segments, fuel should be drawn last so that the takeoff and landing points are both observed to be inside the envelope. The cg diagram may penetrate the envelope as long as the takeoff and landing points are inside it. Additionally, drawing the fuel segment last indicates the maximum amount of fuel that can be carried (if the fuel segment intersects a limit line). Aircraft with zero fuel restrictions must draw pax and baggage first to insure compliance with that limit. Performance criteria may dictate a lower takeoff or landing weight than those maximums indicated on the graph, check the flight manual.

BALLAST PROBLEMS

If the final takeoff or landing points are observed to be outside the cg envelope, simply place the zero tick mark of the appropriate ballast scale (e.g. NOSE BAGGAGE for an aft cg violation) on the out of limits takeoff and/or landing point and read the amount of ballast required where the scale crosses the cg limit line. Be sure to draw a ballast segment for both takeoff and landing points to insure cg compliance. A last minute passenger or bag may be drawn in on the completed diagram also, as long as the segment is added to both the takeoff and landing points. Loadings near the aft limit yield faster climbs and cruise speeds than more forward loadings. (The download on the horizontal stabilizer decreases as the cg moves aft),



MAYDAY AVIONICS INC.

WEIGHT AND BALANCE REPORT
AND EQUIPMENT LIST SUPPLEMENT

Registration	A/C Make	A/C Model	A/C Serial Number
N717S	Mooney	M20F	680202

PERMANENT EQUIPMENT REMOVAL OR INSTALLATION

WORK ORDER: 58862 **A/C HOURS:** 198.07

	WEIGHT (pounds)	CG ARM (inches)	MOMENT (in-lb)	%MAC
ORIGINAL BASIC EMPTY WEIGHT:	1749.70	43.64	76358.03	N/A

ITEM	REMOVED EQUIPMENT	MODEL or P/N	WEIGHT (pounds)	CG ARM (inches)	MOMENT (in-lb)
1	Garmin GPS Receiver	GPS 100	2.00	18.0	36.00
2	Garmin GPS Antenna	011-00013-00	0.50	110.0	55.00
3	Narco COM	COM 120	3.60	15.0	54.00
4	Narco COM	COM 120	3.60	15.0	54.00
5	Narco NAV	NAV 122	3.00	15.0	45.00
6	Narco NAV	NAV 121	2.50	15.0	37.50
7	Narco ADF Receiver	ADF 141	2.30	16.0	36.80
8	Narco ADF Indicator	ADF 101	1.00	18.0	18.00
9	Narco DME	DME 890	3.00	15.0	45.00
10	Narco Transponder	AT 150	2.30	15.0	34.50
11	Narco Audio Panel	CP 136	1.00	16.5	16.50
12	Sigtronics Intercom	SPA-400	0.30	18.0	5.40
13					
14					
15					
	SUB TOTAL REMOVED EQUIPMENT:		-25.10	17.44	-437.70

ITEM	INSTALLED EQUIPMENT	MODEL or P/N	WEIGHT (pounds)	CG ARM (inches)	MOMENT (in-lb)
1	Garmin GPS-WAAS/NAV/COM	GTN 650	7.00	15.0	105.00
2	Garmin GPS-WAAS Antenna	GA 35	0.50	110.0	55.00
3	Garmin NAV/COM	GNC 255A	4.00	15.0	60.00
4	Garmin Transponder	GTX 345	3.10	15.0	46.50
5	Garmin CDI	GI 106B	1.40	17.5	24.50
6	Mid-Continent CDI	MD200-306	1.40	17.5	24.50
7	Garmin Audio Panel	GMA 340	1.70	16.5	28.05
8					
9					
10					
11					
12					
13					
14					
15					
	SUB TOTAL INSTALLED EQUIPMENT:		19.10	17.99	343.55

NOTE: IT IS THE RESPONSIBILITY OF THE PILOT TO ENSURE THAT THE AIRPLANE IS LOADED PROPERLY

NORMAL CATEGORY OPERATION	WEIGHT (pounds)	CG ARM (inches)	MOMENT (in-lb)	NEW %MAC
NEW BASIC EMPTY WEIGHT (BEW):	1743.70	43.74	76268.88	N/A

Signature Richard Brooks for CRS YXXR387Y DATE: 11-10-16

This BEW report supersedes and makes obsolete BEW report dated: 25-Oct-16

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