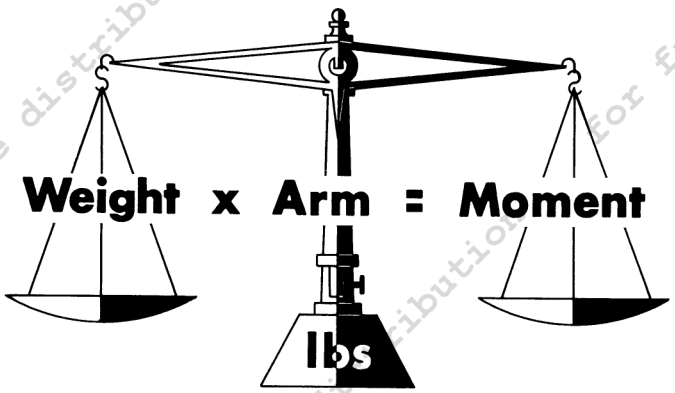
Depa. of Transportation

FEDERAL AVIATION ADMINISTRATION

IFR PILOT EXAM-O-GRAM* NO. 21

IFR Weight and Balance Computations



Applicants preparing for the instrument pilot written examination should be familiar with weight and balance computations as they pertain to instrument flight. Although weight and balance is a prime consideration for every flight, instrument conditions make the consequences of improper loading particularly unsafe. If the total weight of the aircraft is beyond the maximum limit, there is an increase in stalling and landing speeds as well as a decrease in rate of climb, ceiling, and safety factor in turbulent air. If the center of gravity is located outside of allowable limits, the stability of the airplane may be affected and control forces may be erratic. Any of these adverse flight conditions add to the burden imposed on a busy pilot in an instrument environment.

When preparing for an instrument flight, the pilot should systematically check the weight and balance situation as part of his preflight planning. He should take into consideration:

1. Empty weight and center of gravity from airplane records.
2. Actual weights and seating locations of pilot and passengers.
3. Baggage weight and location.
4. Fuel as loaded, or at least a minimum to fly:

    a. To first airport of intended landing.
    b. To alternate (if required by FAR 91.83).
    c. Forty-five minutes at normal cruising speed.

He should apply this information to the charts, tables or instructions in the Airplane Owner's Manual. If limitations are not exceeded, he can conduct a safe operation. If the loading is over maximum design weight or out of allowable center of gravity range, an adjustment must be made in order to maintain safe operations.

A typical weight and balance problem found in the Instrument Pilot Written Examination, or on an actual Instrument Flight, is presented here as an example.

* Exam-O-Grams are non-directive in nature and are issued solely as an information service to individuals interested in Airman Written Examinations.

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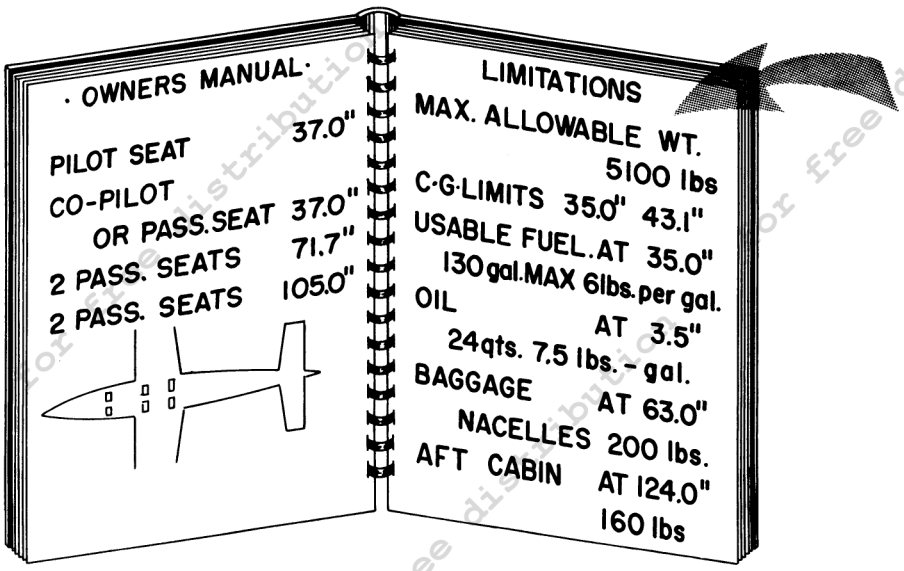
Assume that you are planning a flight in a light twin-engine airplane and that your load consists of four passengers, full fuel, and 360 lbs. of baggage. The weight and balance computations for this flight may be approached and solved as follows:

A. Check the limitations in the AIRPLANE OWNER'S MANUAL



B. Determine the Empty Weight and the Empty Weight Center of Gravity from the latest weight and balance report in the Airplane's Records.

EMPTY WEIGHT	3450 lbs.
EMPTY WEIGHT CENTER OF GRAVITY	36.5" from datum

C. Determine if the Maximum Allowable Weight is exceeded:

Empty weight		3450
Pilot & passenger	155 + 165 lbs	320
Two passengers	160 + 200 lbs	360
One passenger	170 lbs	170
Baggage, Nacelles		200
Baggage, Aft Cabin		160
Fuel	Full	780
Oil	Full	45
		5485 lbs

The maximum allowable weight limit of 5100 lbs. is exceeded by 385 lbs. This condition must be corrected before flight and before a check can be made on the center of gravity location. There are three parts of the useful load which can be off-loaded to reduce weight--fuel, baggage, or passengers. The selection of one or several of these possibilities depends upon the requirements for the flight.

If conditions are such that all passengers and their baggage need to go on the flight, you can carefully calculate your fuel requirements and reduce the fuel load to the minimum required by FAR 91.23.

FUEL REQUIRED FOR IFR FLIGHT

TO THE FIRST AIRPORT OF INTENDED LANDING	43 gals.
TO THE ALTERNATE AIRPORT	27 gals.
(Assume ceilings are low at first airport)	
TO FLY 45 MINUTES AT CRUISING SPEED	20 gals.
	90 gals.

You can reduce the fuel load to 90 gal., a reduction of 240 lbs. This helps, but it is not enough. Now you must insist that either some of the baggage be off-loaded or someone stay home. For the sake of the problem, let's assume that you remove 145 lbs. of baggage from the nacelles. The total weight is thereby reduced 385 lbs., bringing the airplane weight within the maximum allowable limit.

D. Determine if the Center of Gravity is within limits. Although many Owner's Manuals provide short-cut methods, Center of Gravity can always be calculated by dividing total moments by total weight. Moments are a product of weight times arm for each item, and the arm is an indication of the location of the item expressed in inches from a standard datum line. Using the arms given in the owner's manual and the weights calculated in step C above you obtain:

ITEM	WEIGHT (lbs.)	X	ARM (in.)	=	MOMENTS
Empty weight	3450		36.5		125925.0
Pilot & passenger	320		37.0		11840.0
Two passengers	360		71.7		25812.0
One passenger	170		105.0		17850.0
Baggage (Nacelles)	55		63.0		3465.0
Baggage (Aft cabin)	160		124.0		19840.0
Fuel	540		35.0		18900.0
Oil	45		3.5		157.5
	5100				223789.5

CENTER OF GRAVITY $223789.5 \div 5100 = 43.88$

Out of limits again! These calculations show that the center of gravity is located .78" behind the aft limit, and an unsafe flight condition exists.

You can make a correction by moving some of the heavier loads to relatively forward locations. This can be accomplished by having the passengers swap seats or by moving some baggage to forward compartments. In this case, we assume that you elect to shift 145 lbs. of baggage from the aft cabin to the nacelles; now, the moments for these items are:

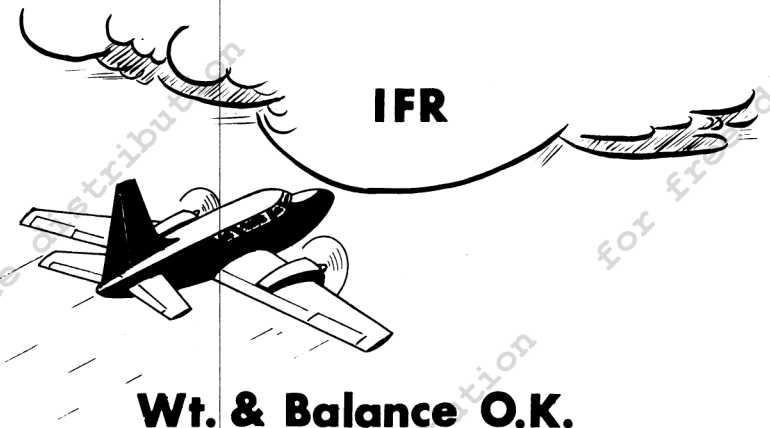
	WEIGHT	ARM	MOMENTS
Baggage (Nacelles)	200	63.0	12600.0
Baggage (Aft Cabin)	15	124.0	1860.0

When these new moments are used in the calculations, we find that the total moments have changed to 214944.5, even though the total weight remained constant at 5100 lbs.

CENTER OF GRAVITY $214944.5 \div 5100 = 42.15$

Within limits! However, you should investigate the effect of fuel burn on Center of Gravity location for your particular aircraft.

The weight and balance problem for the flight has been solved--and a dangerous flight condition has been averted. By carefully limiting fuel to that required for the flight and by proper placement of the baggage, all limitations have been observed. All passengers can go on the flight, and you are assured that, as far as weight and balance is concerned, your preflight action will result in a safe IFR flight.



Wt. & Balance O.K.