

U.S. DEPARTMENT OF TRANSPORTATION
Federal Aviation Administration
VFR PILOT EXAM-O-GRAM* NO. 13

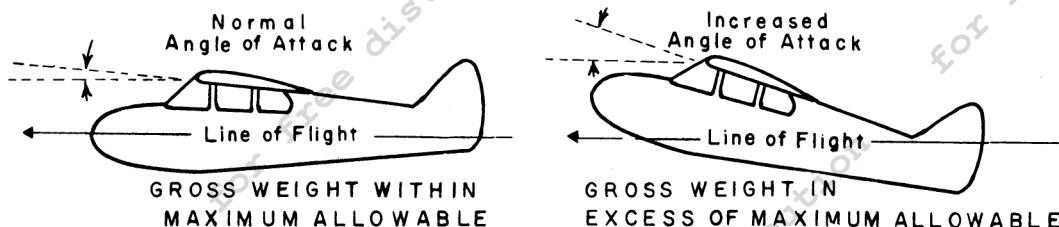
WEIGHT AND BALANCE

Loading the family automobile for a trip requires little serious planning. You can C-R-A-M as much luggage into the trunk as you have space, squeeze as many persons into the seats as you have room, and top off the gas tank with no thought given to Gross Weight or Center of Gravity. A similar approach to loading your "flying machine" could result in a serious accident.

WHAT IS EXCESSIVE WEIGHT? Assume that your airplane is a 4-place airplane with a baggage allowance of 120 pounds, a usable fuel capacity of 39 gallons, and an oil supply of 8 quarts. On a hypothetical flight you take on full fuel and oil servicing, toss the suitcases in the baggage compartment, and you and your three passengers eagerly climb aboard. This seems like a reasonable load, but if you had placed each of them on the scales you might have found that you and the passengers average 180 lbs. each (720 lbs.), and the four suitcases, 30 lbs. each (120 lbs.). The usable fuel load weighs 234 lbs. and the oil 15 lbs. Assume, also, that the Weight and Balance Data for the airplane shows an empty weight of 1,325 lbs. and a maximum allowable gross weight of 2,200 lbs. NOW, add the weight of the useful load to the empty weight and compare the total to the allowable gross weight. (1,089 lbs. + 1,325 lbs. = 2,414 lbs.) . . . 214 lbs. excess!

WHAT RESTRICTIONS ARE THERE ON WEIGHT AND BALANCE? In many civilian airplanes it is not possible to fill all seats, baggage compartment, and tanks, and still remain within the approved weight and balance limits. If you do not wish to leave a passenger behind (a normal reaction) you must reduce your fuel load and plan on shorter legs enroute or cut down on the baggage carried, or both. Frequently, restrictions are placed on rear seat occupancy with maximum baggage allowance aboard. By all means follow your airplane's Weight and Balance restrictions. The loading conditions and the empty weight of your particular airplane may differ from those shown in the Owner's Manual, especially if modifications have been made or equipment has been added to the original basic airplane.

IS CRUISE PERFORMANCE AFFECTED BY AN EXCESS LOAD? At normal weight, the airplane requires a certain angle of attack to maintain straight-and-level flight at a given airspeed. To sustain a heavier load at that same airspeed, the angle of attack must be greater to provide the increased lift that is necessary. More power must be added to overcome the increased drag which results from the increased angle of attack. Additional power burns more fuel, thereby reducing the range of the aircraft.



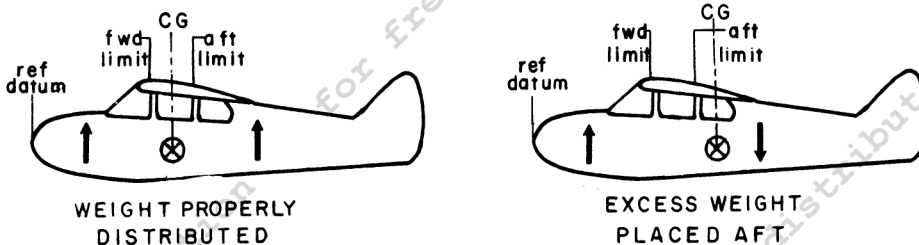
* Exam-O-Grams are non-directive in nature and are issued solely as an information service to individuals interested in Airman Written Examinations.

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IS CLIMB PERFORMANCE AFFECTED BY AN EXCESS LOAD? Time to climb to a given altitude is lengthened, because the angle of attack is greater and the extra thrust required to carry the additional weight limits the rate of climb and may limit the climbing speed, since this depends on the surplus power available. The additional time in climbing at the higher power setting also increases the fuel consumption.

IS "G" FORCE TOLERANCE AFFECTED? Assume that your airplane has a limit-load factor of 3.8 "G's". If the allowable gross weight is not exceeded, this means the wings can safely support 3.8 times the weight of the airplane and its contents. In accelerated flight (pull-ups, turns, turbulent air) the actual load on the wings would be much greater than the normal load, which of course results in much greater stresses in the wing structure. Overloading, therefore, has the effect of decreasing the "G" load capability of the aircraft and thus could result in the wing being stressed to the point of popped rivets, permanent distortion, or structural failure.

HOW IS AN AIRPLANE BALANCED? An airplane, like a steelyard scale, is in perfect balance when the weight is distributed in such a manner that it remains level when freely suspended. In an airplane, however, as long as the Center of Gravity lies anywhere within specified limits, balance can be maintained in flight. Flight with the CG outside of this range results in unsatisfactory or dangerous flight characteristics. Loading an airplane then, is simply a matter of distributing the load so that the CG falls within the allowable range. This can be accomplished by arranging the load in accordance with the Center of Gravity Envelope provided for each airplane.



DOES IMPROPER LOAD DISTRIBUTION AFFECT SAFETY? YES! When loading conditions cause the Center of Gravity to fall outside allowable limits, stability is adversely affected and erratic control forces may develop. Stalling speed, takeoff distance, and landing speed may be increased to the point of actual danger.

Due to the size of many baggage compartments there might be a tendency to fill them to capacity, ignoring the placarded baggage weight limitations. This could produce a Center of Gravity aft of allowable limits creating a highly dangerous flight condition. The result would be a nose high attitude which could lead to a stall from which recovery might not be effected due to inadequate elevator control.

**AN AIRPLANE'S BEHAVIOR IN THE AIR
IS DEPENDENT ON WEIGHT AND BALANCE!**