Private Pilot (ASEL) Ground School Course

Lesson 10 | Weight and Balance

Lesson Overview

Lesson Objectives:

- Develop a knowledge of aircraft weight and balance terms and principles.
- Develop an understanding of to correct weight and balance issues.
- Skill to correctly determine through calculation if an airplane is loaded within limits.

Lesson Completion Standards:

- Student demonstrates satisfactory knowledge of weight and balance by answering questions and actively participating in classroom discussions.
- Correctly calculates a weight and balance problem.

Weight & Balance

- All airplanes have limits on the maximum weight they can carry and where that weight is placed within the airplane
- Within these limits, airplanes perform normally; outside of them, they behave erratically
- Structural damage and in-flight stability are the two most important reasons why an airplane’s weight is restricted, and why the weight must be distributed in a certain way
- Calculating whether the plane is within its stated restrictions is referred to as doing a weight-and-balance calculation
- Crucial part of preflight planning

Terms

Weight and Balance

Weight and Balance Terminology

- *Note: Terms defined by the General Aviation Manufacturers Association as industry standard are marked with GAMA*

Weight Terms

- *Standard Empty Weight* (GAMA): Aircraft weight that consists of the airframe, engines, and all items of operating equipment that have fixed locations and are permanently installed in the aircraft, including fixed ballast, hydraulic fluid, unusable fuel, and full engine oil
- *Basic Empty Weight* (GAMA) - Standard empty weight plus the weight of optional and special equipment that have been installed
- *Licensed Empty Weight* - The empty weight that consists of the airframe, engine(s), unusable fuel, and undrainable oil plus standard and optional equipment as specified in the equipment list (prior to GAMA standardization)

Weight Terms

- ***Fuel Load:*** The expendable part of the load of the aircraft (includes only usable fuel)
- ***Useful Load:*** Weight of the pilot, copilot, passengers, baggage, usable fuel, and drainable oil (is the basic empty weight subtracted from the MAGW)
- ***Payload*** (GAMA): Weight of occupants, cargo, and baggage
- ***Gross Weight = Empty Weight + Useful Load***

Weight Terms

- ***Standard Weights:*** Established weights for numerous items involved in weight and balance computations
  - Gasoline: 6 lb/gal
  - Jet A, Jet A-1: 6.8 lb/gal
  - Jet B: 6.5 lb/gal
  - Oil: 7.5 lb/gal (not quarts)
  - Water: 8.35 lb/gal

Weight Terms

- ***Maximum Zero Fuel Weight*** (GAMA): Maximum weight, exclusive of usable fuel
- ***Maximum Ramp Weight:*** Total weight of a loaded aircraft including all fuel (greater than the takeoff weight due to the fuel that will be burned during the taxi and run-up operations)
- ***Maximum Takeoff Weight:*** Maximum allowable weight for takeoff
- ***Maximum Landing Weight:*** Greatest weight an aircraft can have at landing

CG Terms

- ***Center of Gravity (CG):*** Point about which an aircraft would balance if it were possible to suspend it at that point (expressed in inches from the reference datum or in percent of MAC)
- ***CG Limits:*** Specified forward and aft points within which the CG must be located during flight (are indicated on pertinent aircraft specifications)
- ***CG Range:*** Distance between the forward and aft CG limits indicated on pertinent aircraft specifications

More Terms

- ***Moment Index:*** Moment divided by a constant such as 100, 1,000, or 10,000 to simplify weight and balance computations of aircraft where heavy items and long arms result in large, unmanageable numbers
- ***Station:*** Location in the aircraft that is identified by a number designating its distance in inches from the datum (datum is identified as station zero - an item located at station +50 would have an arm of 50 inches)
- ***Delta:*** Greek letter expressed by the symbol Δ indicate a change of values (Δ CG indicates a change or movement of the CG)
- ***Floor Load Limit:*** Maximum weight the floor can sustain per square inch/foot as provided by the manufacturer

Effect of Weight and Balance on Performance

Weight and Balance

Excessive Weight And Structural Damage

- Airplane wings are designed to support a certain amount of weight
- Excessive weight can damage a wing
- Airplanes are designed to be flown up to a specific maximum gross weight
- While it’s possible to become airborne beyond this maximum certified weight, structural problems can arise when turbulence or high-G maneuvering is experienced

Excessive Weight And Structural Damage

- If an airplane is certified in the utility category, it can withstand 4.4 positive Gs without structural damage
- If it has a maximum gross weight of 2,000 pounds, its wings are certified to withstand 4.4 times the maximum gross weight of 2,000 pounds or a total of 8,800 pounds
- Distributing 8,800 pounds of force over the wings will bend them slightly
- When the force is removed, the wings will flex back to their original position

Excessive Weight And Structural Damage

- Suppose you take off in the same airplane with a gross weight of 2,100 pounds
- The airplane will still become airborne when only 100 pounds over gross weight
- What happens if turbulence is encountered, and you experienced 4.4Gs?
- The airplane must now support 9,240 pounds of weight (4.4 X 2,100)
- That's 440 pounds <u>*beyond*</u> the 8,800 pounds the engineers designed the structure for

Effects of Weight

- An overloaded aircraft may not be able to leave the ground
- If it does become airborne, it may exhibit unexpected and unusually poor flight characteristics

Performance Deficiencies of an Overloaded Aircraft

- Higher takeoff speed
- Longer takeoff run
- Reduced rate and angle of climb
- Lower maximum altitude
- Shorter range
- Reduced cruising speed
- Reduced maneuverability
- Higher stalling speed
- Higher approach and landing speed
- Longer landing roll
- Excessive weight on the nose wheel

Weight Changes

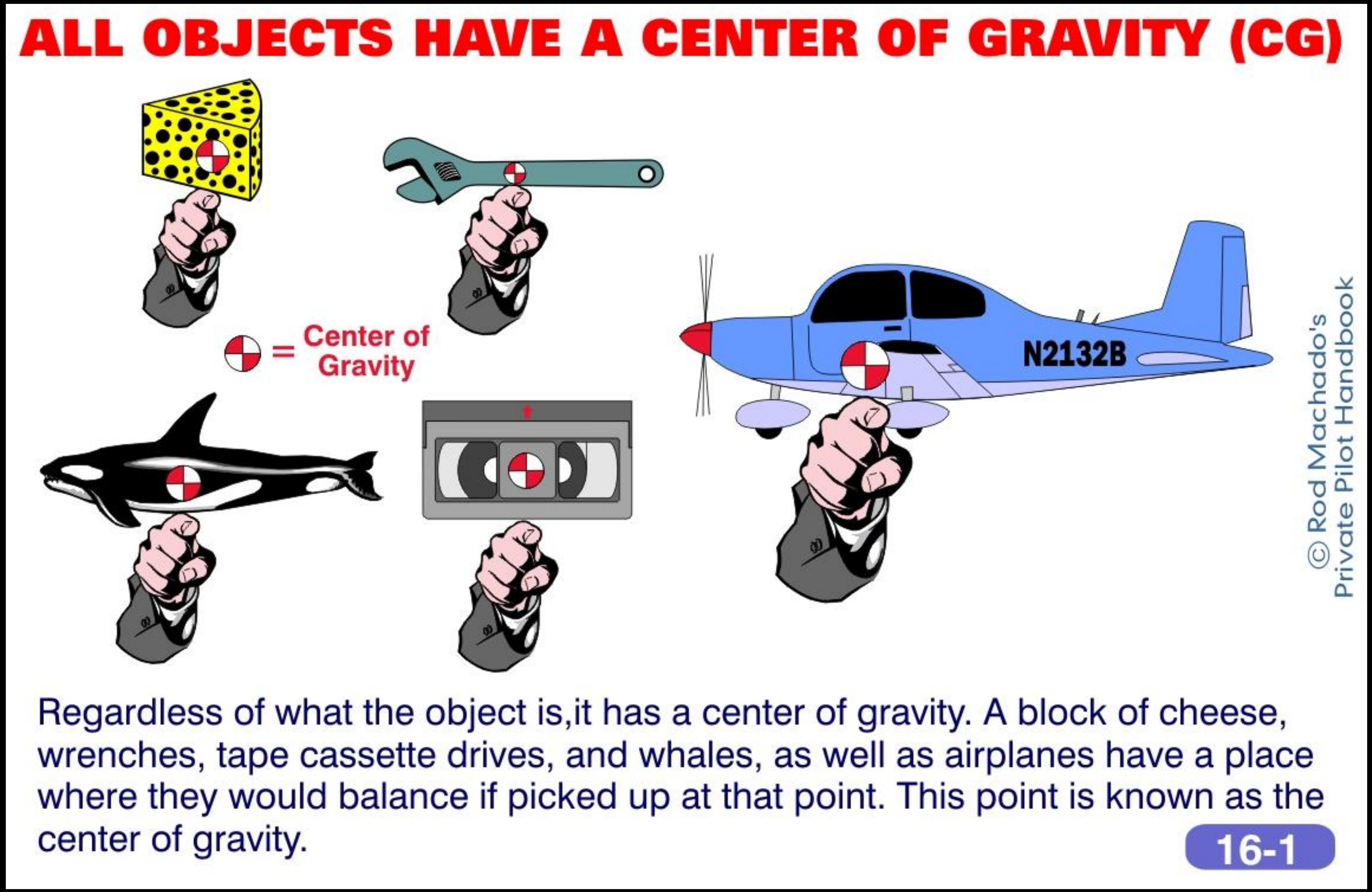
- The operating weight of an aircraft can be changed by altering the fuel load
- Gasoline weighs 6 pounds per gallon
- Thirty gallons of fuel may weigh more than one passenger
- If a pilot lowers airplane weight by reducing fuel, the resulting decrease in the range of the airplane must be taken into consideration during flight planning

Weight Changes

- During flight, fuel burn is the only weight change that takes place
- As fuel is used the aircraft becomes lighter and performance is improved
- The installation of extra radios or instruments, as well as repairs or modifications, affect the weight of an aircraft

Center of Gravity

- CG of any object is the point where the object would balance
- CG is precisely at the center for an object whose weight is evenly distributed along its length
- For an airplane, where weight is not distributed evenly along its length, you must calculate where the CG is

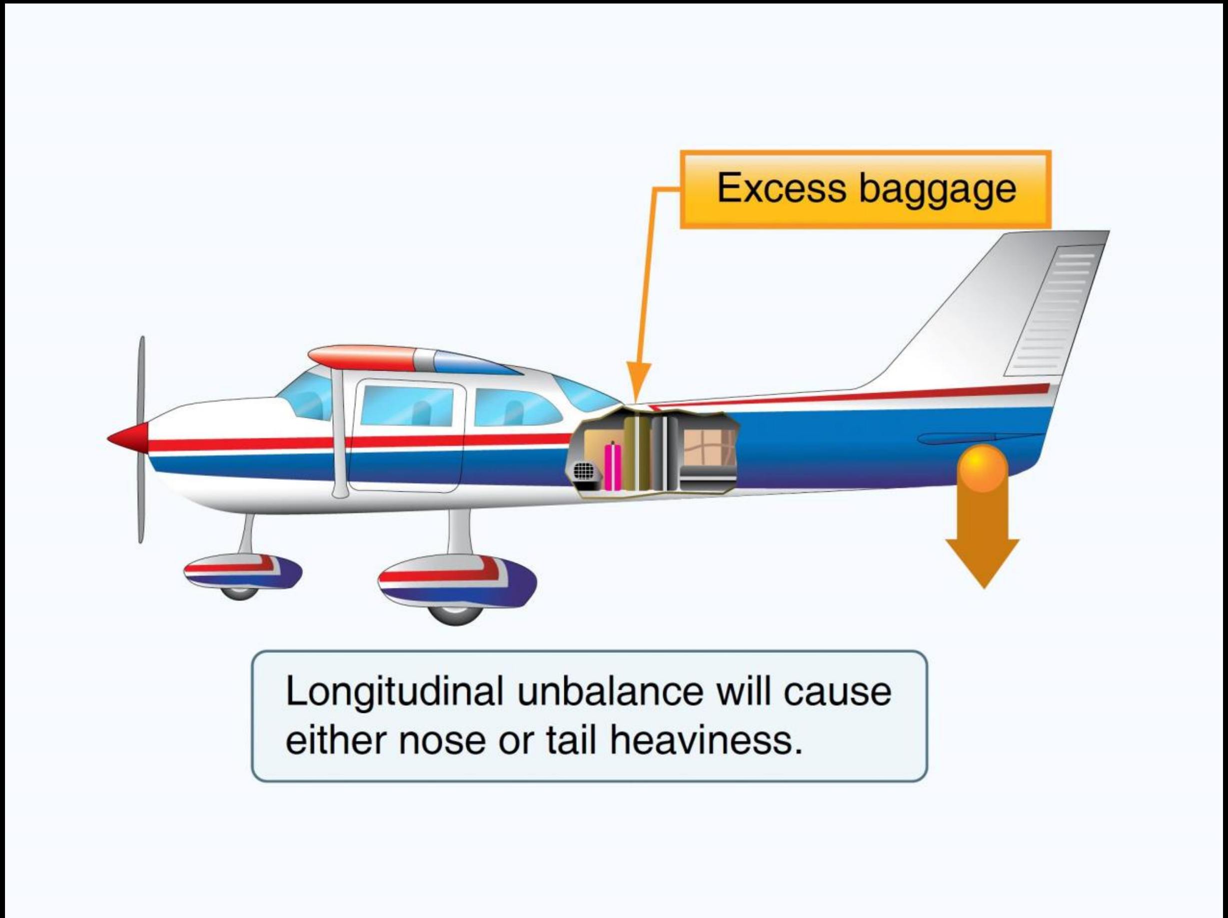


Balance, Stability, and Center of Gravity

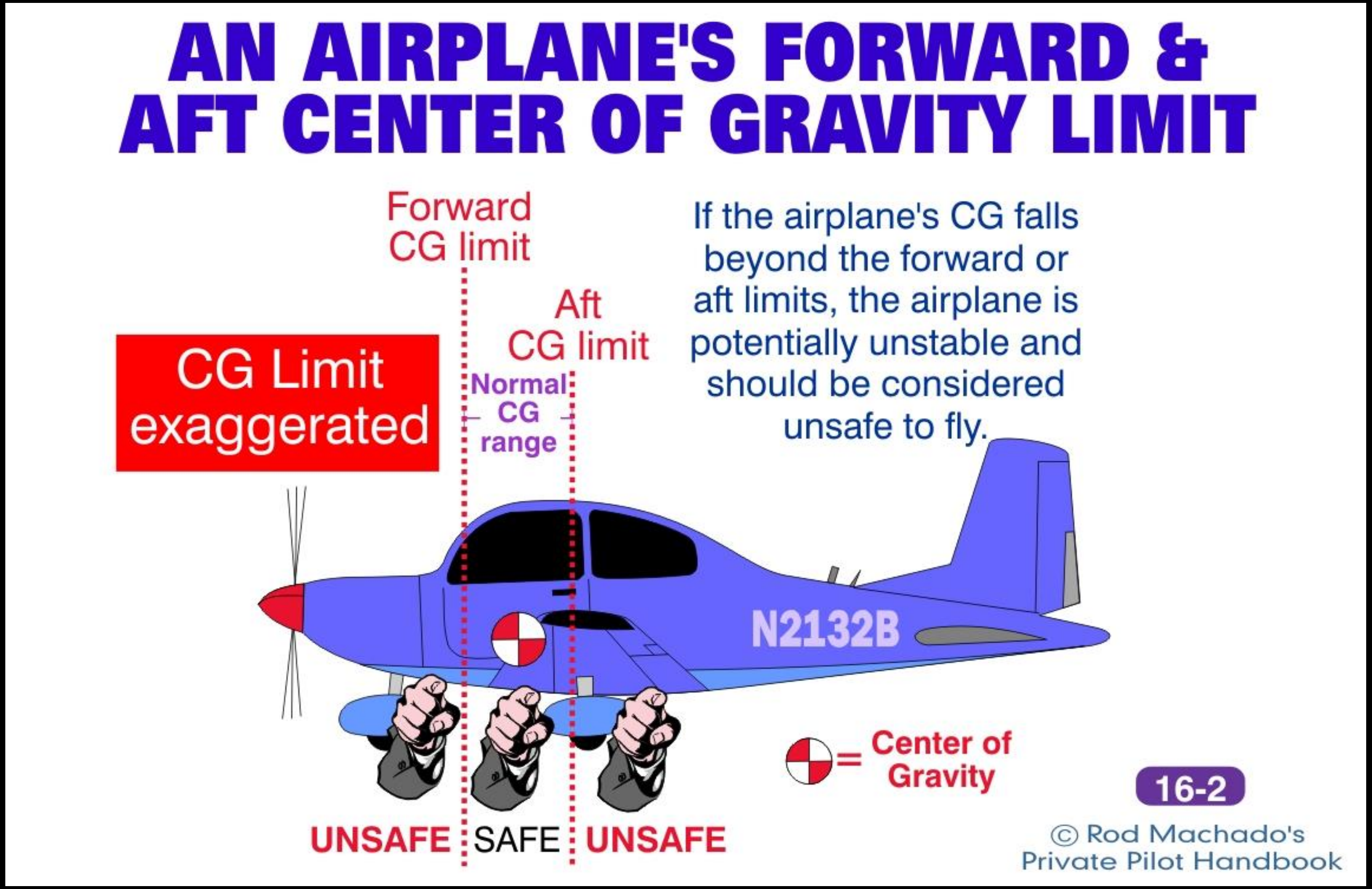
- *Balance* refers to the location of the CG of an aircraft
- The CG is a point at which the aircraft would balance if it were suspended at that point
- The primary concern in balancing an aircraft is the fore and aft location of the CG along the longitudinal axis
- The CG is not a fixed point
- CG location depends on the distribution of weight in the aircraft
- As variable load items are shifted or expended, there is a resultant shift in CG location

CG Displacement

- Too far forward causes nose-heavy condition
- Too far aft causes a tail-heavy condition
- It is possible the pilot could not control the aircraft if the CG location produced an unstable condition



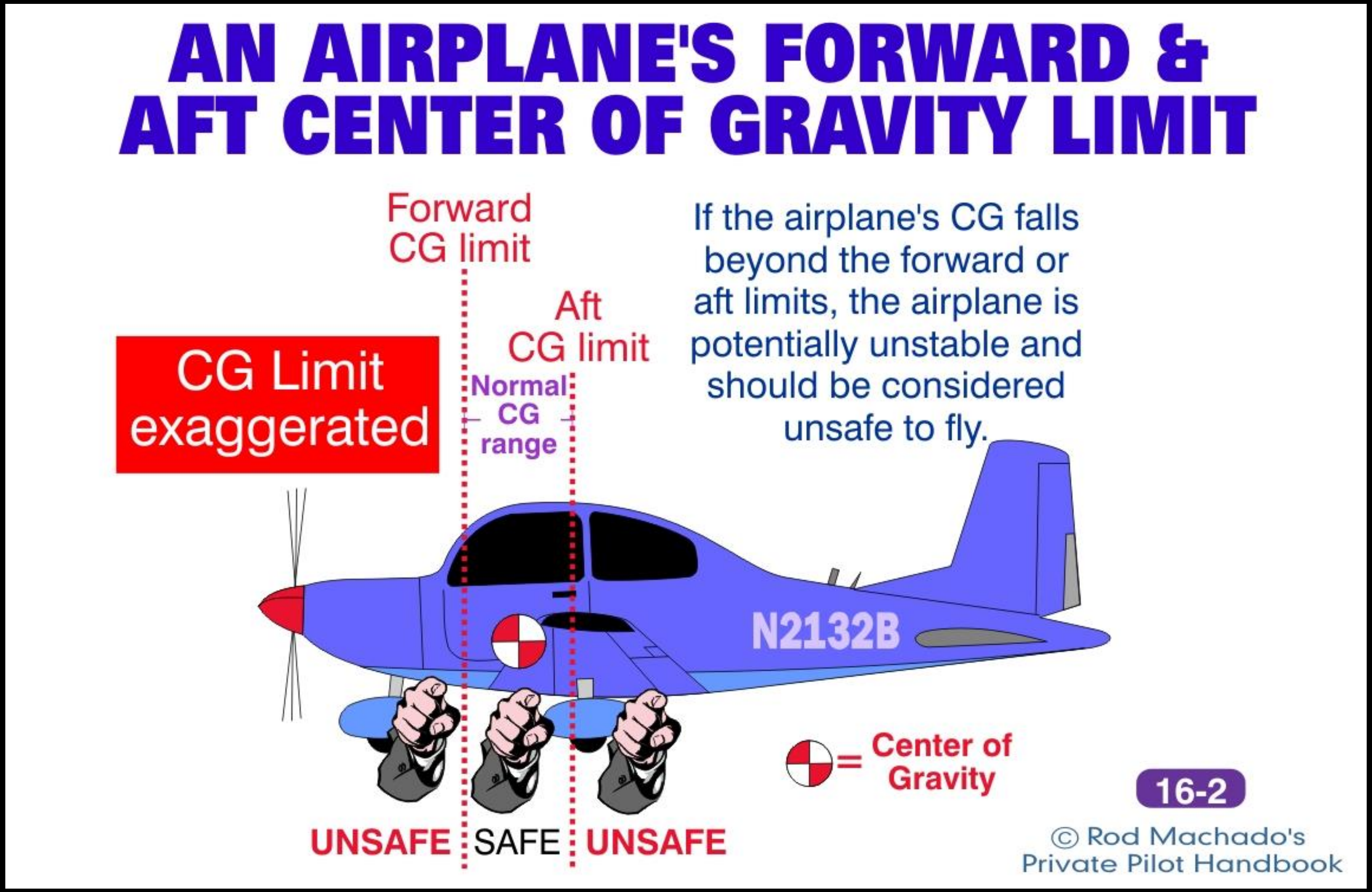
Forward and Aft CG Limits



- Distance between forward and back limits for the CG range is certified for an aircraft by the manufacturer
- Located in AFM/POH
- ***Forward Limit*** located at position where full-up elevator/control deflection is required to obtain a high AOA for landing
- ***Aft Limit*** is the most rearward position at which the CG can be located for the most critical maneuver or operation

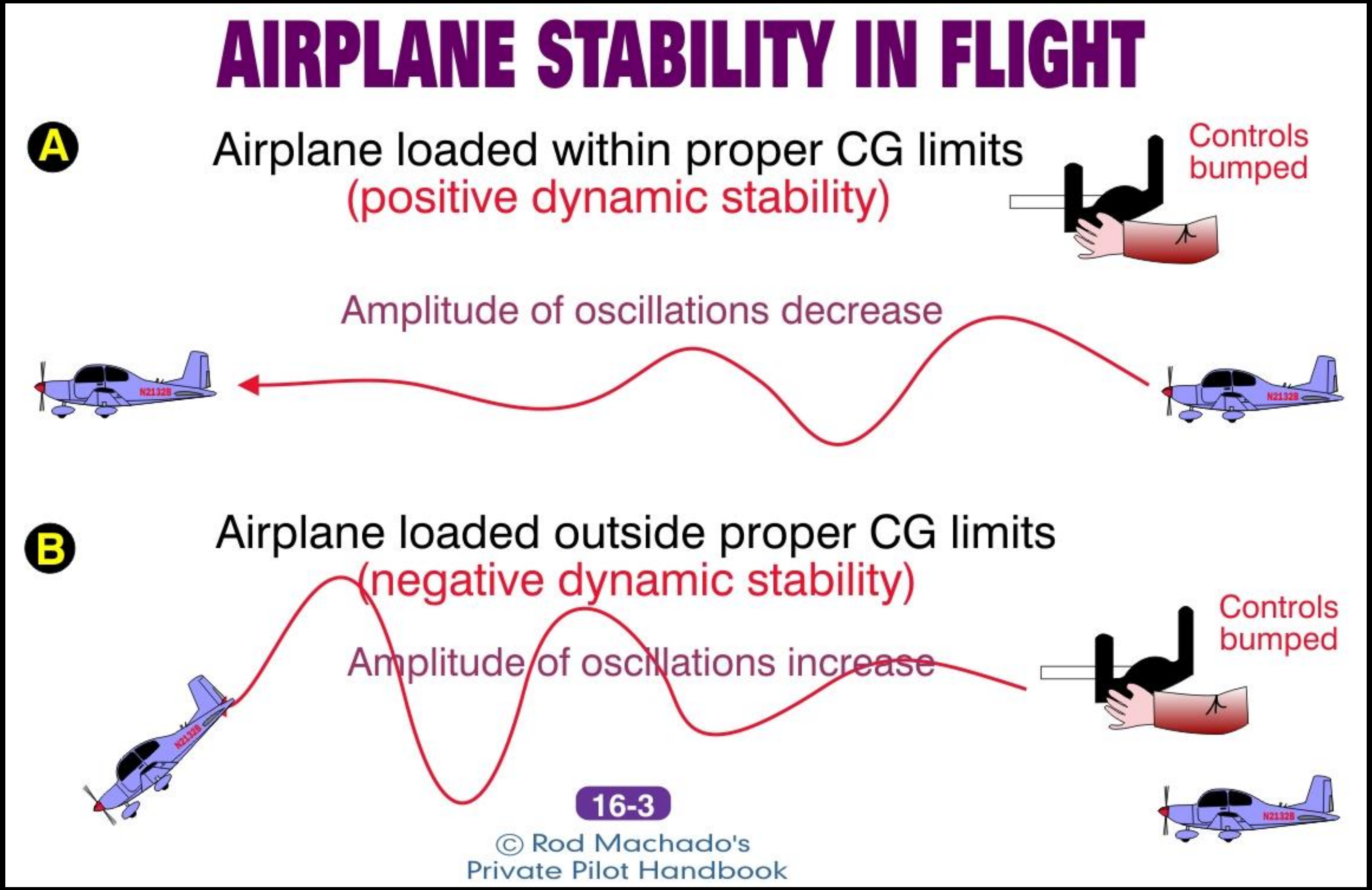
Forward and Aft CG Limits

- For an airplane to be positively stable, its weight must not be concentrated too far aft
- Weight concentrated too far forward may prevent sufficient pitch control to hold the nose up during landing



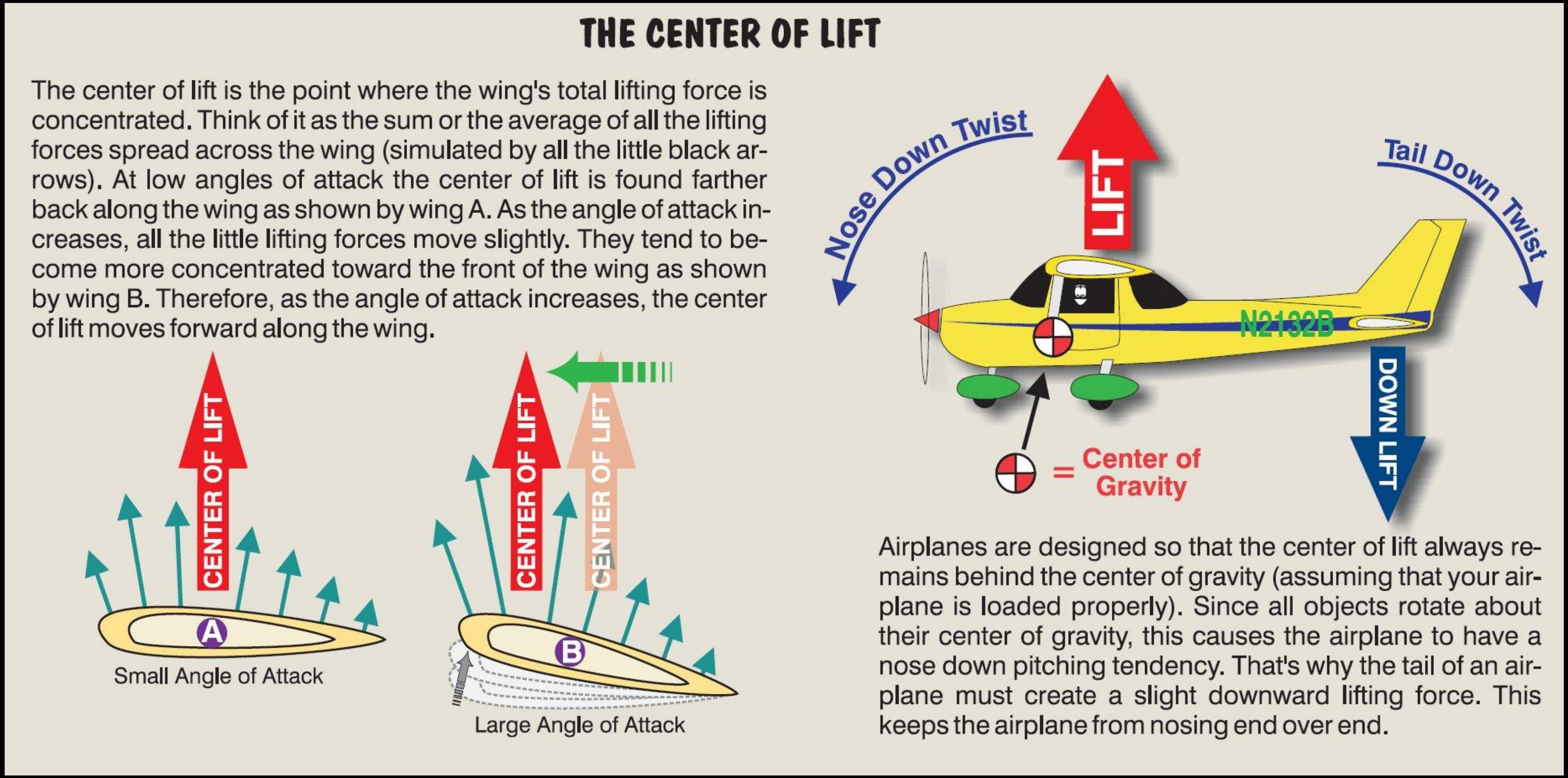
Longitudinal Stability

- If airplane returns to level flight after its controls are disturbed, it has positive dynamic stability, making it less difficult to control
- If airplane does not return to its original flight configuration, and keeps diverging farther from it in a series of oscillations, it has negative dynamic stability

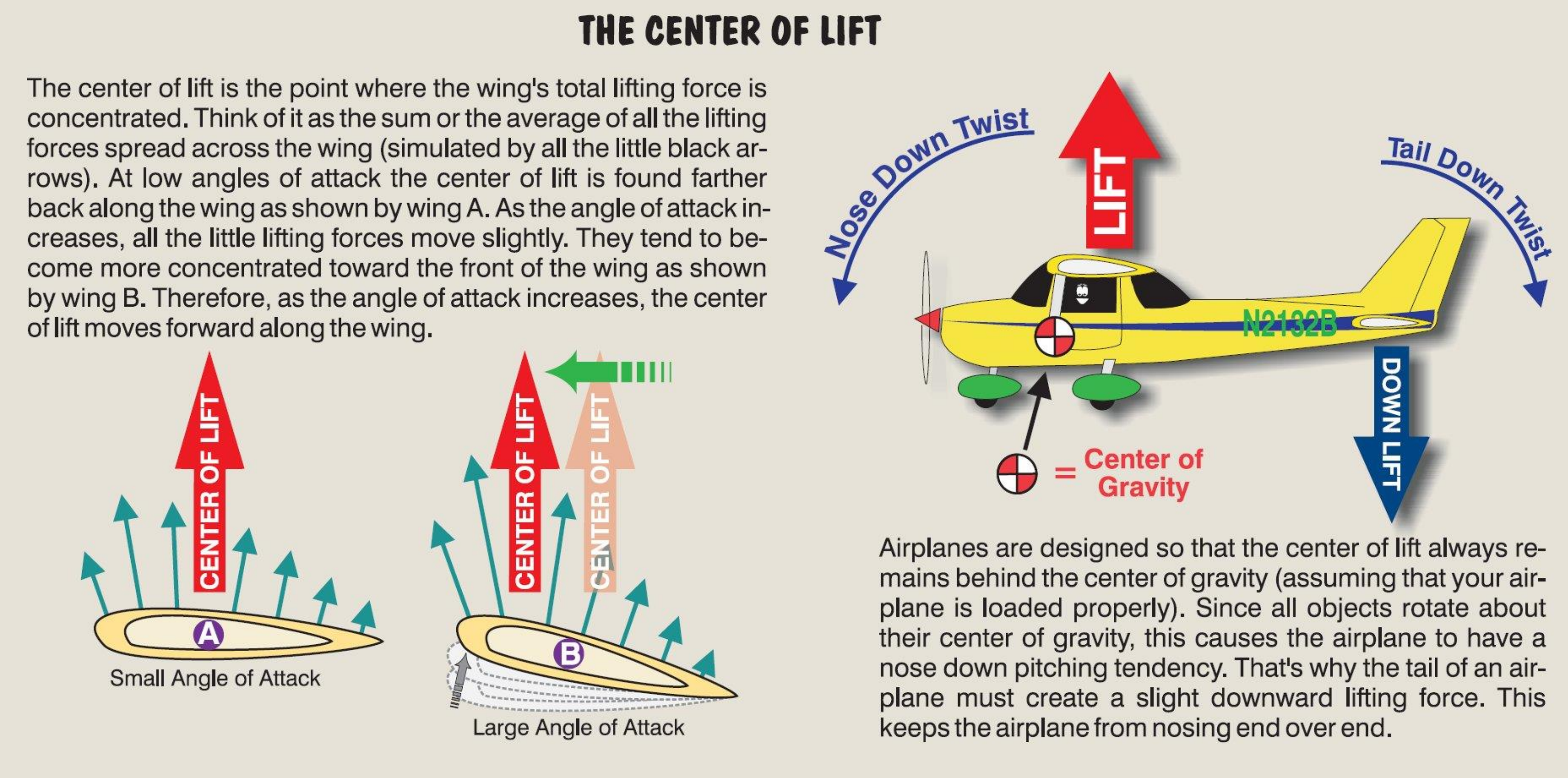


Center of Lift (Center of Pressure)

- Point where wing's total lifting force is concentrated
- Sum of all the lifting forces spread across the wing
- At low AOA the CL is further back along the wing
- As the AOA increases the CL moves forward



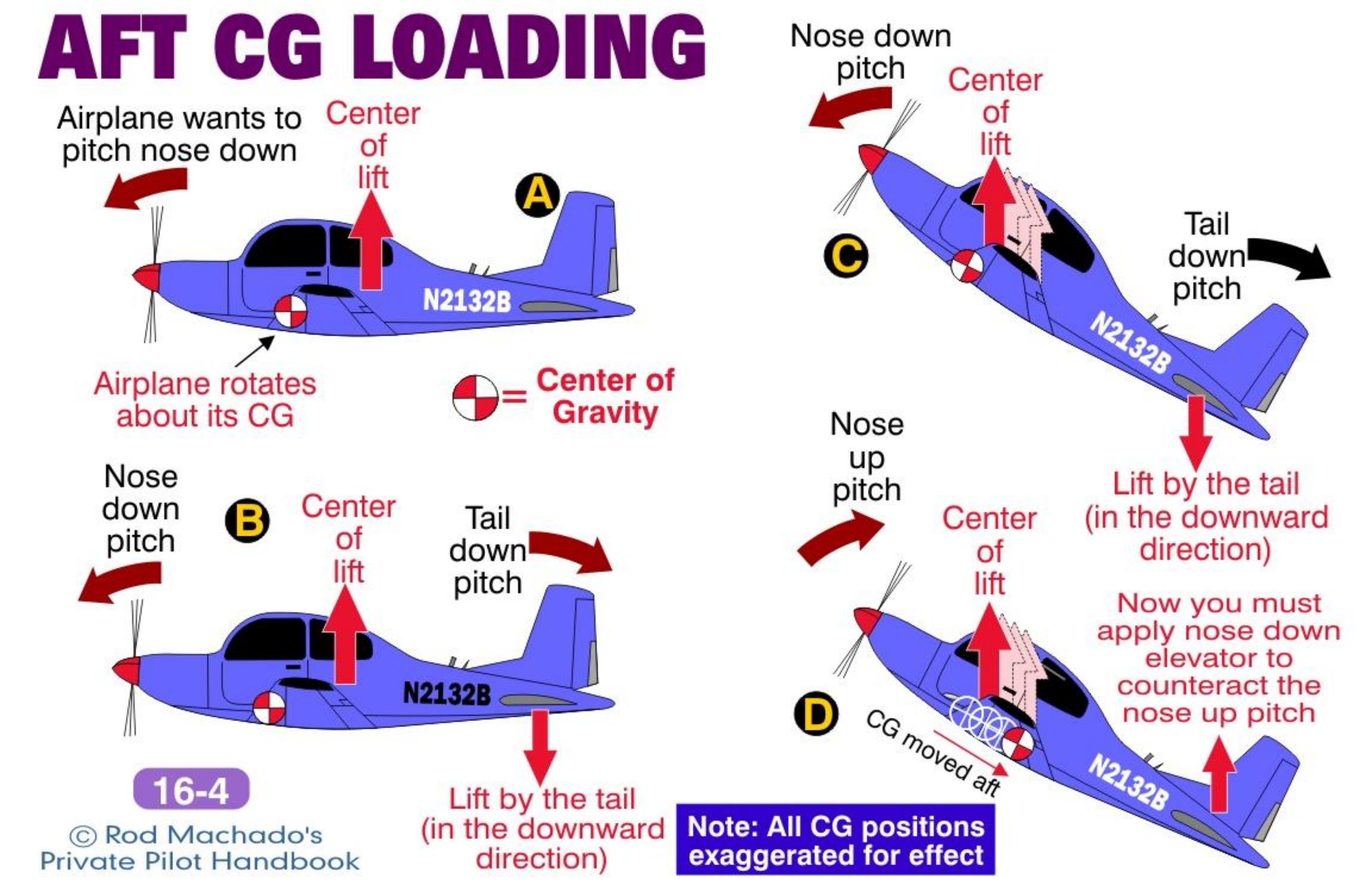
Center of Lift (Center of Pressure)



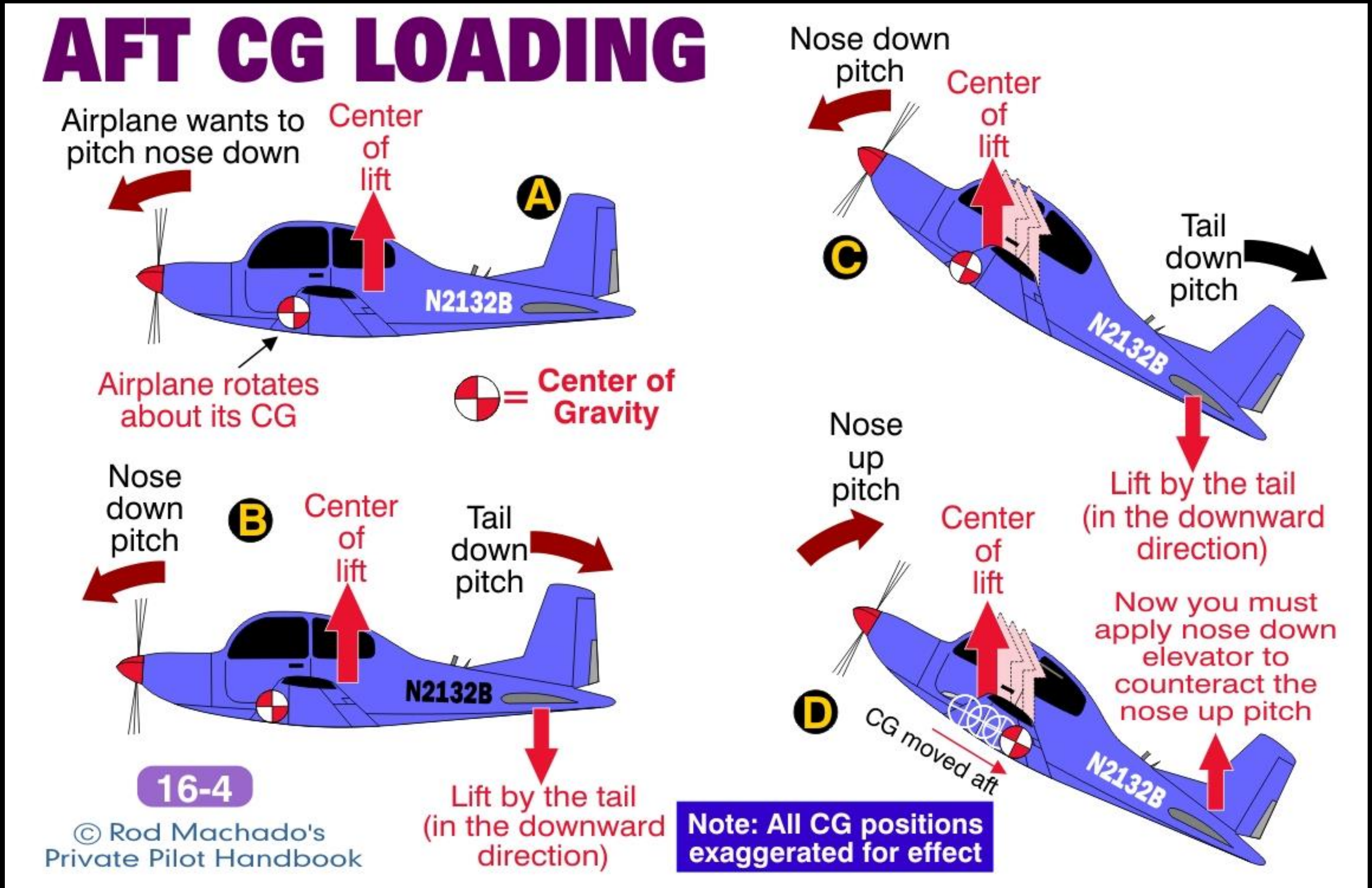
- CL must *always* remain behind the CG
- Causes nose to pitch down
- Tail (horizontal stabilizer) must create a slight *downward* lifting force to balance nose down twist

Aft CG Loading

- If the CG is too far aft, the CL, at high AOA, might move ahead of the CG
- Airplane wants to pitch up and increase its angle of attack even more
- You must apply a lot of forward elevator control to get the nose to pitch down
- Under certain conditions (slow airspeeds and high angles of attack for instance) the airplane may not respond



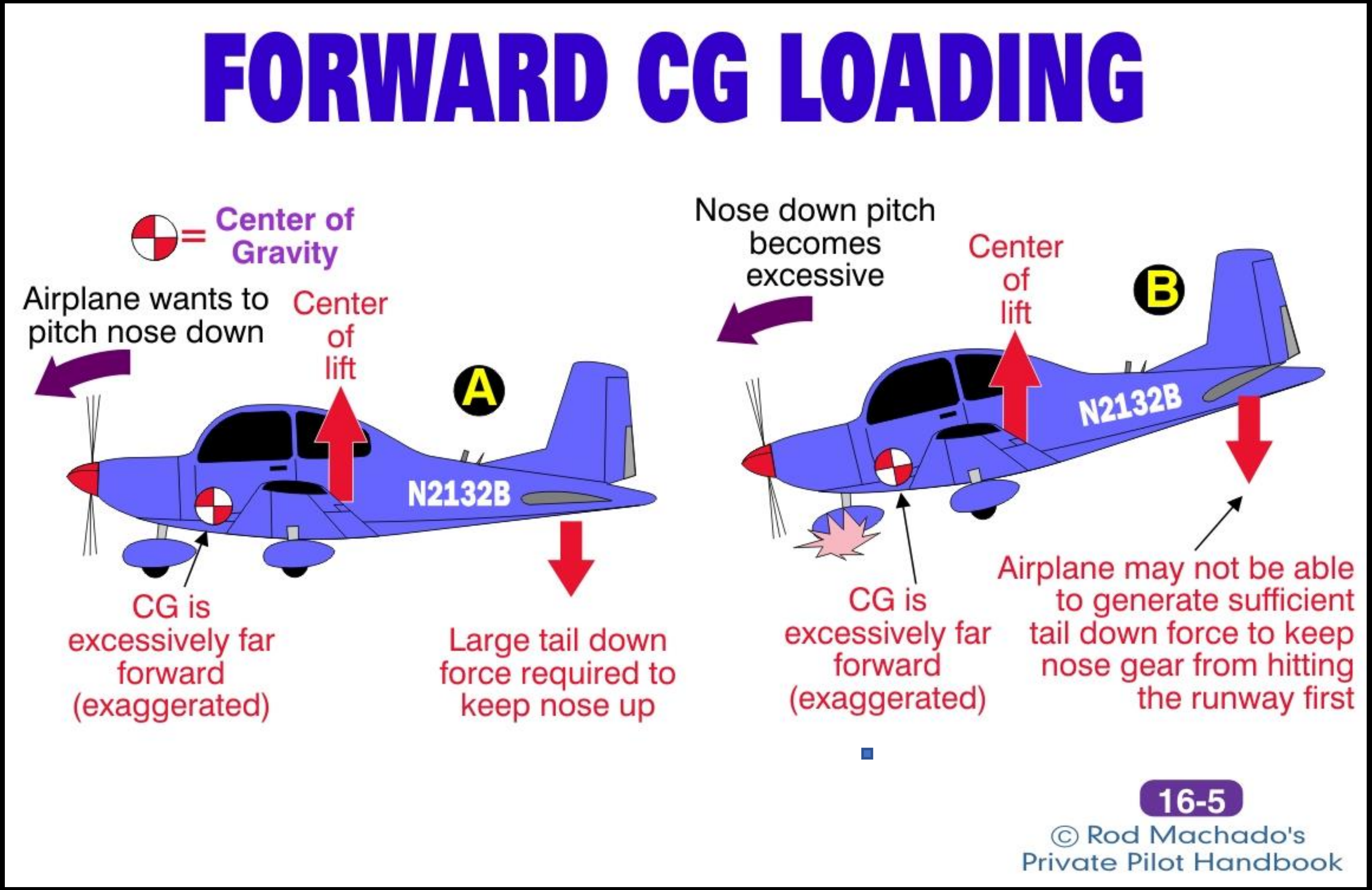
Exceeding Aft CG Limit



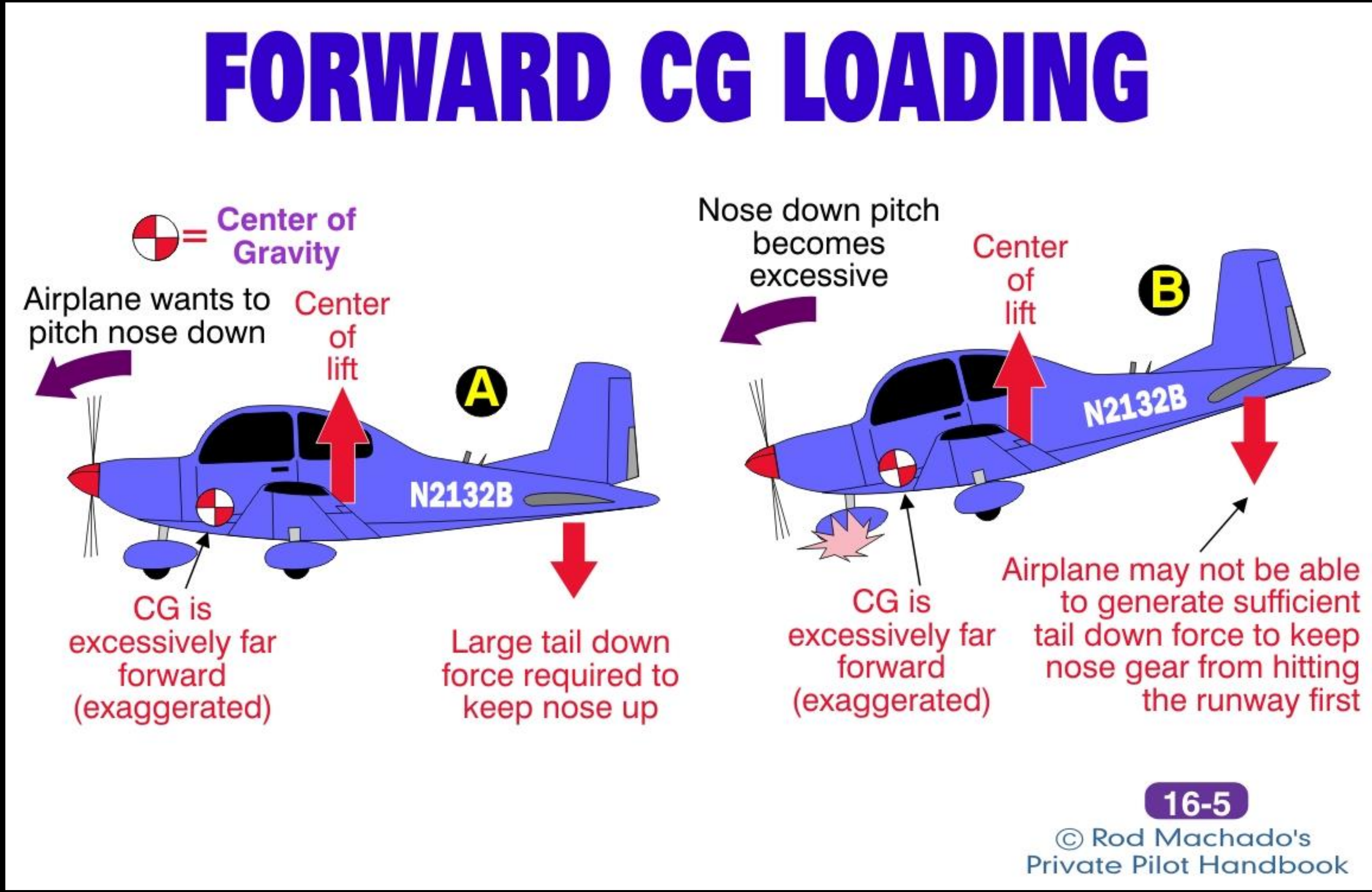
- Decreased longitudinal stability
- Control difficulty
- Violent stall characteristics
- Very light control forces making it easy to overstress an aircraft inadvertently

Fwd CG Loading

- With CG ahead of the forward limit an excessive tail-down force is required to keep the nose up
- During landing, as the airplane slows, there may not be enough airflow over the tail to generate this tail-down force
- Excessive forward loading causes higher stalling speeds, decreased performance, and higher stick forces



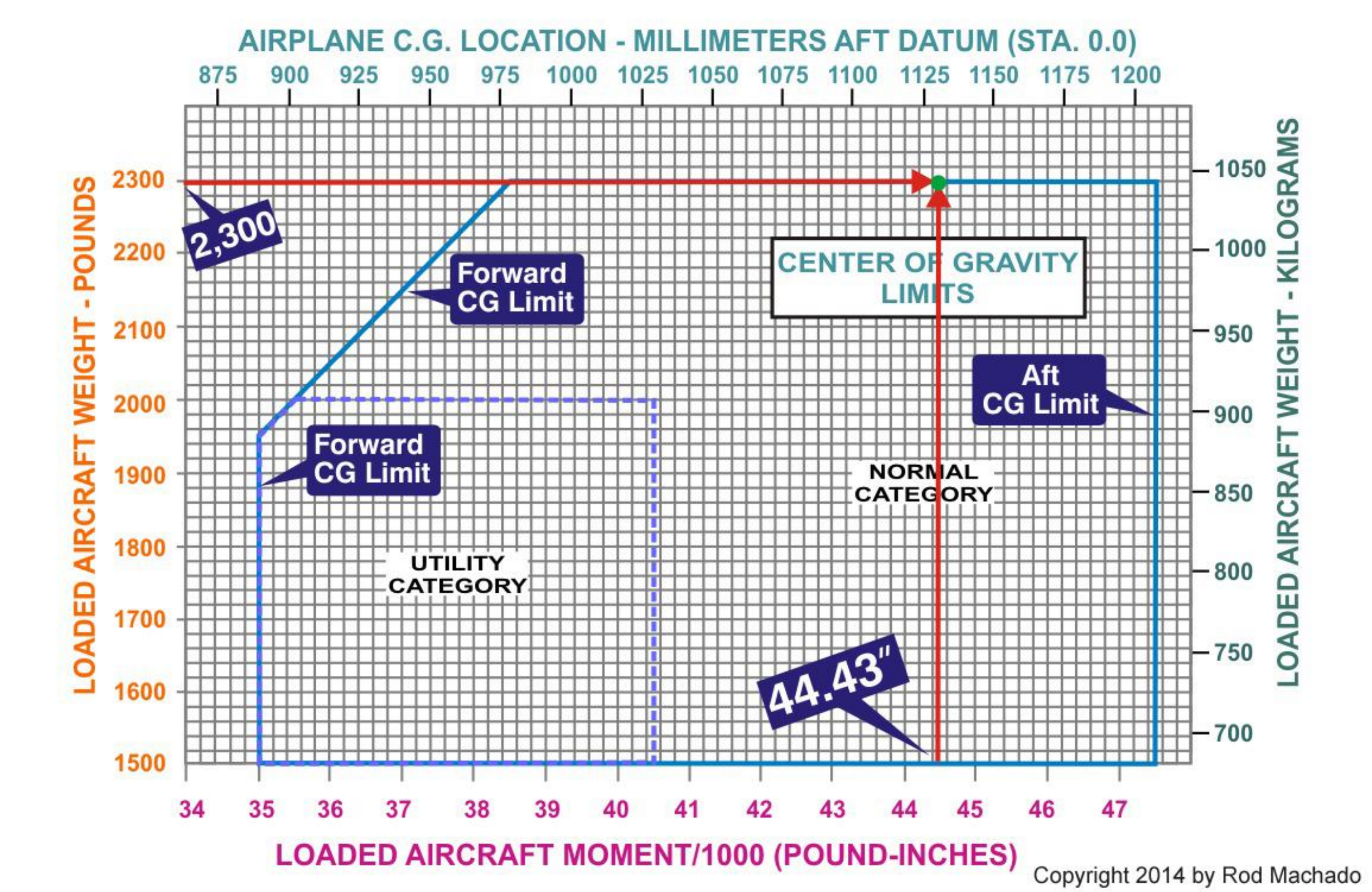
Exceeding Forward CG Limit



- Excessive loads on nosewheel
- Tendency to nose over on tailwheel airplanes
- Decreased performance
- Higher stalling speeds
- Higher control forces

Variable CG Limits

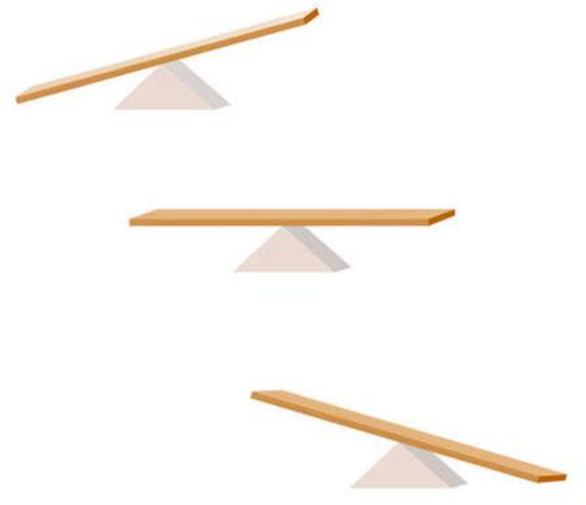
- For some aircraft both fore and aft CG limits may be specified to vary as gross weight changes
- They may also be changed for certain operations:
  - Acrobatic flight
  - Retraction of the landing gear
  - Installation of special loads and devices that change the flight characteristics

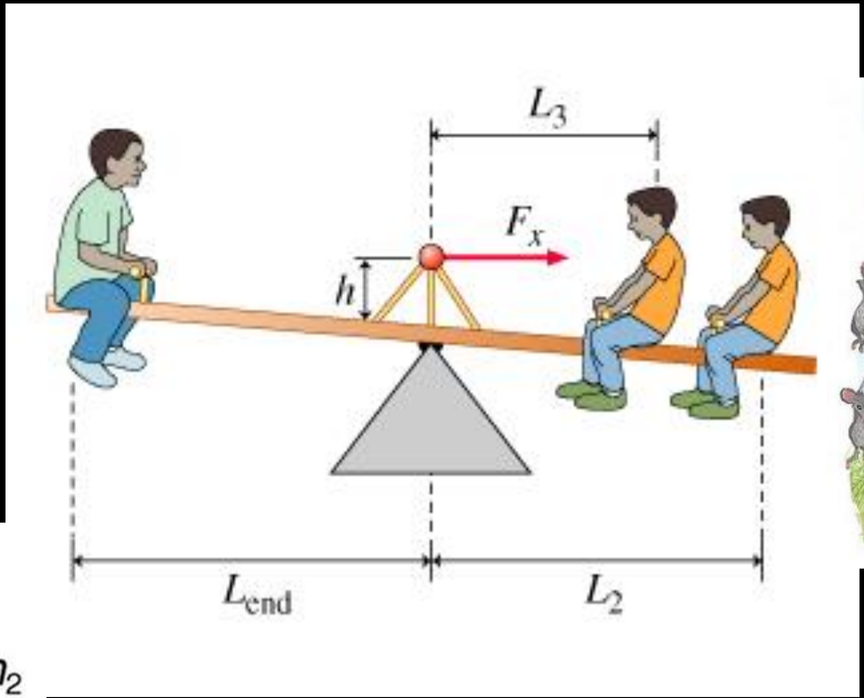


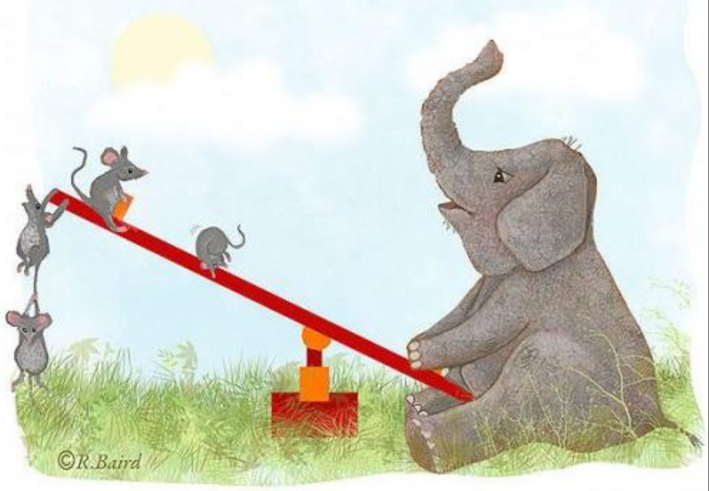
Weight Shifting

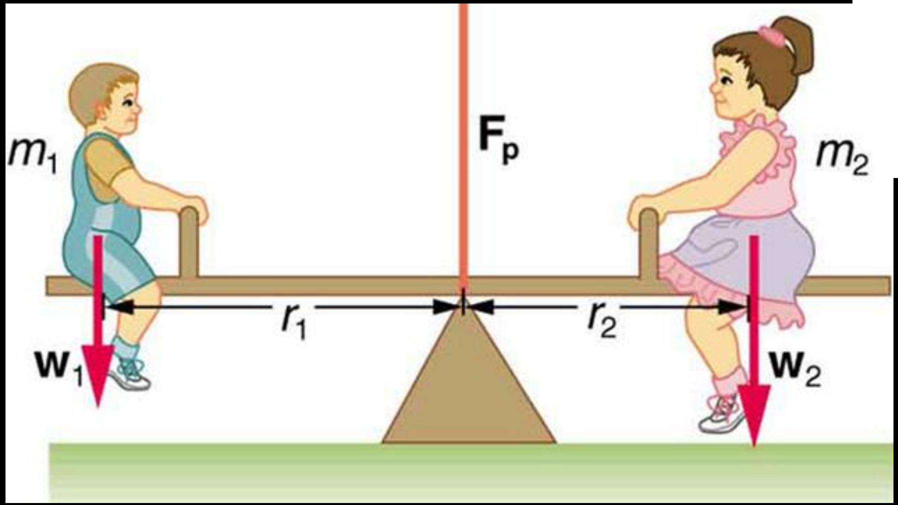
- Actual location of CG can be altered by many variable factors
- Placement of baggage and cargo items determines the CG location
- Assignment of seats to passengers can also be used as a means of obtaining a favorable balance
- If an aircraft is tail heavy place heavy passengers in forward seats
- Fuel burn can also affect the CG based on the location of the fuel tanks
- Most small aircraft carry fuel in the wings very near the CG and fuel burn has little effect on the CG

Wait a *Moment* …Teeter Totters?







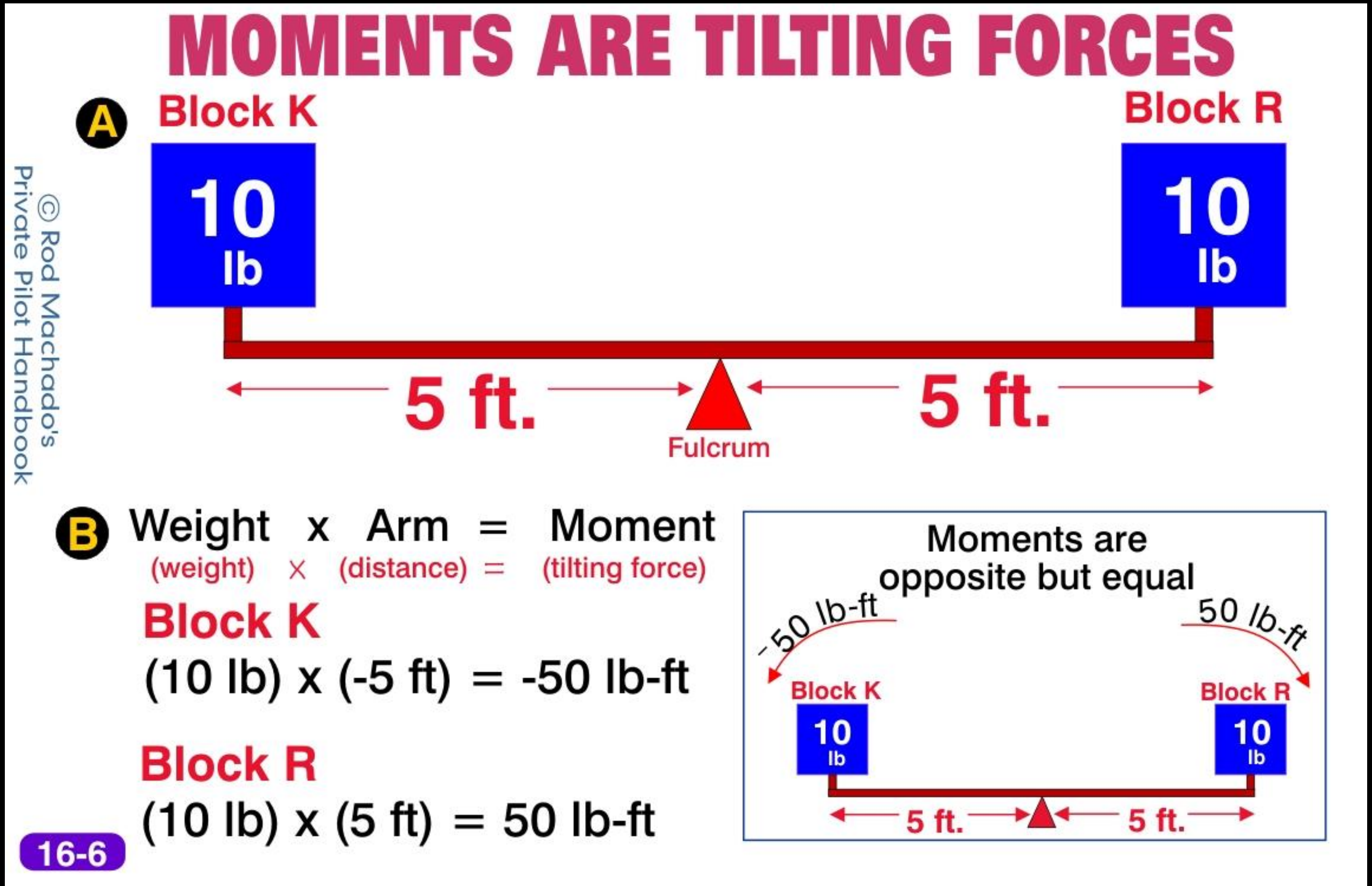


Moments

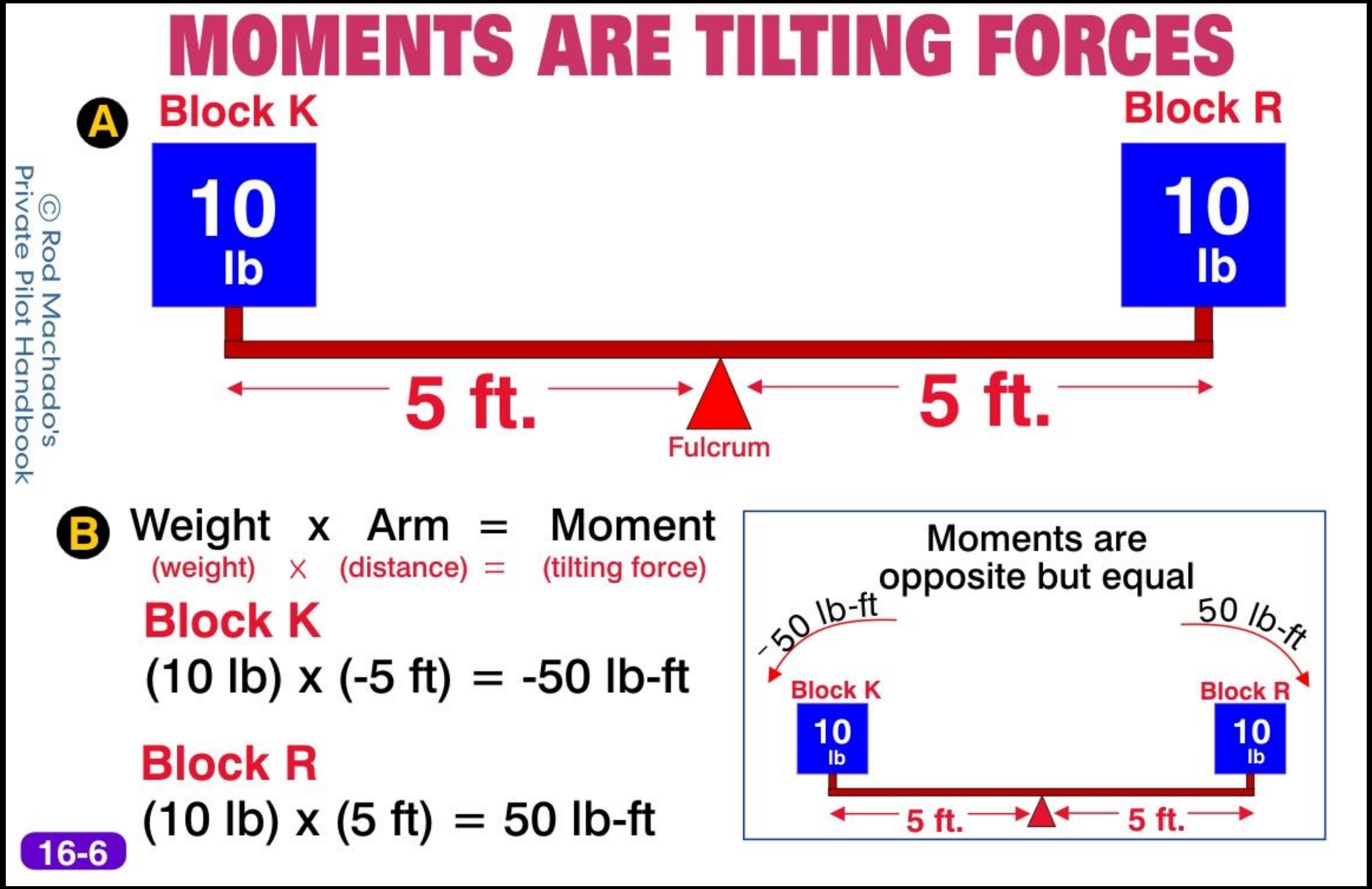
- To locate the center of gravity on an airplane you must find the moment
- Moment is a measure of the tilting force that weight imposes on an airplane

Moments

- Two 10-pound blocks placed on a plank at equal distances of five feet from the balance point
- The plank is perfectly balanced
- The plank's CG (balance point) is located at the fulcrum

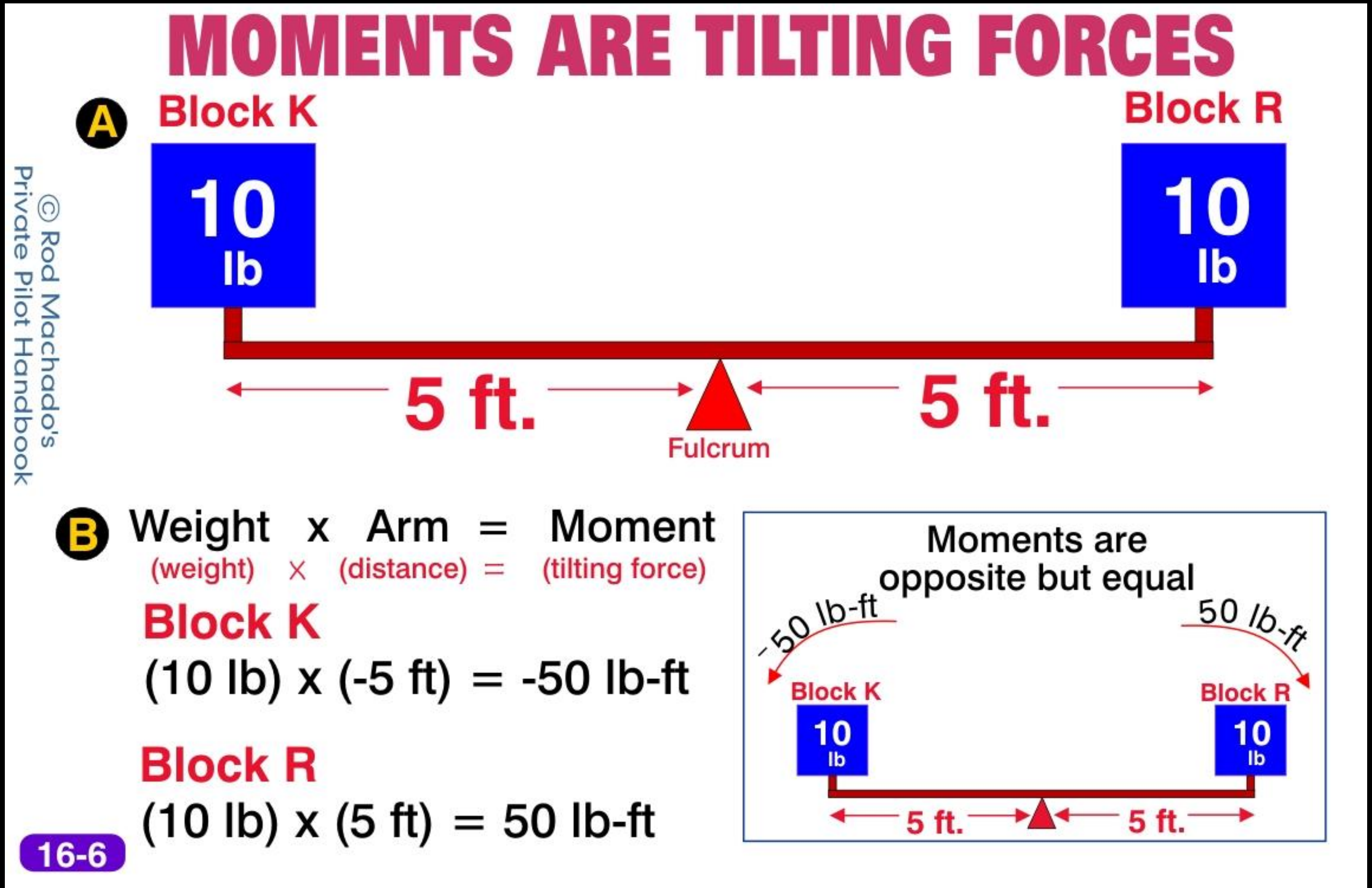


Moments



- Plank's balance point is located at the fulcrum
- Block K causes the plank to tilt CCW (to the left)
- Block R causes a similar tilt but in the CW direction (to the right)
- This tilting force is the plank's moment

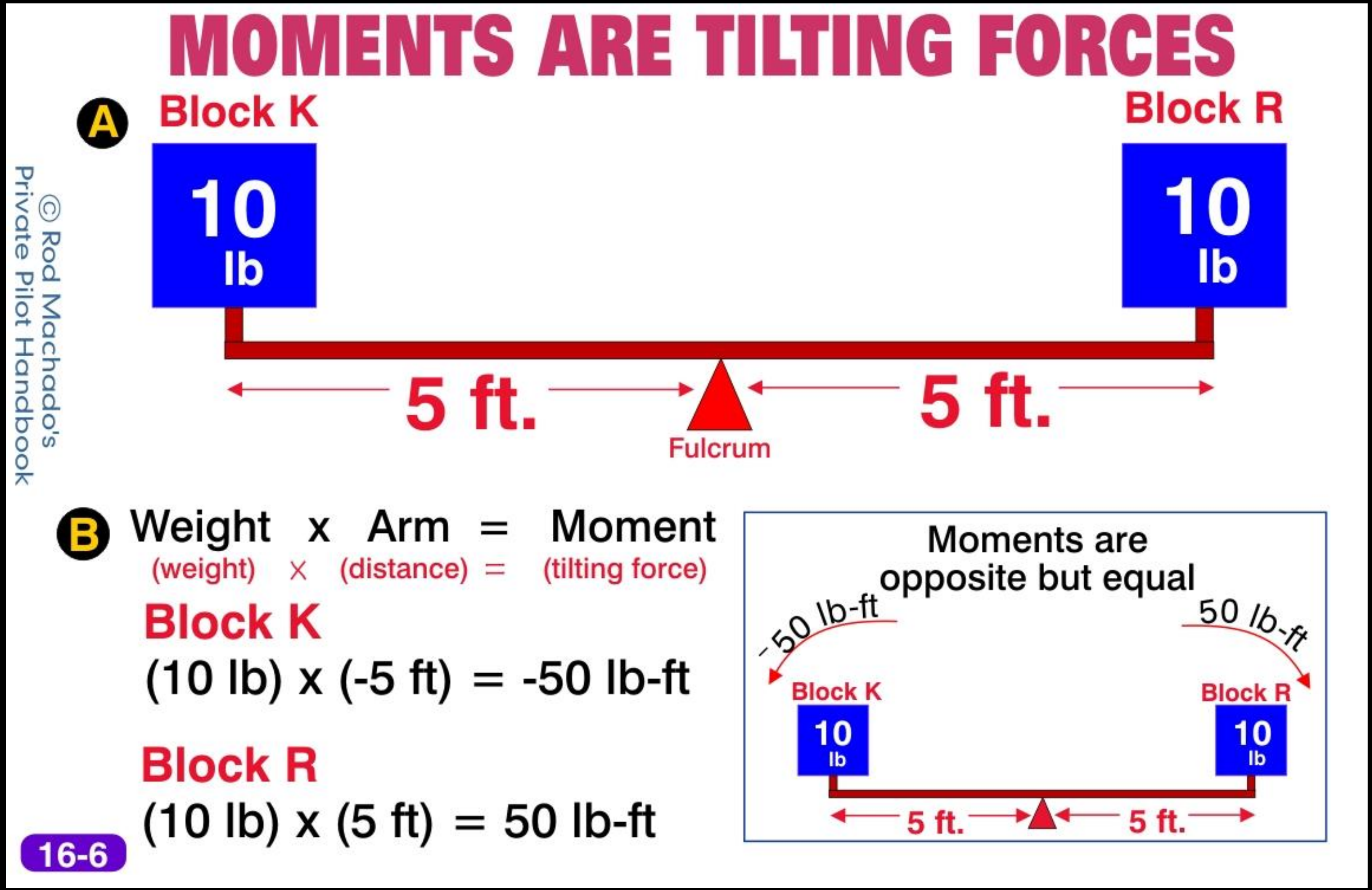
Moments



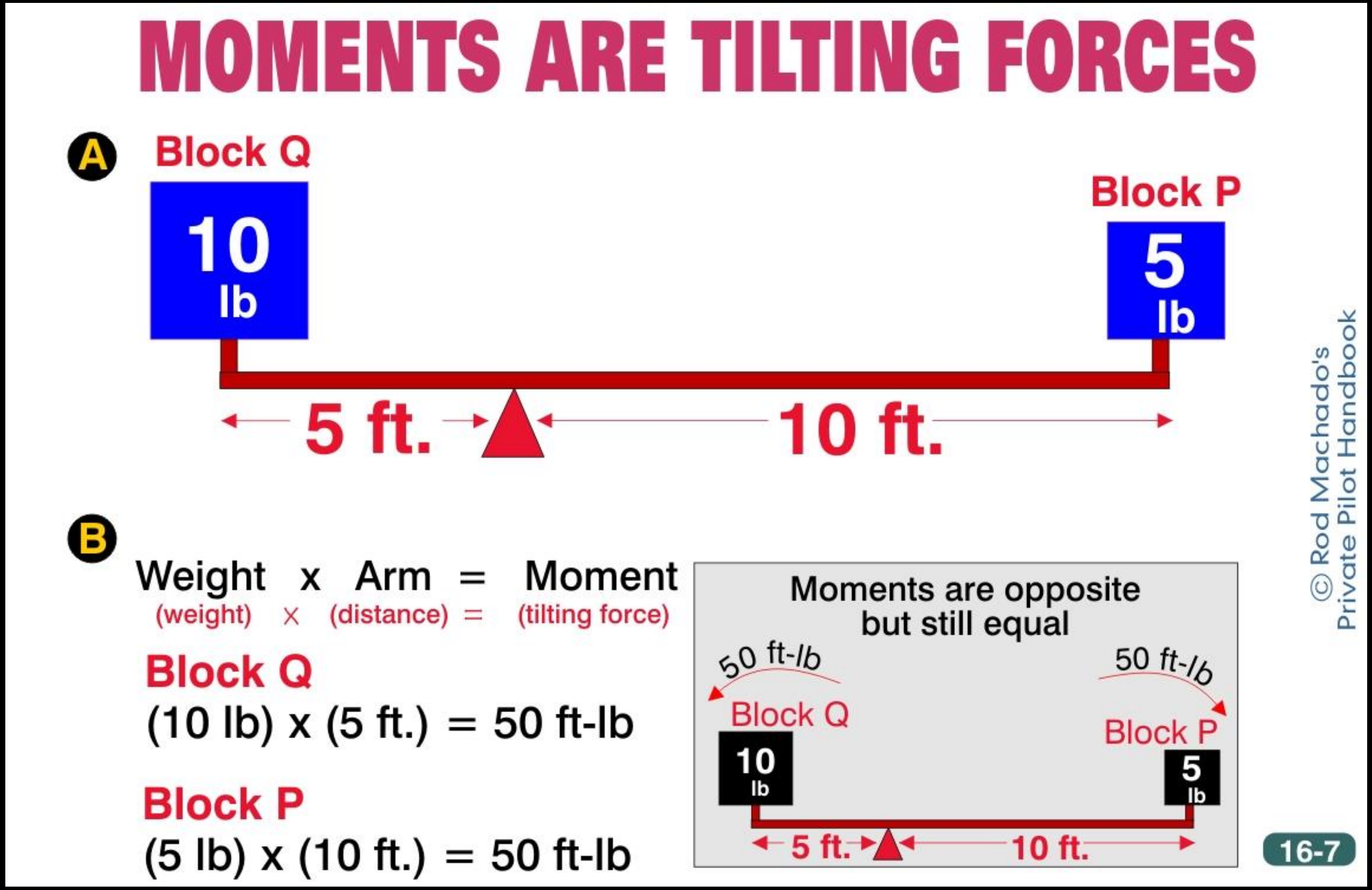
- Since the plank balances, the opposite tilting forces or moments caused by both blocks are opposite yet equal
- They cancel out each other and the plank remains balanced at the fulcrum

Moments

- Arm is the distance the weight is placed from the fulcrum
- Multiplying the weight times its arm is the moment
- A moment is the numerical value of the amount of tilt that an object produces
- CCW is minus; CW is plus
- Block K and Block R both produce the same moment (tilting force) of 50 lb-ft in opposite directions about the fulcrum



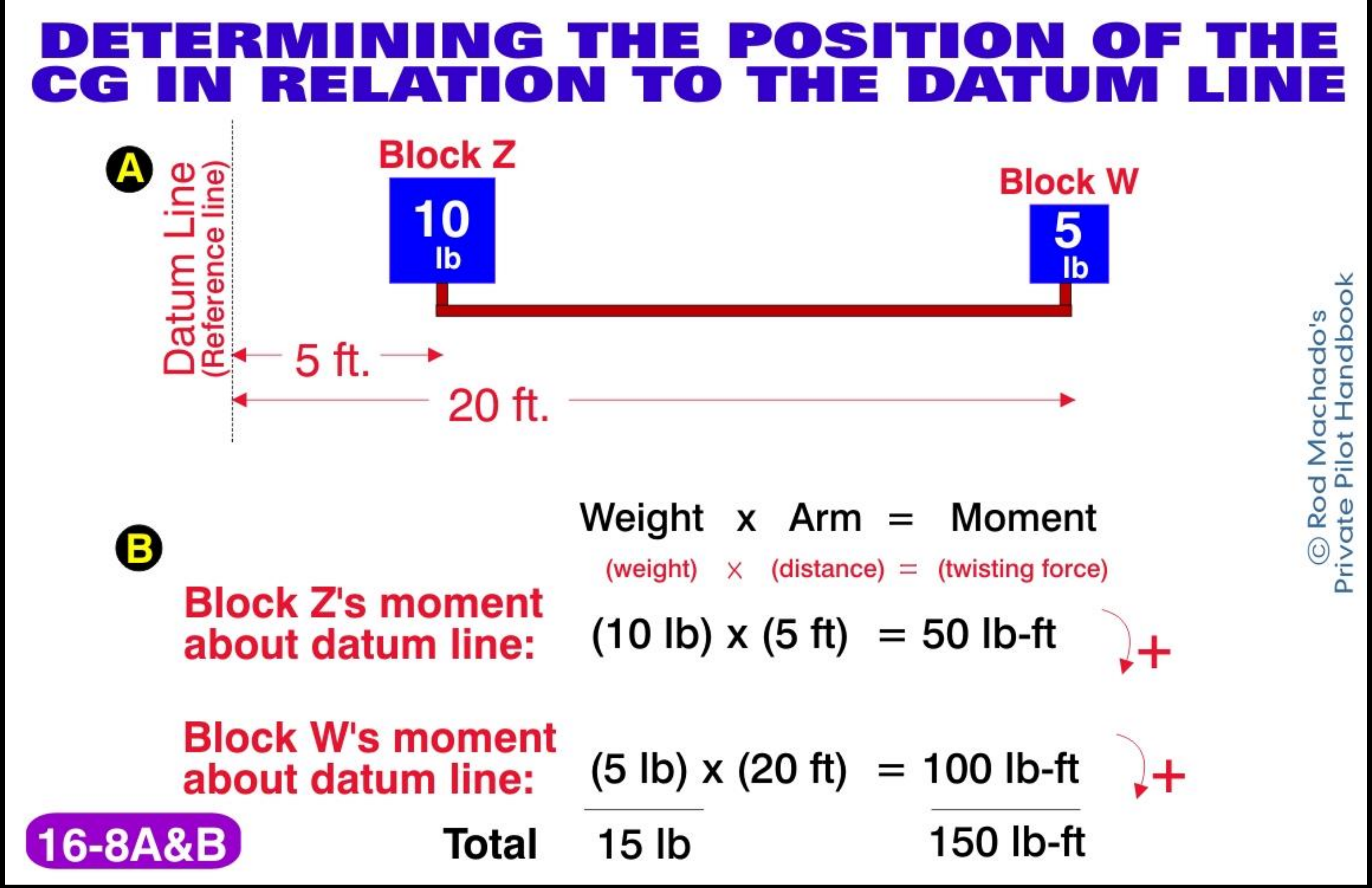
Moments



- While Blocks P and Q have different weights, they produce the same moment about the fulcrum)
- By multiplying their weights times their arms, you obtain a moment (tilting force) of 50 lb-ft for both blocks
- Since the moments are equal but in opposite directions, the plank remains in balance

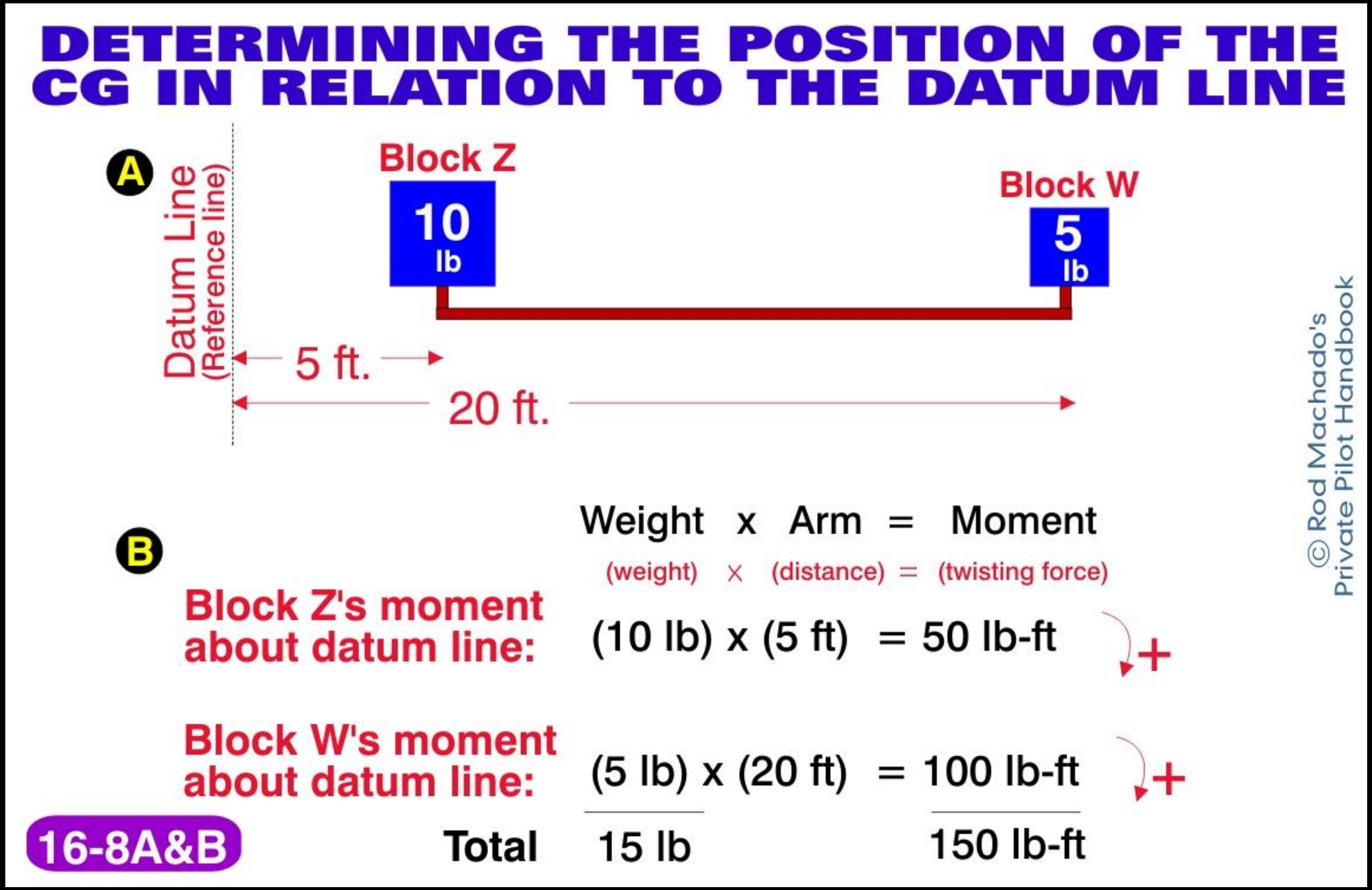
Finding CG When Weights & Moments are Known

- Plank without a fulcrum
- Objective is to find where to place the fulcrum so the plank will balance
- Datum line is an arbitrary vertical reference line from which to measure distances

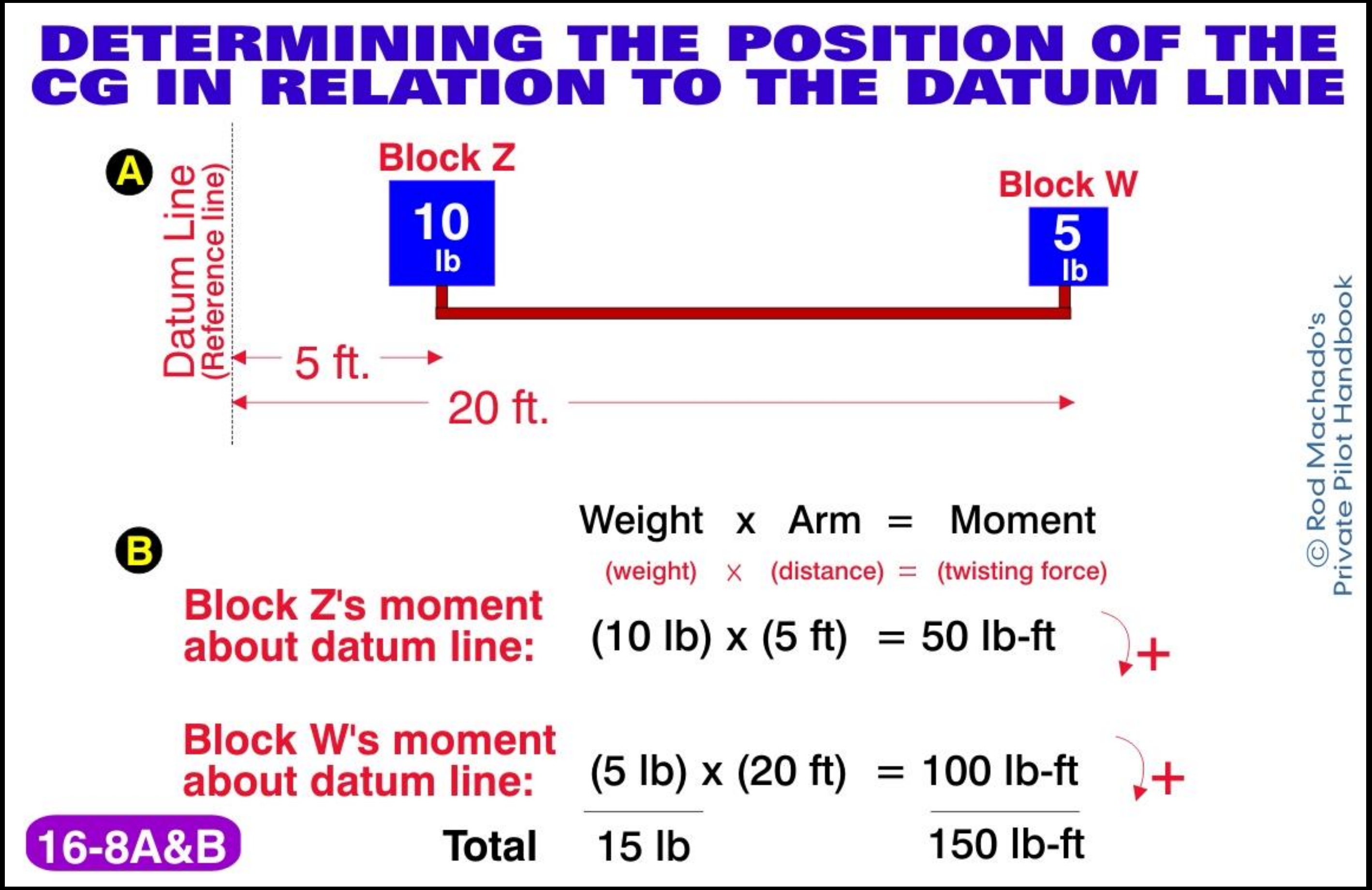


Find CG of Two Weights

- *Objective:* Find point past the datum where these weights would balance if a fulcrum was placed under the plank
- Find the moment of Block Z about the datum line
- Multiply Block Z's weight times its arm (its distance from datum line)
- Do the same with Block W

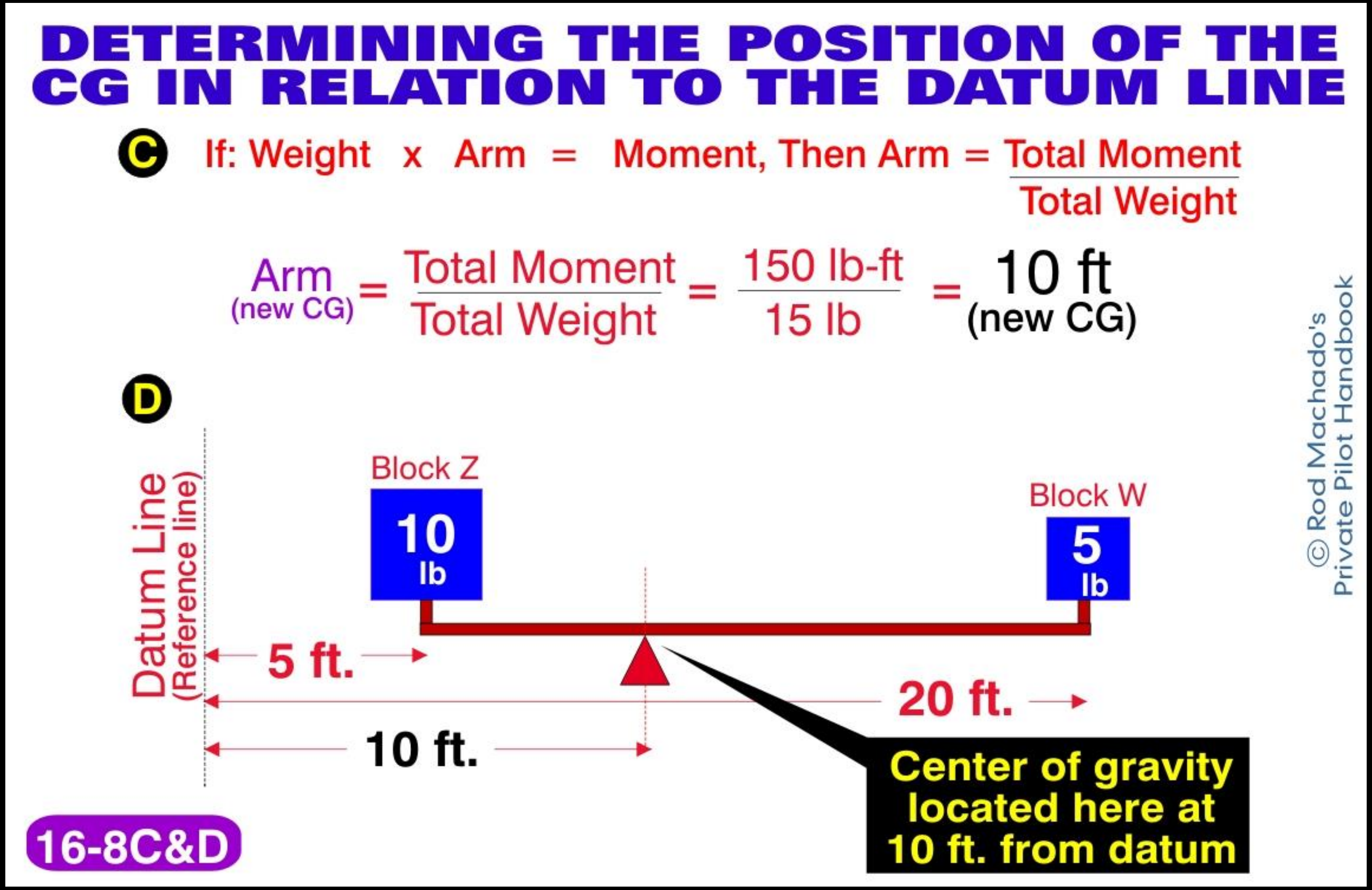


Find CG of Two Weights



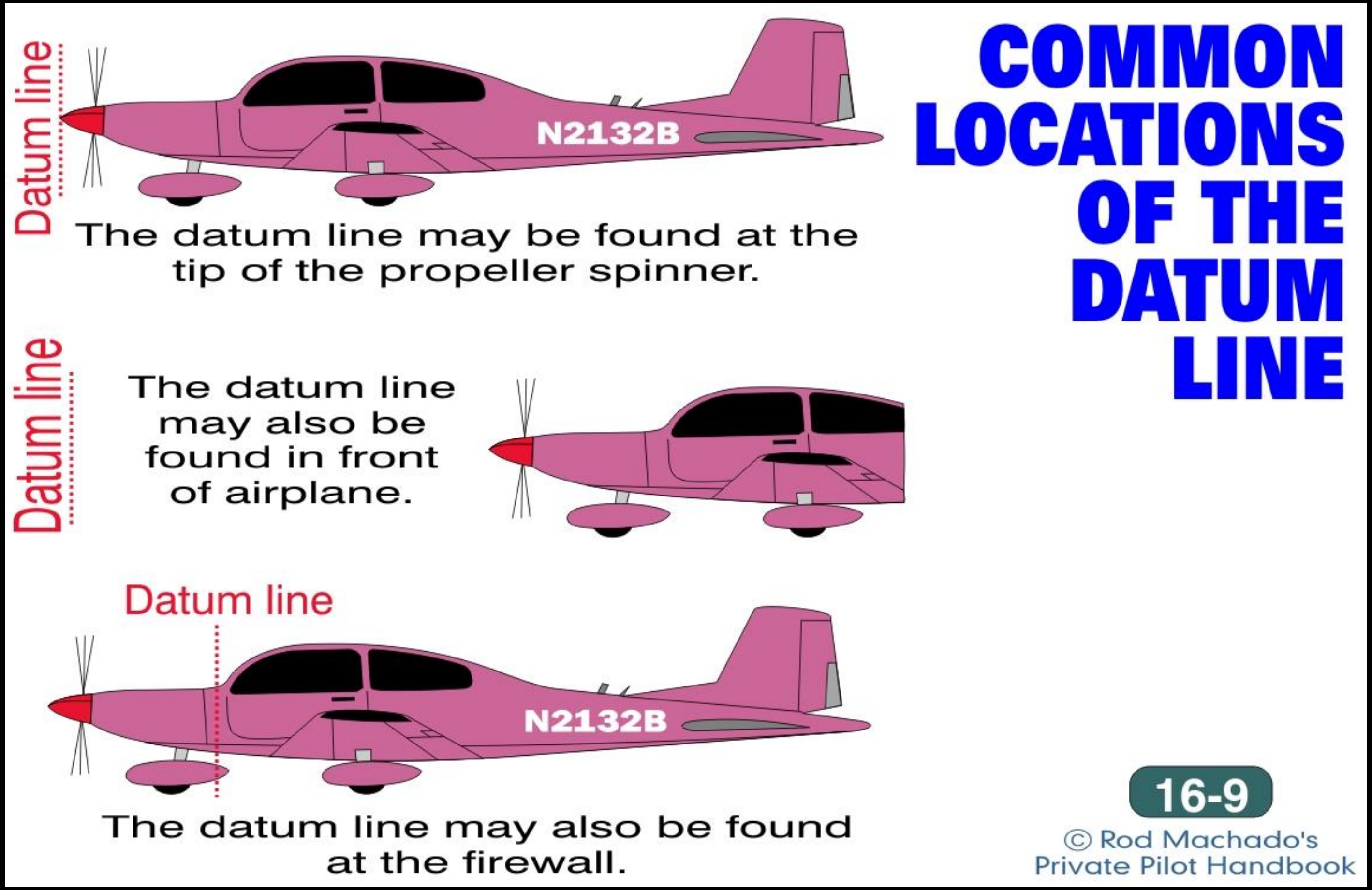
- Add <u>all</u> weights and moments
- These are the <u>***total***</u> weights and moments produced by these weights

Find CG of Two Weights



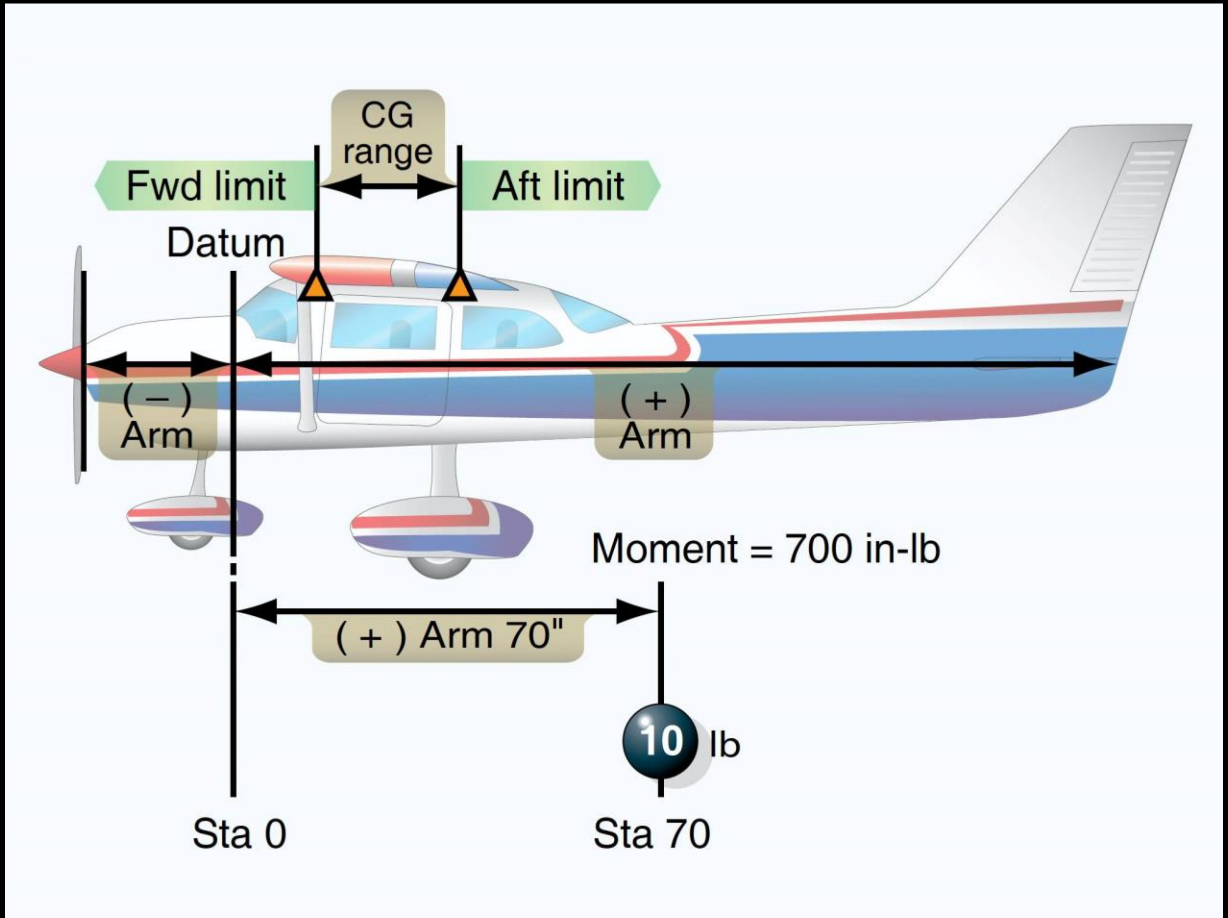
- Dividing Total Moments by Total Weights equals the arm (distance) where the plank balances
- The arm represents the CG location of these two weights
- Finding the CG of an airplane is done in exactly the same way

Datum Line



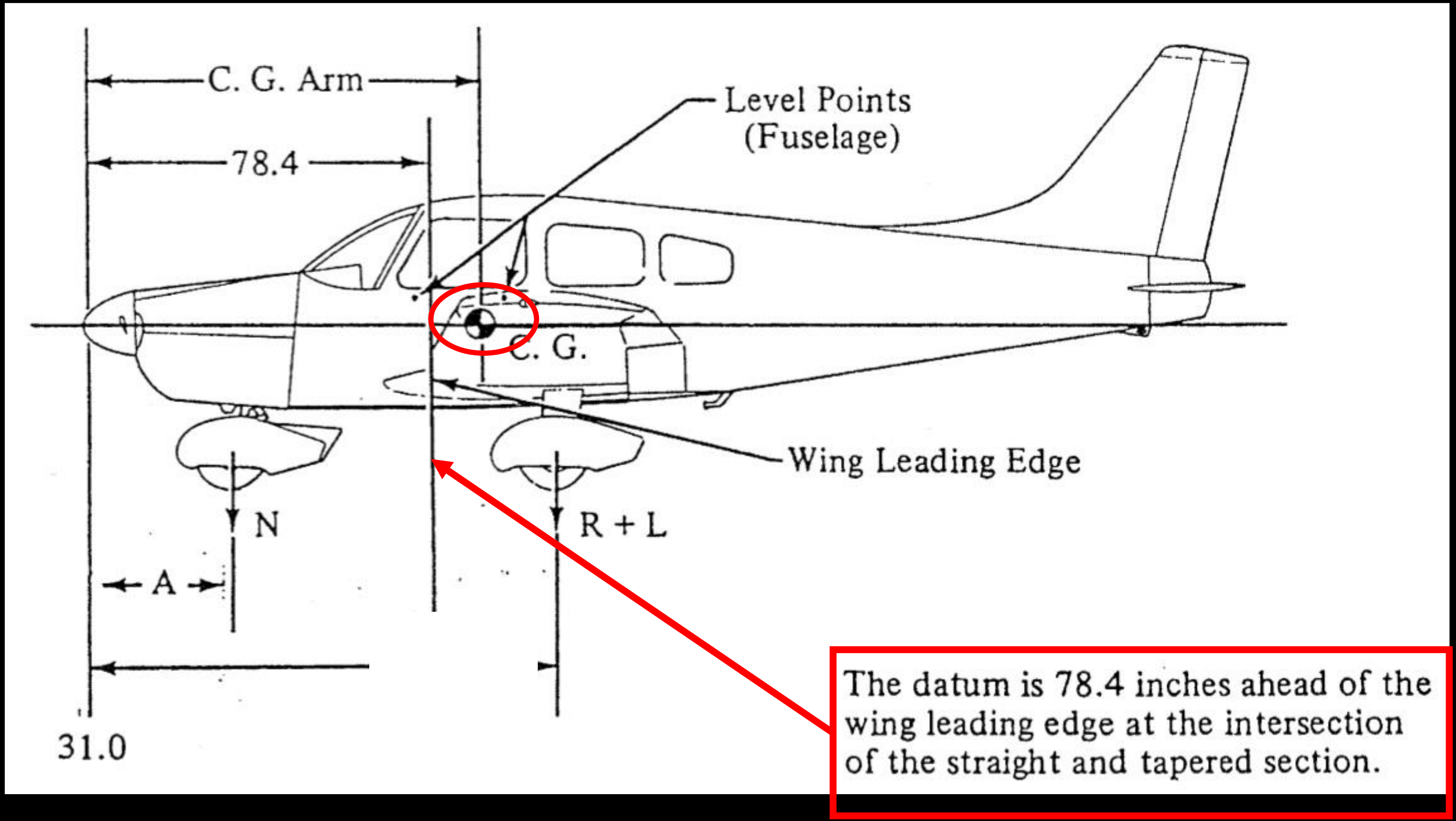
- Can be placed wherever the design engineer chooses
- When located at the firewall, everything to the left of the datum line produces a negative value; and everything to the right a positive value
- Oil located to the left of a firewall datum line, produces a negative moment
- The negative moment must be subtracted from the total moments before dividing

Datum *(Reference Datum)*

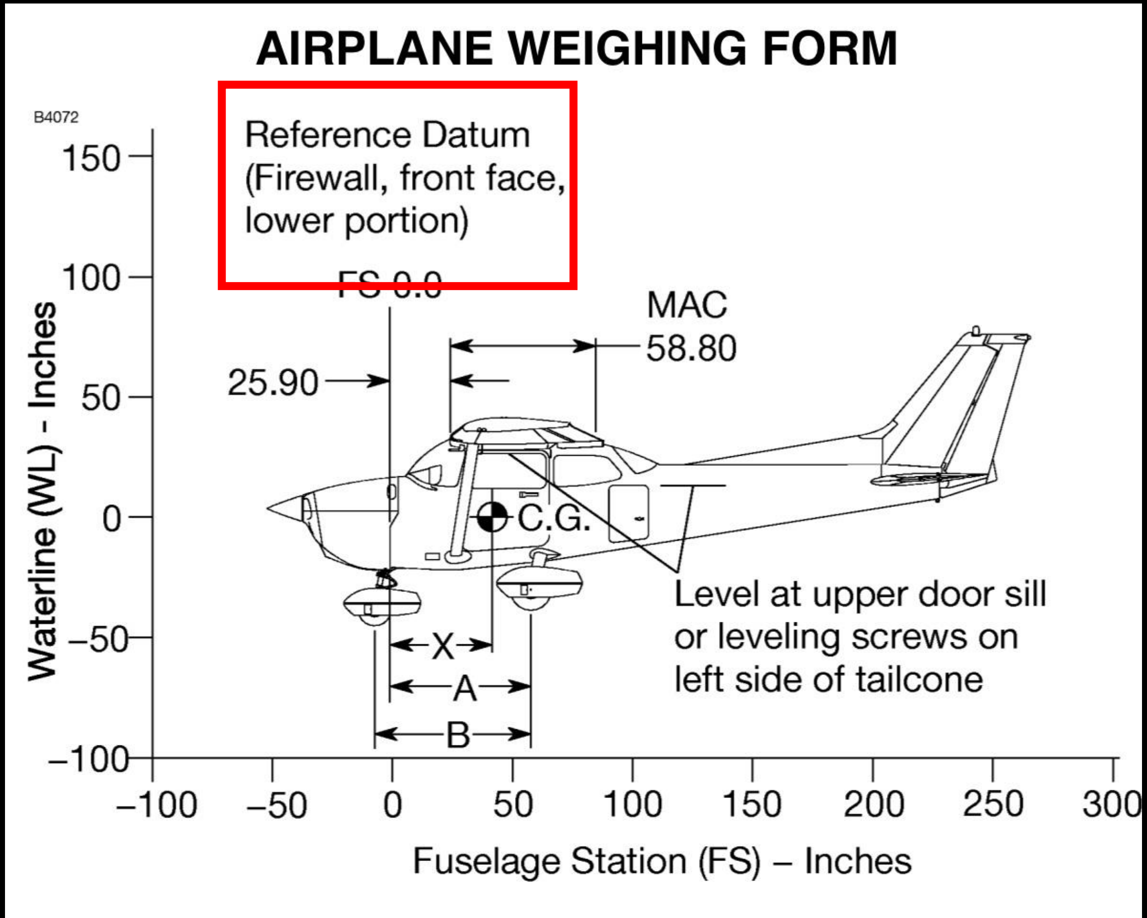


- Imaginary vertical plane or line from which all measurements of arm are taken (established by the manufacturer; all moment arms and the location of CG range are measured from this point)

Piper Archer Datum

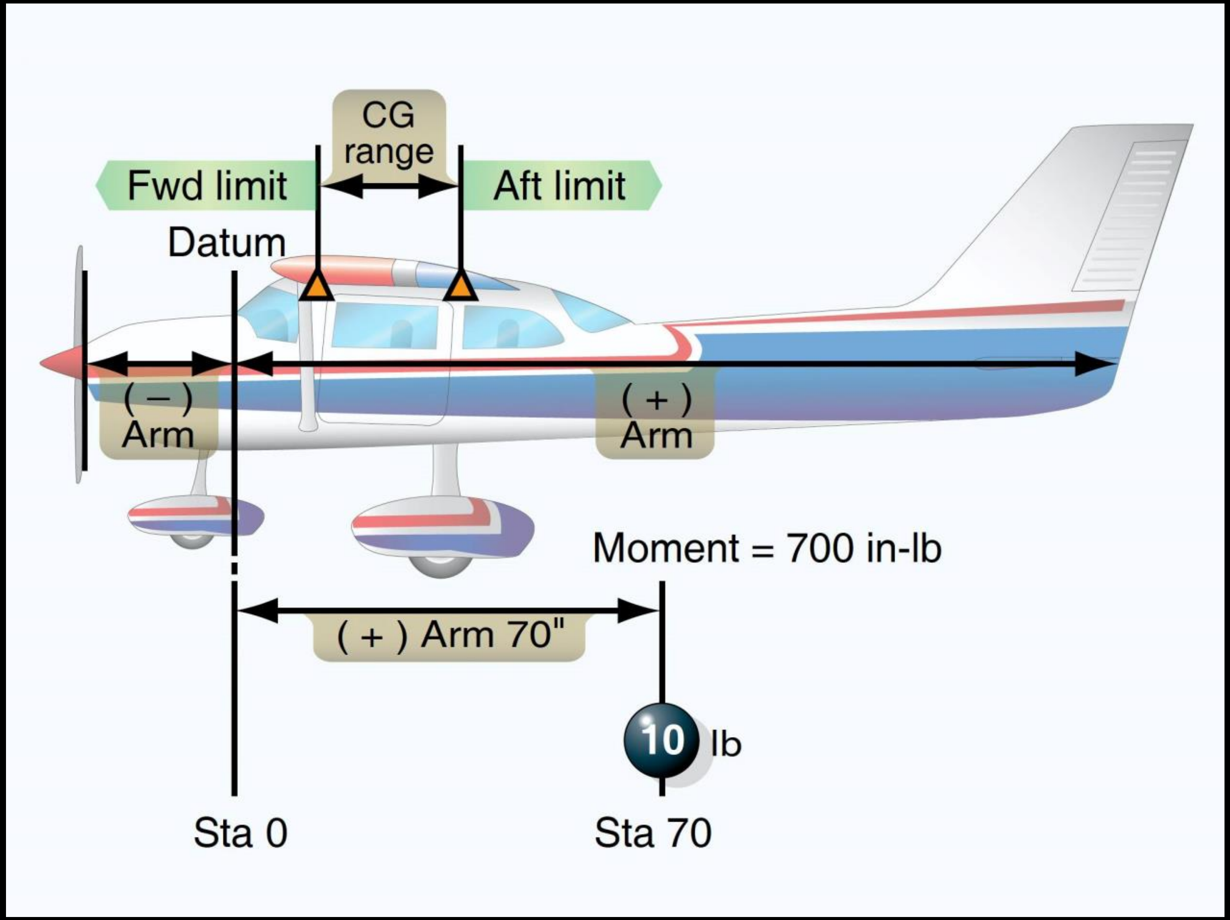


Cessna 172 Datum

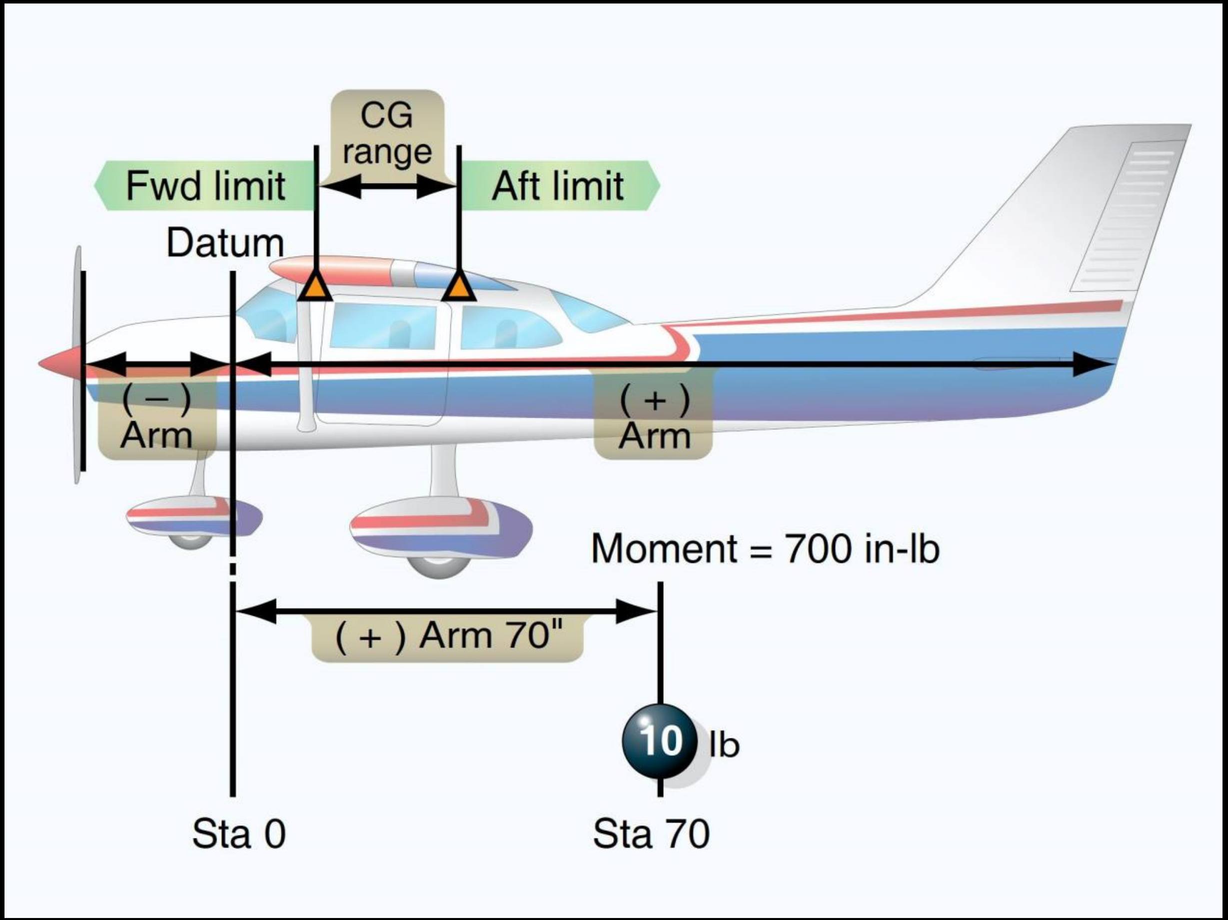


Arm *(Moment Arm)*

- Horizontal distance in inches from the reference datum line to the CG of an item (plus if measured aft of datum and minus if measured forward of datum

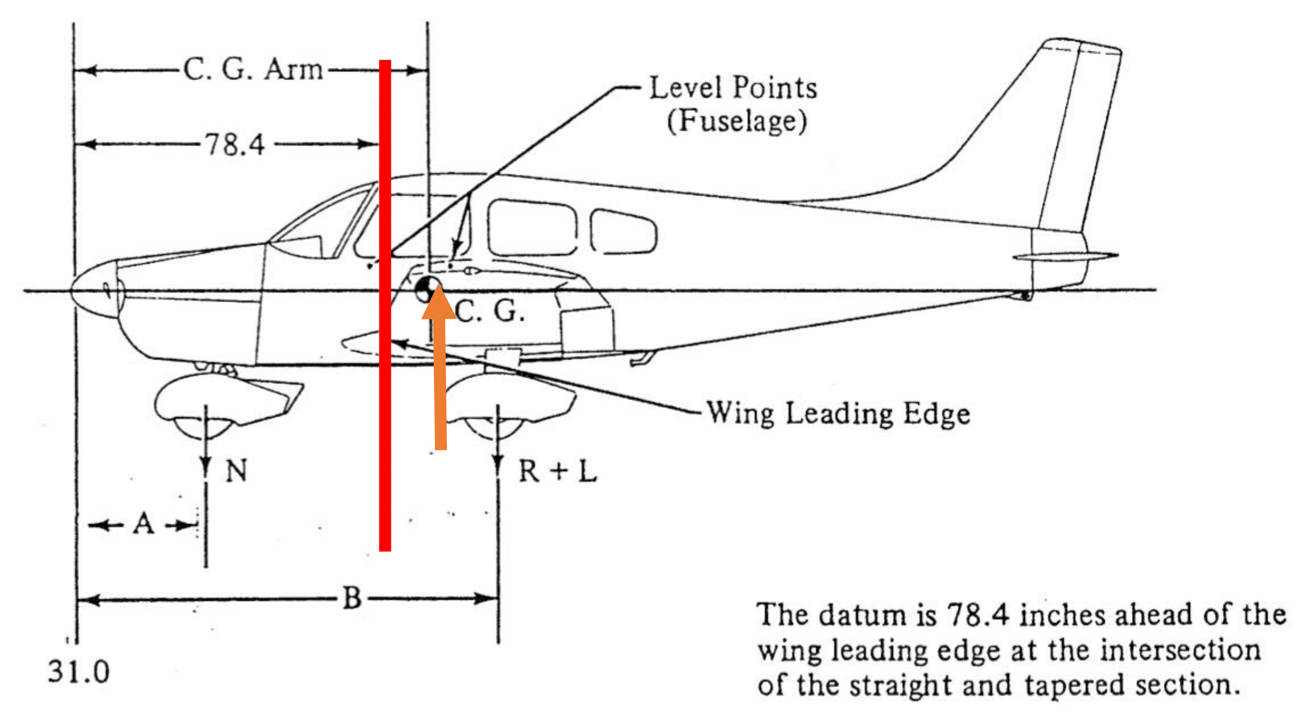


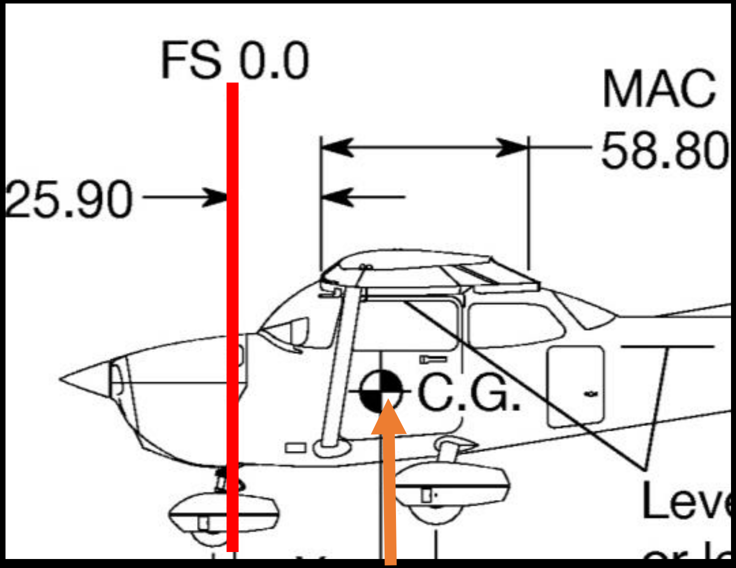
Moment



- Product of the weight of an item multiplied by its arm
- Are expressed in pound-inches (in-lb)
- Total Moment is the weight of the airplane multiplied by the distance between the datum and the CG

Datums Station CG





Finding Moment or Arm

$$Weight \times Arm = Moment$$

$$Arm = \frac{Moment}{Weight}$$

$$CG = \frac{Total\ Moments}{Total\ Weight}$$

W/B Calculation

Weight and Balance

W/B Problem – Computational

- Airplane's empty weight along with the arm and moment is listed in the airplane's weight and balance papers
- The empty-weight arm is the point where the weight of the empty airplane is concentrated (its CG)
- This arm is used in computing the empty weight moment
- Arms for Front seat occupants, Fuel, and Oil are also given

WORKING AN ACTUAL CG PROBLEM

A

	Weight (lb)	x	Arm (inches)	=	Moment (in-lb)
Empty weight	1,495.0		101.4		151,593.0
Pilot & front passenger	380.0		64.0		24,320.0
Fuel (30 gal. no reserve)	180.0		96.0		17,280.0
Oil (8 qts)	15.0		32.0		480.0
Total					

How far aft the datum is the CG located?

16-11A

W/B Problem – Computational

- The pilot and front passenger weigh a combined 380 pounds
- Both sit at an arm (distance) of 64.0 inches aft of the datum
- Multiply their weight and arm to get moment of 24,320 lb-in

WORKING AN ACTUAL CG PROBLEM

A

	Weight (lb)	x	Arm (inches)	=	Moment (in-lb)
Empty weight	1,495.0		101.4		151,593.0
Pilot & front passenger	380.0		64.0		24,320.0
Fuel (30 gal. no reserve)	180.0		96.0		17,280.0
Oil (8 qts)	15.0		32.0		480.0
Total					

How far aft the datum is the CG located?

16-11A

W/B Problem – Computational

- 30 gallons of usable fuel on this flight
- To find fuel weight multiply 30 times 6 pounds/gallon = 180 pounds
- The fuel tanks are located at an arm of 96.0 inches aft of the datum
- To find moment for fuel multiply 180 pounds times 96.0 inches = 17,280 lb-in

WORKING AN ACTUAL CG PROBLEM

A

	Weight (lb)	x	Arm (inches)	=	Moment (in-lb)
Empty weight	1,495.0		101.4		151,593.0
Pilot & front passenger	380.0		64.0		24,320.0
Fuel (30 gal. no reserve)	180.0		96.0		17,280.0
Oil (8 qts)	15.0		32.0		480.0
Total					

How far aft the datum is the CG located?

16-11A

W/B Problem – Computational

- Engine has 8 quarts of oil (4 quarts per gallon)
- Oil weighs 7.5 pounds per gallon, so total weight of oil is 2 gallons times 7.5 pounds = 15 lb
- Engine oil is located at an arm of 32.0 inches aft of the datum
- Multiply 15 pounds times 32.0 inches = 480 lb-in

WORKING AN ACTUAL CG PROBLEM

A

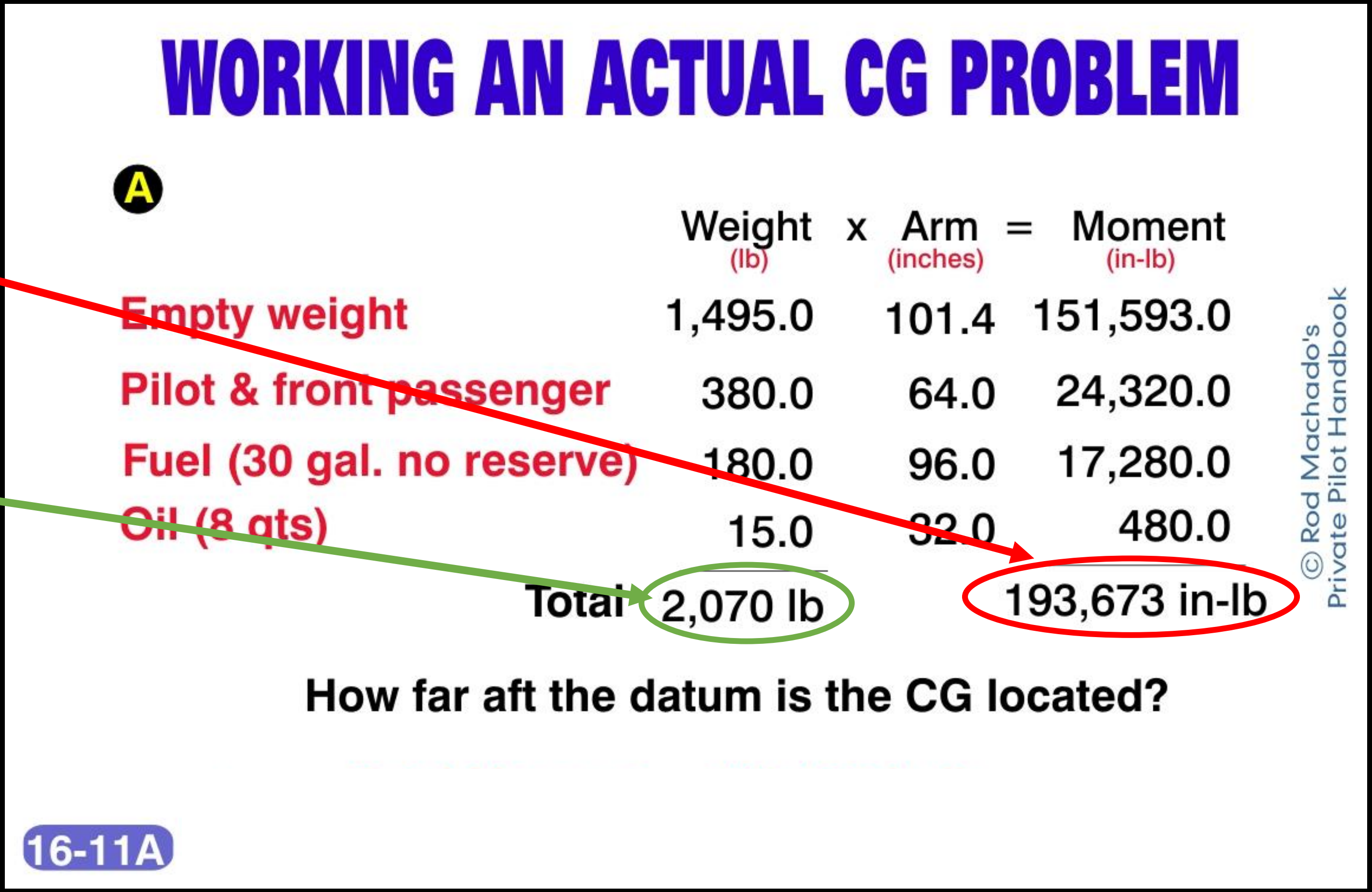
	Weight (lb)	x	Arm (inches)	=	Moment (in-lb)
Empty weight	1,495.0		101.4		151,593.0
Pilot & front passenger	380.0		64.0		24,320.0
Fuel (30 gal. no reserve)	180.0		96.0		17,280.0
Oil (8 qts)	15.0		32.0		480.0
Total					

How far aft the datum is the CG located?

16-11A

W/B Problem – Computational

- Total the Weight column and the Moment column
- Total Moment = 193,673 in-lb
- Total Weight = 2,070 lb
- *Ensure Total Weight is less than or equal to Maximum Gross Weight*



W/B Problem – Computational

- To find the CG for the loaded airplane divide the total moments by the total weights
- Weight X Arm = Moment
- Arm (CG) = Total Moments / Total Weight
- This arm is the point where the full airplane would balance (its Center of Gravity)
- *CG = 93.6 in*

WORKING AN ACTUAL CG PROBLEM

A

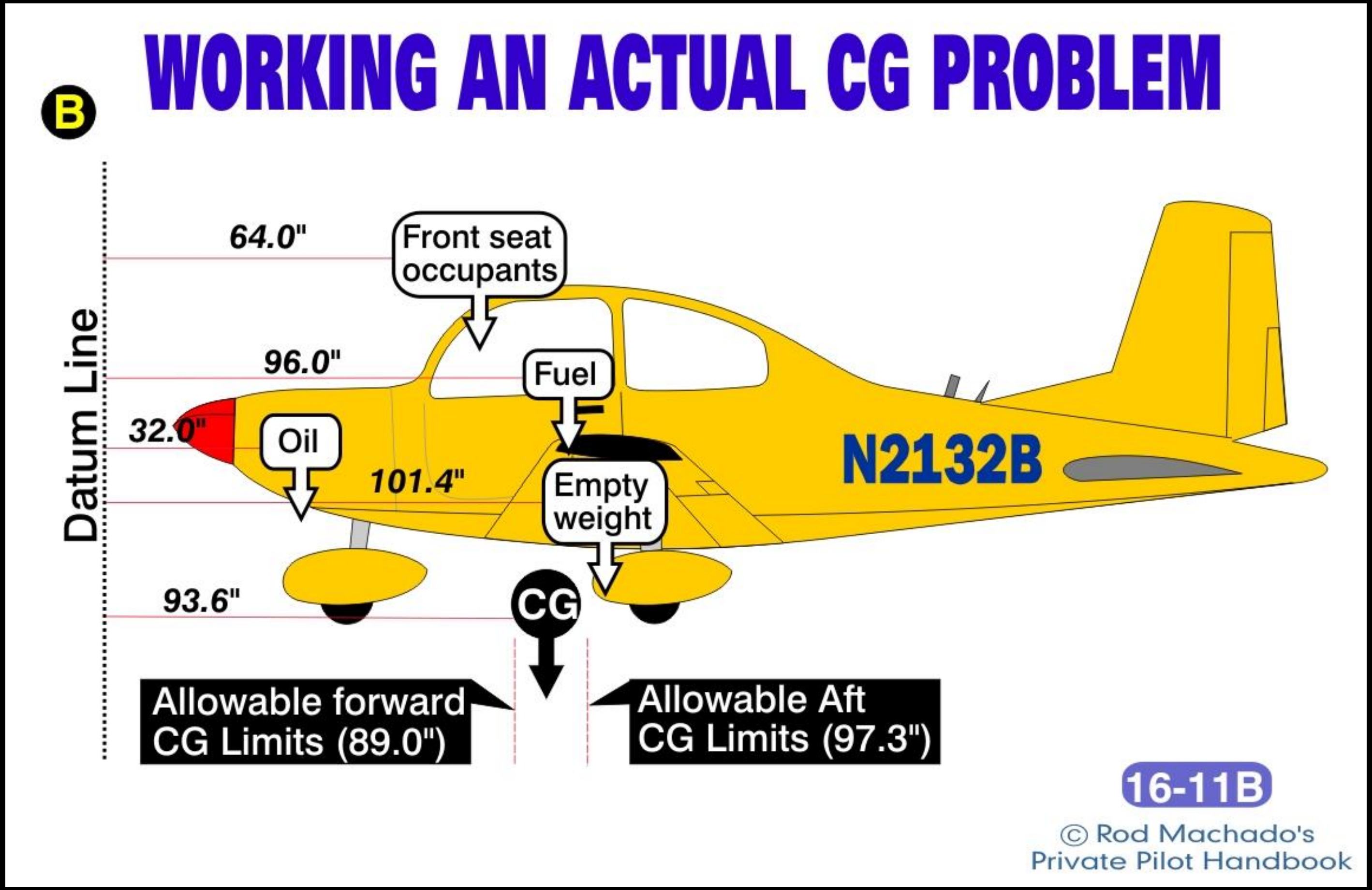
	Weight (lb)	x	Arm (inches)	=	Moment (in-lb)
Empty weight	1,495.0		101.4		151,593.0
Pilot & front passenger	380.0		64.0		24,320.0
Fuel (30 gal. no reserve)	180.0		96.0		17,280.0
Oil (8 qts)	15.0		32.0		480.0
Total	2,070 lb				193,673 in-lb

How far aft the datum is the CG located?

$$\text{Arm (new CG)} = \frac{\text{Total Moment}}{\text{Total Weight}} = \frac{193{,}673 \text{ in-lb}}{2{,}070 \text{ lb}} = 93.6 \text{ in (new CG aft datum)}$$

16-11A

W/B Problem – Computational



- *CG = 93.6 in*
- Forward and aft CG limits are expressed in inches past the datum line
- Determine if the CG is within the appropriate limits for safe flight
- Forward CG limit is at 89.0 inches and the aft limit is 97.3 inches
- With a CG of 93.6 inches the airplane falls within the proper CG limits

W&B Tables

- Charts show moments for variable weights of occupants, usable fuel, baggage, auxiliary fuel and oil (oil for this airplane is included in the basic empty weight)
- They reduce the amount of multiplication you must do

USEFUL LOADS WEIGHTS & MOMENTS

OCCUPANTS

❶ FRONT SEATS ARM 85		❷ REAR SEATS ARM 121	
Weight	Moment/100	Weight	Moment/100
120	102	120	145
130	110	130	157
140	119	140	169
150	128	150	182
160	136	160	194
170	144	170	206
180	153	180	218
190	162	190	230
200	170	200	242

16-12A

USABLE FUEL

MAIN WING TANKS ARM 75

Gallons	Weight	Moment/100
5	30	22
10	60	45
15	90	68
20	120	90
25	150	112
30	180	135
35	210	158
40	240	180
44	264	198

AUXILIARY WING TANKS ARM 94

Gallons	Weight	Moment/100
5	30	28
10	60	56
15	90	85
19	114	107

*OIL

Quarts	Weight	Moment/100
10	19	5

*Included in basic Empty Weight

BAGGAGE OR 5TH SEAT OCCUPANT ARM 140

Weight	Moment/100
10	14
20	28
30	42
40	56
50	70
60	84
70	98
80	112
90	126
100	140
110	154

W&B Tables

- Chart shows that all the moments are divided by 100
- This is a reduction factor making large moments easier to work with
- Since the front seat arm is 85, multiplying 85 inches × 320 pounds = 27,200 lb-in of moment
- When divided by a reduction factor of 100 the moment becomes:
  272 lb-in (27,200/100 = 272)

USEFUL LOADS WEIGHTS & MOMENTS

OCCUPANTS

1 FRONT SEATS ARM 85		2 REAR SEATS ARM 121	
Weight	Moment/100	Weight	Moment/100
120	102	120	145
130	110	130	157
140	119	140	169
150	128	150	182
160	136	160	194
170	144	170	206
180	153	180	218
190	162	190	230
200	170	200	242

16-12A

W&B Tables

- *Find the moment of the front seat occupants weighing 320 pounds*
- Look in the weight column and find the moments for any weight combinations that add up to 320
  - For instance:
    120 lb produces a moment of 102 200 lb produces a moment of 170
  - Adding these together gives you a moment of 272
- Manual calculation:
  320 x 85 = 27,200
  27,200 / 100 = 272

USEFUL LOADS WEIGHTS & MOMENTS

OCCUPANTS			
① FRONT SEATS ARM 85		② REAR SEATS ARM 121	
Weight	Moment/100	Weight	Moment/100
120	102	120	145
130	110	130	157
140	119	140	169
150	128	150	182
160	136	160	194
170	144	170	206
180	153	180	218
190	162	190	230
200	170	200	242

16-12A

W&B Tables

- Same procedure for finding moments is used for rear seats, usable fuel, baggage or 5th seat occupant, auxiliary wing tank fuel, and oil
- The weight of the oil and its moment are included in this airplane's basic empty weight
- Do *not* include oil in this weight and balance problem

BAGGAGE OR 5TH SEAT OCCUPANT
ARM 140

Weight	Moment 100
10	14
20	28
30	42
40	56
50	70
60	84
70	98
80	112
90	126
100	140
110	154

USABLE FUEL

MAIN WING TANKS
ARM 75

Gallons	Weight	Moment 100
5	30	22
10	60	45
15	90	68
20	120	90
25	150	112
30	180	135
35	210	158
40	240	180
44	264	198

AUXILIARY WING TANKS
ARM 94

Gallons	Weight	Moment 100
5	30	28
10	60	56
15	90	85
19	114	107

*OIL

Quarts	Weight	Moment 100
10	19	5

*Included in basic Empty Weight

W&B Tables

USEFUL LOADS WEIGHTS & MOMENTS

Basic Empty Weight ~ 2015

MOM / 100 ~ 1554

MOMENT LIMITS vs WEIGHT

Moment limits are based on the following weight and center of gravity limit data (landing gear down).

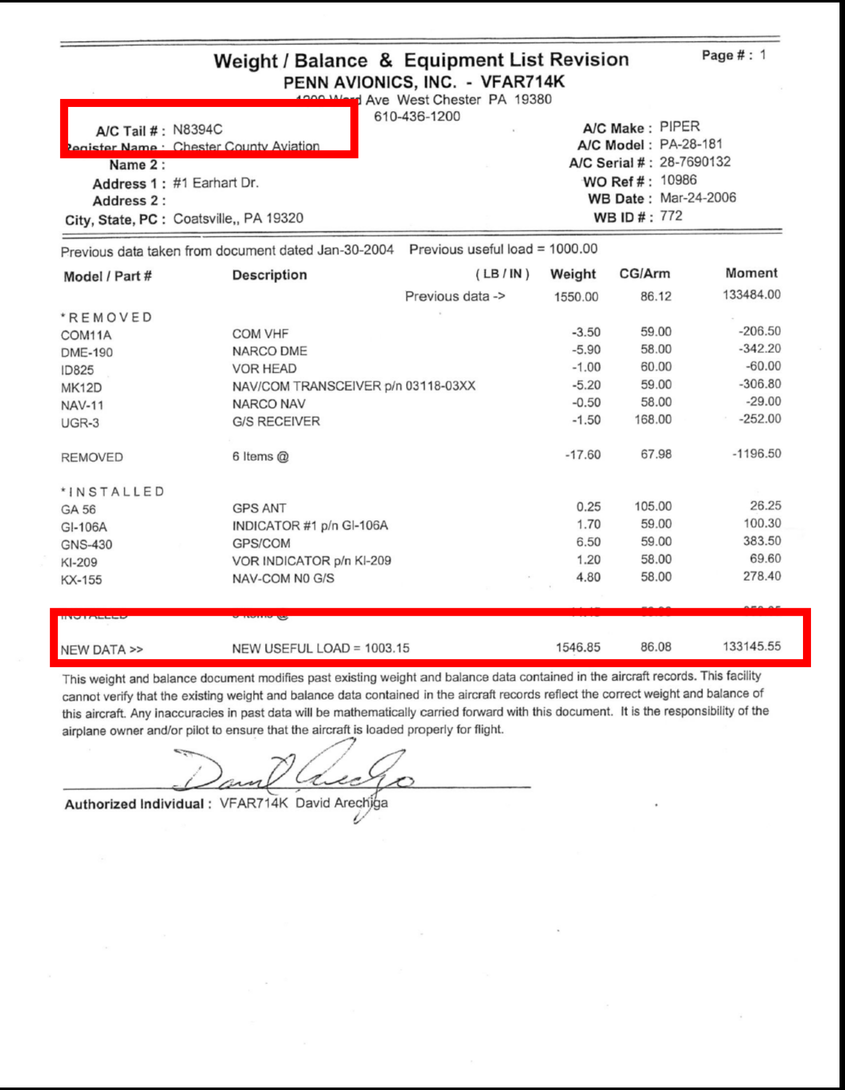
WEIGHT CONDITION	FORWARD CG LIMIT	AFT CG LIMIT
2950 lb (takeoff or landing)	82.1	84.7
2525 lb	77.5	85.7
2475 lb or less	77.0	85.7

16-12F/G

- Basic empty weight and its moment divided by the reduction factor of 100
- Forward and aft CG limits for variable weight conditions

Aircraft Empty Weight & Arm

- The loading conditions and empty weight of a particular aircraft may differ from that found in the AFM/POH because modifications or equipment changes may have been made
- W&B records for <u>each particular airplane</u> provide the empty weight, arm, and moment



Weight / Balance & Equipment List Revision Page # : 1

PENN AVIONICS, INC. - VFAR714K

[illegible] Ave West Chester PA 19380

610-436-1200

A/C Tail # : N8394C
Register Name : Chester County Aviation
Name 2 :
Address 1 : #1 Earhart Dr.
Address 2 :
City, State, PC : Coatsville,, PA 19320

A/C Make : PIPER
A/C Model : PA-28-181
A/C Serial # : 28-7690132
WO Ref # : 10986
WB Date : Mar-24-2006
WB ID # : 772

Previous data taken from document dated Jan-30-2004 Previous useful load = 1000.00

Model / Part #	Description	(LB / IN)	Weight	CG/Arm	Moment
		Previous data ->	1550.00	86.12	133484.00
*REMOVED					
COM11A	COM VHF		-3.50	59.00	-206.50
DME-190	NARCO DME		-5.90	58.00	-342.20
ID825	VOR HEAD		-1.00	60.00	-60.00
MK12D	NAV/COM TRANSCEIVER p/n 03118-03XX		-5.20	59.00	-306.80
NAV-11	NARCO NAV		-0.50	58.00	-29.00
UGR-3	G/S RECEIVER		-1.50	168.00	-252.00
REMOVED	6 Items @		-17.60	67.98	-1196.50
*INSTALLED					
GA 56	GPS ANT		0.25	105.00	26.25
GI-106A	INDICATOR #1 p/n GI-106A		1.70	59.00	100.30
GNS-430	GPS/COM		6.50	59.00	383.50
KI-209	VOR INDICATOR p/n KI-209		1.20	58.00	69.60
KX-155	NAV-COM N0 G/S		4.80	58.00	278.40
INSTALLED	[illegible] Items @		[illegible]	[illegible]	[illegible]
NEW DATA >>	NEW USEFUL LOAD = 1003.15		1546.85	86.08	133145.55

This weight and balance document modifies past existing weight and balance data contained in the aircraft records. This facility cannot verify that the existing weight and balance data contained in the aircraft records reflect the correct weight and balance of this aircraft. Any inaccuracies in past data will be mathematically carried forward with this document. It is the responsibility of the airplane owner and/or pilot to ensure that the aircraft is loaded properly for flight.

Authorized Individual : VFAR714K David Arechiga

EPRFBO

- What items do you include in the FAA weight and balance calculations?
- Every
  Pilot
  Regrets
  Flying
  Barely
  Overweight
- When given a weight and balance problem to solve, list these letters
- Write **W × A = M**
  (Weight × Arm = Moment)
  across the top of the page

WEIGHT & BALANCE FORMAT

	Weight	X Arm	= Moment/100
E - Empty weight............................	lb	in	in-lb
P - Pilot & front seat occupants.......	lb	in	in-lb
R - Rear seat occupants.................	lb	in	in-lb
F - Fuel (6 lb/gal)...........................	lb	in	in-lb
B - Baggage..................................	lb	in	in-lb
O - Oil (7.5 lb/gal)..........................	lb	in	in-lb
Totals			in-lb / 100

16-16

W/B Problem – Table

- *Determine if the airplane's weight and balance is within safe limits:*
  - Front seat occupants: 320 pounds
  - Rear seat occupants: 295 pounds
  - Fuel (main wing tanks): 44 gallons
  - Baggage: 56 pounds

WEIGHT & BALANCE FORMAT

	Weight	X Arm	= Moment/100
E - Empty weight...........................	lb	in	in-lb
P - Pilot & front seat occupants.......	lb	in	in-lb
R - Rear seat occupants.................	lb	in	in-lb
F - Fuel (6 lb/gal)...........................	lb	in	in-lb
B - Baggage..................................	lb	in	in-lb
O - Oil (7.5 lb/gal)..........................	lb	in	in-lb
Totals			in-lb / 100

16-16

W/B Problem – Table

- *Step 1: Find the basic empty weight and its moment*
- Unique to each airplane and located in the Airplane Flight Manual
- Basic Empty Weight: 2015
  Moment/100: 1554

USEFUL LOADS WEIGHTS & MOMENTS

Basic Empty Weight ~ 2015

MOM / 100 ~ 1554

MOMENT LIMITS vs WEIGHT

Moment limits are based on the following weight and center of gravity limit data (landing gear down).

WEIGHT CONDITION	FORWARD CG LIMIT	AFT CG LIMIT
2950 lb (takeoff or landing)	82.1	84.7
2525 lb	77.5	85.7
2475 lb or less	77.0	85.7

16-12F/G

W/B Problem – Table

- Basic Empty Weight: 2015 Moment/100: 1554
- Insert into table

Weight & Balance Problem Number 1

	Weight	X Arm	= Moment/100
E - Empty weight............................	2,015 lb	..........in	1,554.0 in-lb
P - Pilot & front seat occupants.......	lb	85 in	in-lb
R - Rear seat occupants.................	lb	121 in	in-lb
F - Fuel (6 lb/gal)............................	lb	75 in	in-lb
B - Baggage..................................	lb	140 in	in-lb
O - Oil (included in empty weight)..	.lb	..........in	in-lb

16-14

W/B Problem – Table

- *Step 2: Find the moment for 320 lb of front seat occupants*
- Moment for 120 lb: 102
  Moment for 200 lb: 170
- Front seat moment = 102 + 170 = 272

USEFUL LOADS WEIGHTS & MOMENTS

OCCUPANTS			
❶ FRONT SEATS ARM 85		❷ REAR SEATS ARM 121	
Weight	Moment/100	Weight	Moment/100
120	102	120	145
130	110	130	157
140	119	140	169
150	128	150	182
160	136	160	194
170	144	170	206
180	153	180	218
190	162	190	230
200	170	200	242

16-12A

W/B Problem – Table

- Front seat occupants' weight: 320
  Front seat occupants' moment: 272
- Insert into table

Weight & Balance Problem Number 1

	Weight	X Arm	= Moment/100
E - Empty weight............................	2,015 lb	..........in	1,554.0 in-lb
P - Pilot & front seat occupants.......	320 lb	85 in	272.0 in-lb
R - Rear seat occupants..................	lb	121 in	in-lb
F - Fuel (6 lb/gal)............................	lb	75 in	in-lb
B - Baggage....................................	lb	140 in	in-lb
O - Oil (included in empty weight)..	.lb	..........in	in-lb

16-14

W/B Problem – Table

- *Step 3: Find the moment for 295 lb of rear seat occupants*
- Since the exact weight of our rear seat occupants doesn't appear in the table, we must multiply their weights times the arm of the rear seat (121")
- 295 x 121 = 35,695 Moment/100 = 35,695/ 100 = 357
- Rear seat occupants' moment = 357

USEFUL LOADS WEIGHTS & MOMENTS

OCCUPANTS			
① FRONT SEATS ARM 85		② REAR SEATS ARM 121	
Weight	Moment/100	Weight	Moment/100
120	102	120	145
130	110	130	157
140	119	140	169
150	128	150	182
160	136	160	194
170	144	170	206
180	153	180	218
190	162	190	230
200	170	200	242

16-12A

W/B Problem – Table

- Rear seat occupants' weight: 295
- Rear seat occupants moment = 357
- Insert into table

Weight & Balance Problem Number 1

	Weight	X Arm	= Moment/100
E - Empty weight............................	2,015 lb	..........in	1,554.0 in-lb
P - Pilot & front seat occupants.......	320 lb	85 in	272.0 in-lb
R - Rear seat occupants.................	295 lb	121 in	357.0 in-lb
F - Fuel (6 lb/gal)............................	lb	75 in	in-lb
B - Baggage..................................	lb	140 in	in-lb
O - Oil (included in empty weight)..	.lb	..........in	in-lb

16-14

W&B #1

- *Step 4: Find the weight and moment for 44 gal. of fuel*
- Note: Use the listed weight of the fuel - not the gallons!
- Fuel weight: 264
  Fuel moment: 198

USEFUL LOADS WEIGHTS & MOMENTS

USABLE FUEL

MAIN WING TANKS ARM 75		
Gallons	Weight	Moment/100
5	30	22
10	60	45
15	90	68
20	120	90
25	150	112
30	180	135
35	210	158
40	240	180
44	264	198

16-12B

W/B Problem – Table

- Fuel weight: 264
  Fuel moment: 198
- Insert into table

Weight & Balance Problem Number 1

	Weight	X Arm	= Moment/100
E - Empty weight............................	2,015 lb	..........in	1,554.0 in-lb
P - Pilot & front seat occupants.......	320 lb	85 in	272.0 in-lb
R - Rear seat occupants.................	295 lb	121 in	357.0 in-lb
F - Fuel (6 lb/gal)............................	264 lb	75 in	198.0 in-lb
B - Baggage..................................	[illegible] lb	140 in	in-lb
O - Oil (included in empty weight)..	..lb	..........in	in-lb

16-14

W/B Problem – Table

- *Step 5: Find the moment for the baggage*
- Since no moment is listed for 56 lb, multiply this times the arm of 140" & divide by 100 to obtain the moment of the baggage
- (56 x 140)/100 = 78.4
- Baggage moment: 78.4

USEFUL LOADS WEIGHTS & MOMENTS

BAGGAGE OR 5TH SEAT OCCUPANT

ARM 140

Weight	Moment/100
10	14
20	28
30	42
40	56
50	70
60	84
70	98
80	112
90	126
100	140
110	154

16-12C

W/B Problem – Table

- Baggage weight: 56
- Baggage moment: 78.4
- Insert into table

Weight & Balance Problem Number 1

	Weight	X Arm	= Moment/100
E - Empty weight............................	2,015 lb	..........in	1,554.0 in-lb
P - Pilot & front seat occupants.......	320 lb	85 in	272.0 in-lb
R - Rear seat occupants.................	295 lb	121 in	357.0 in-lb
F - Fuel (6 lb/gal)............................	264 lb	75 in	198.0 in-lb
B - Baggage....................................	56 lb	140 in	78.4 in-lb
O - Oil (included in empty weight)..	.lb	..........in	in-lb

16-14

W/B Problem – Table

- Step 6: The note says that oil is included in the basic empty weight, so we don't need to do anything here

USEFUL LOADS WEIGHTS & MOMENTS

AUXILIARY WING TANKS
ARM 94

Gallons	Weight	Moment / 100
5	30	28
10	60	56
15	90	85
19	114	107

*OIL

Quarts	Weight	Moment / 100
10	19	5

*Included in basic Empty Weight

16-12D/E

W/B Problem – Table

- Step 7: Add the total weight and the total moments

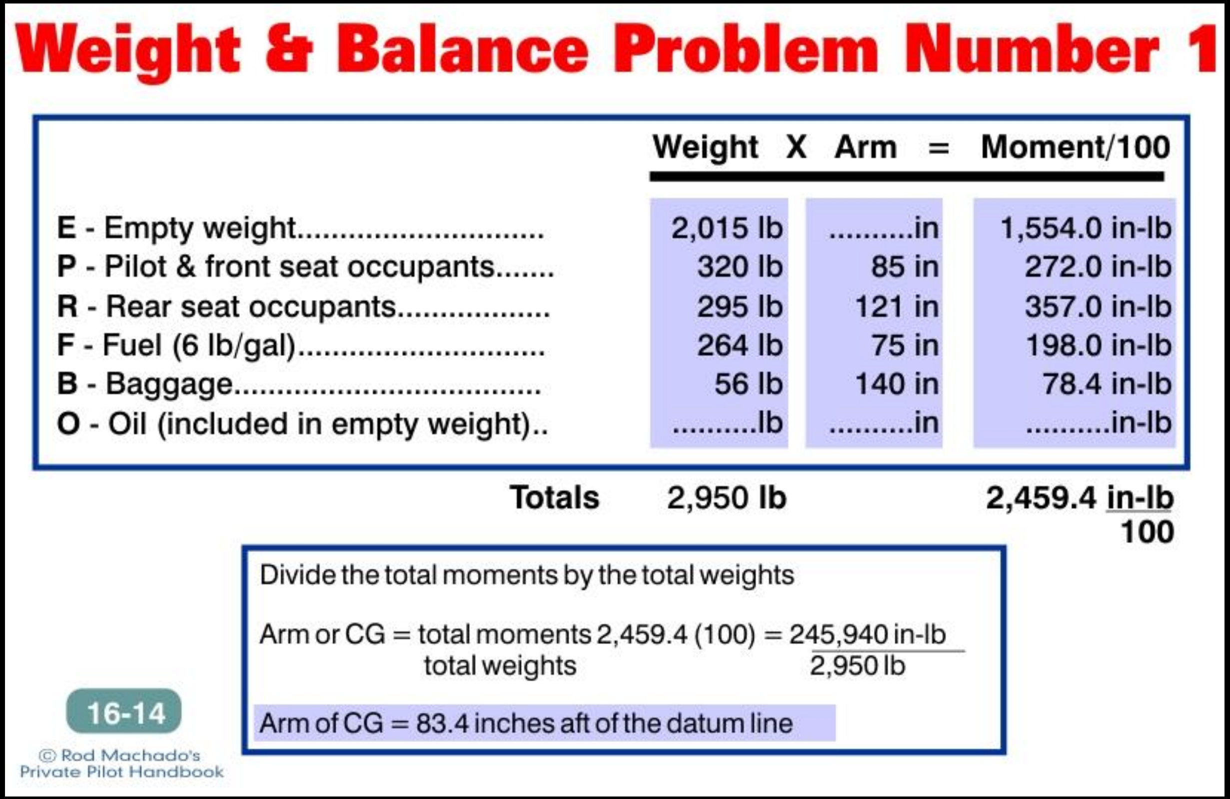
Weight & Balance Problem Number 1

	Weight	X Arm	= Moment/100
E - Empty weight............................	2,015 lb	..........in	1,554.0 in-lb
P - Pilot & front seat occupants.......	320 lb	85 in	272.0 in-lb
R - Rear seat occupants.................	295 lb	121 in	357.0 in-lb
F - Fuel (6 lb/gal)............................	264 lb	75 in	198.0 in-lb
B - Baggage....................................	56 lb	140 in	78.4 in-lb
O - Oil (included in empty weight)..	..........lb	..........in	..........in-lb
Totals	2,950 lb		2,459.4 in-lb / 100

16-14

W/B Problem – Table

- *Step 8: Move the decimal place of the total moments two digits to the right to correct for the reduction factor of moment/100*
- Step 9: Compute the CG by dividing the total moments by the total weight
- CG = 83.4 in


Weight & Balance Problem Number 1

	Weight	X Arm	= Moment/100
E - Empty weight.............................	2,015 lb	..........in	1,554.0 in-lb
P - Pilot & front seat occupants.......	320 lb	85 in	272.0 in-lb
R - Rear seat occupants.................	295 lb	121 in	357.0 in-lb
F - Fuel (6 lb/gal)............................	264 lb	75 in	198.0 in-lb
B - Baggage....................................	56 lb	140 in	78.4 in-lb
O - Oil (included in empty weight)..	..........lb	..........in	..........in-lb
Totals	2,950 lb		2,459.4 in-lb / 100

Divide the total moments by the total weights

Arm or CG = total moments / total weights = 2,459.4 (100) = 245,940 in-lb / 2,950 lb

Arm of CG = 83.4 inches aft of the datum line

16-14

© Rod Machado's Private Pilot Handbook

W/B Problem – Table

- Step 10: Determine if the CG and weight fall within acceptable limits
- Total weight: 2,950 lb
- CG of 83.4 in is within limits

USEFUL LOADS WEIGHTS & MOMENTS

Basic Empty Weight ~ 2015

MOM / 100 ~ 1554

MOMENT LIMITS vs WEIGHT

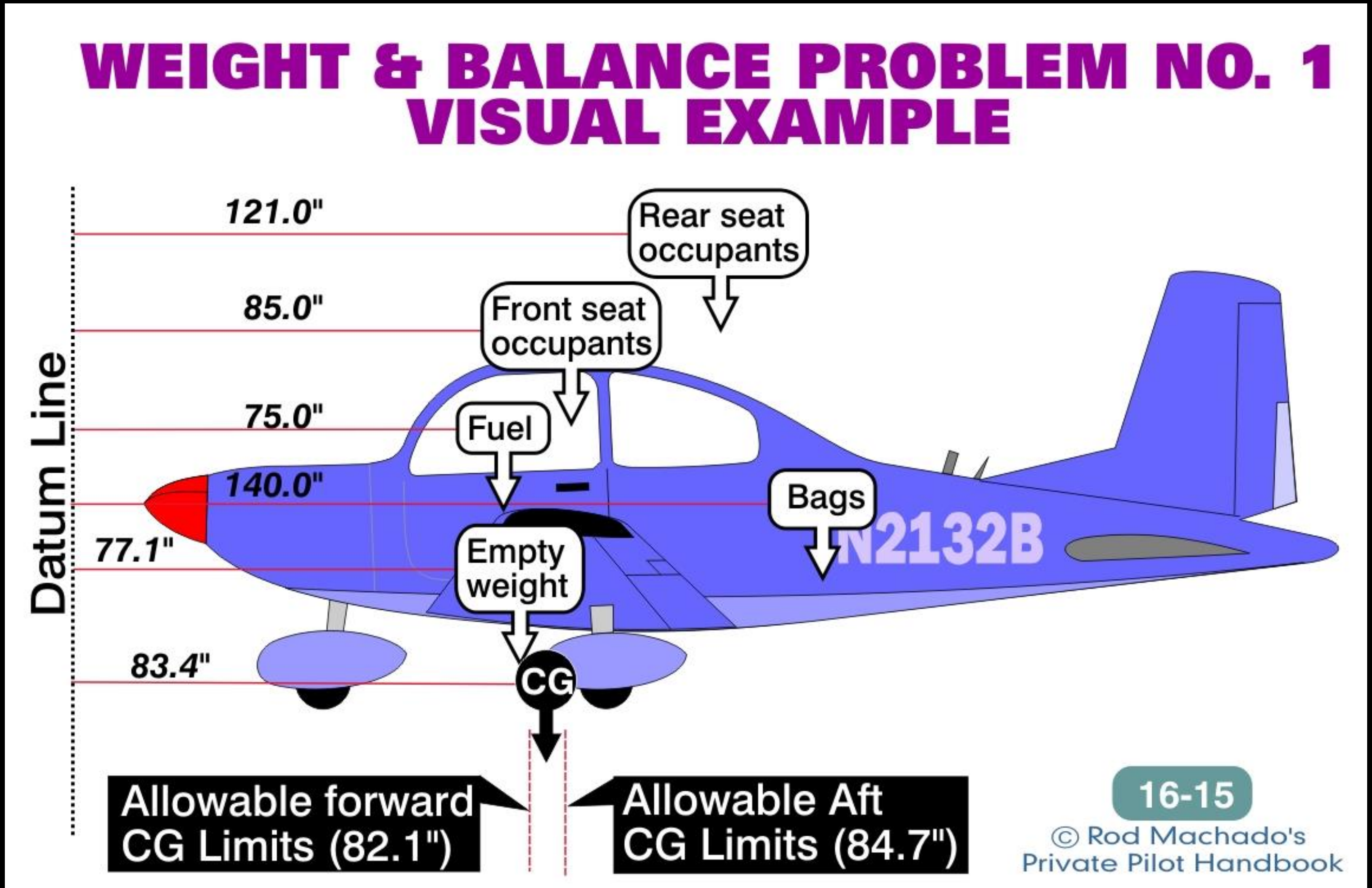
Moment limits are based on the following weight and center of gravity limit data (landing gear down).

WEIGHT CONDITION	FORWARD CG LIMIT	AFT CG LIMIT
2950 lb (takeoff or landing)	82.1	84.7
2525 lb	77.5	85.7
2475 lb or less	77.0	85.7

16-12F/G

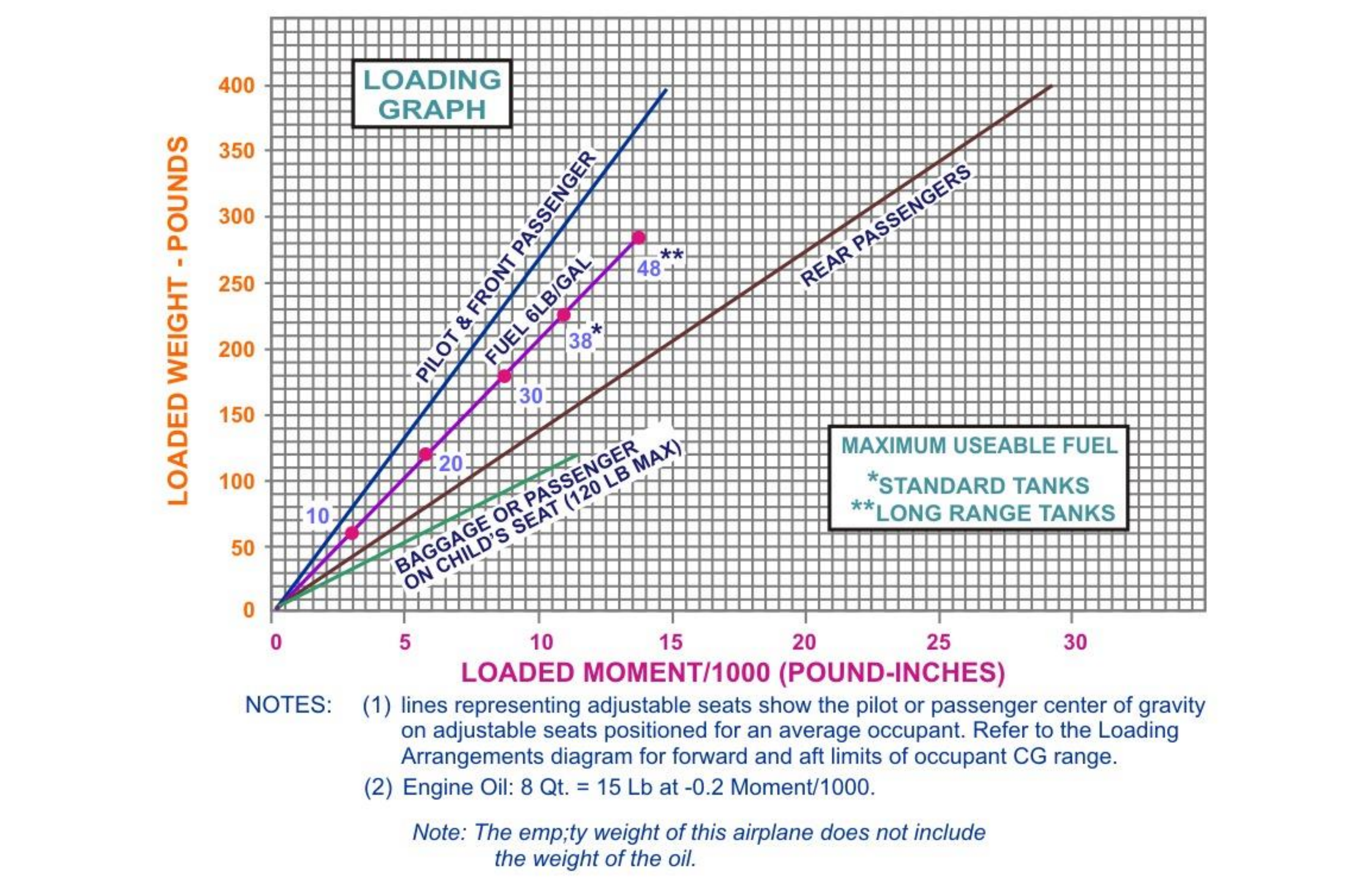
W/B Problem – Table

- CG of 83.4 in is within limits



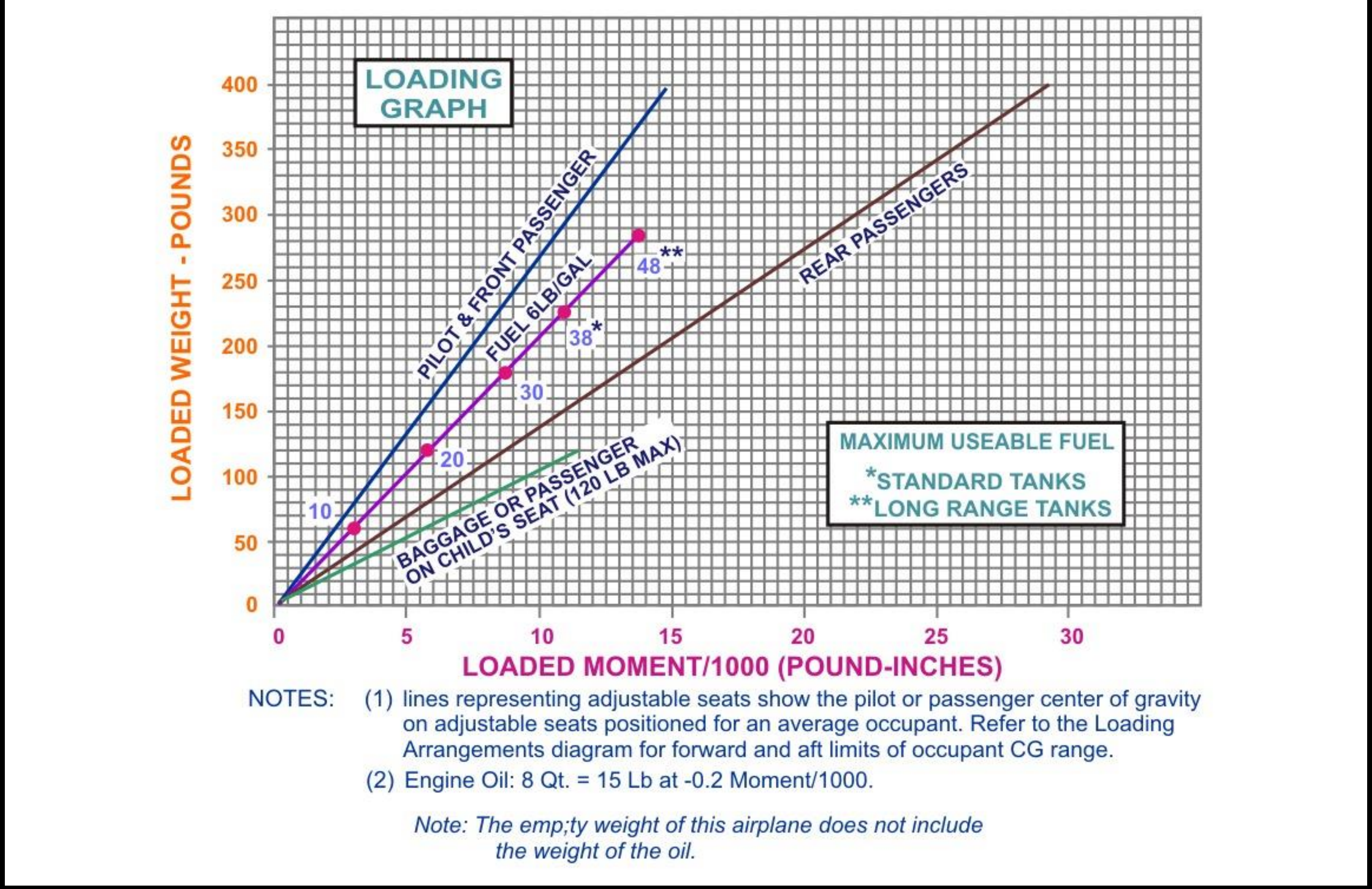
Graphical W&B Chart

- No multiplication used in finding moments
- The loading graph has weights along the vertical axis and moments/1000 along the horizontal axis
- Reduction factor of 1000 is used for the moments, but will not factor into your computations

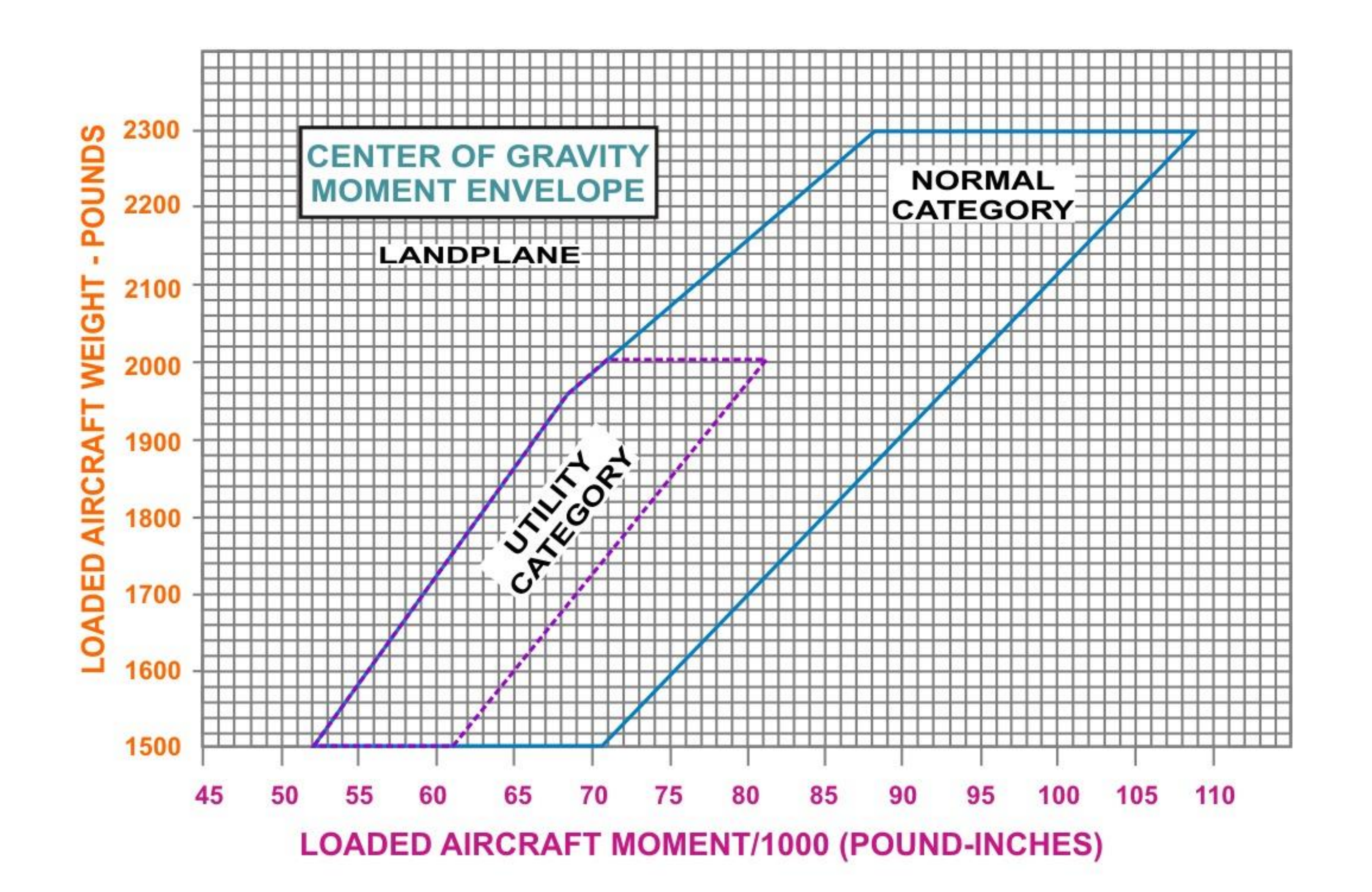


Graphical W&B Chart

- To find the moments for specific weights proceed horizontally along the weight lines
- When reaching the desired diagonal line (pilot, passenger, fuel or baggage) drop straight down to find the moments



Graphical W&B Chart



- When the total moments and weights are totaled, proceed to the Center of Gravity/Moment Envelope chart
- Compare weights and moments to see if they fall within the envelope
- This airplane has both a normal and utility category envelope
- The CG must fall within the utility CG envelope for certain flight operations to be performed (such as spins)

W/B Problem – Graph

- ***Using the airplane loading information determine if the airplane is within its proper CG limits***
- Empty weight/CG given
- Find moments for:
  Front seat
  Rear seat
  Fuel (38 gallons)
- Bottom of chart shows Note 2: Engine Oil 8 qt = 15 lb at
  -0.2 Moment/1000

Weight & Balance Problem No. 6

Using the loading graph in Figure 21A and the center of gravity envelope in Figure 21B, determine if the airplane is within the proper CG limits based on the information below.

	Weight	X Arm	= Moment/1000
E - Empty weight	1,350 lb	..........in	51.5
P - Pilot & front seat occupants	310 lb	..........in	....
R - Rear seat occupants..................	96 lb	..........in	....
F - Fuel (38 gallons)	..........lb	..........in	....
B - Baggage	..........lb	..........in	....
O - Oil (8 quarts)	..........lb	..........in	-0.2

Solution To Problem No. 6

Step 1. Using the loading graph in Figure 21A, find the individual moments for the weights listed below. Remember that the oil weighs 7.5 lb/gal. Eight quarts of oil equals two gallons or 15 lb total. The oil moment is negative indicating that it is ahead of the datum line.

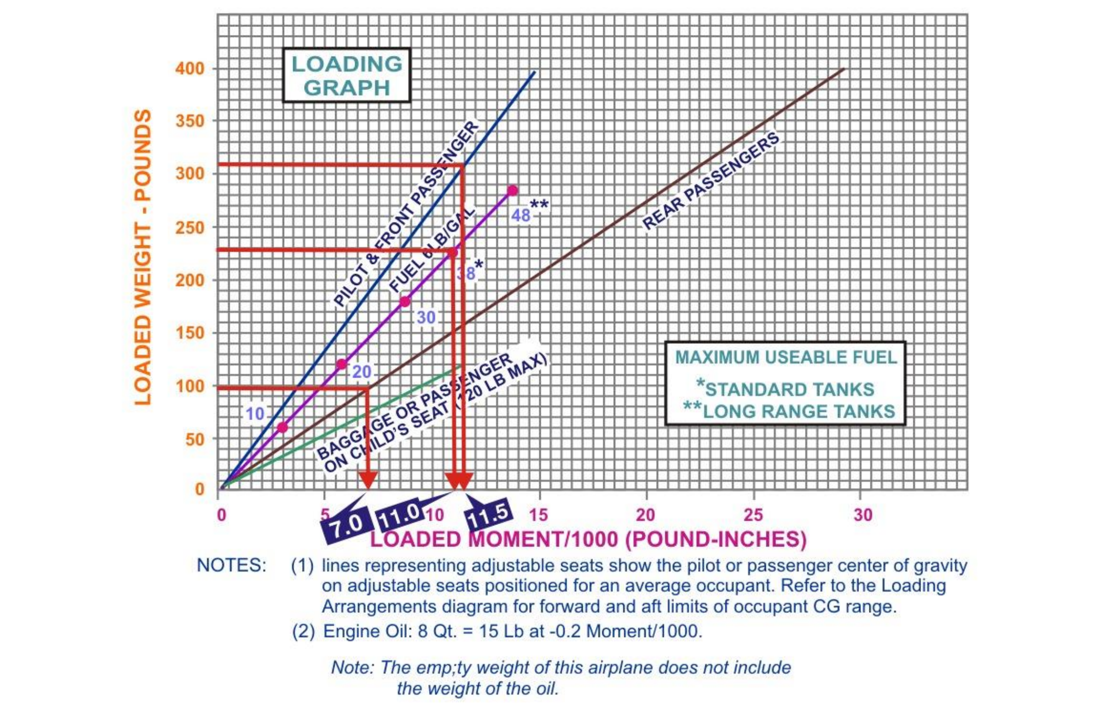
	Weight	X Arm	= Moment/1000
E - Empty weight	1,350 lb	..........in	51.5
P - Pilot & front seat occupants	310 lb	..........in	11.5
R - Rear seat occupants	96 lb	..........in	7.0
F - Fuel 38 gal. (6lb x 38 gal = 228 lb)	228 lb	..........in	11.0
B - Baggage	(no bags) lb	..........in	....
O - Oil (8 quarts)	15 lb	..........in	-0.2

Step 2. Add the totals — **Totals** 1,999 lb — 80.8 **lb-in / 1000**

W/B Problem – Graph

- Find moments for:
  Front seat: 11.5
  Rear seat: 7.0

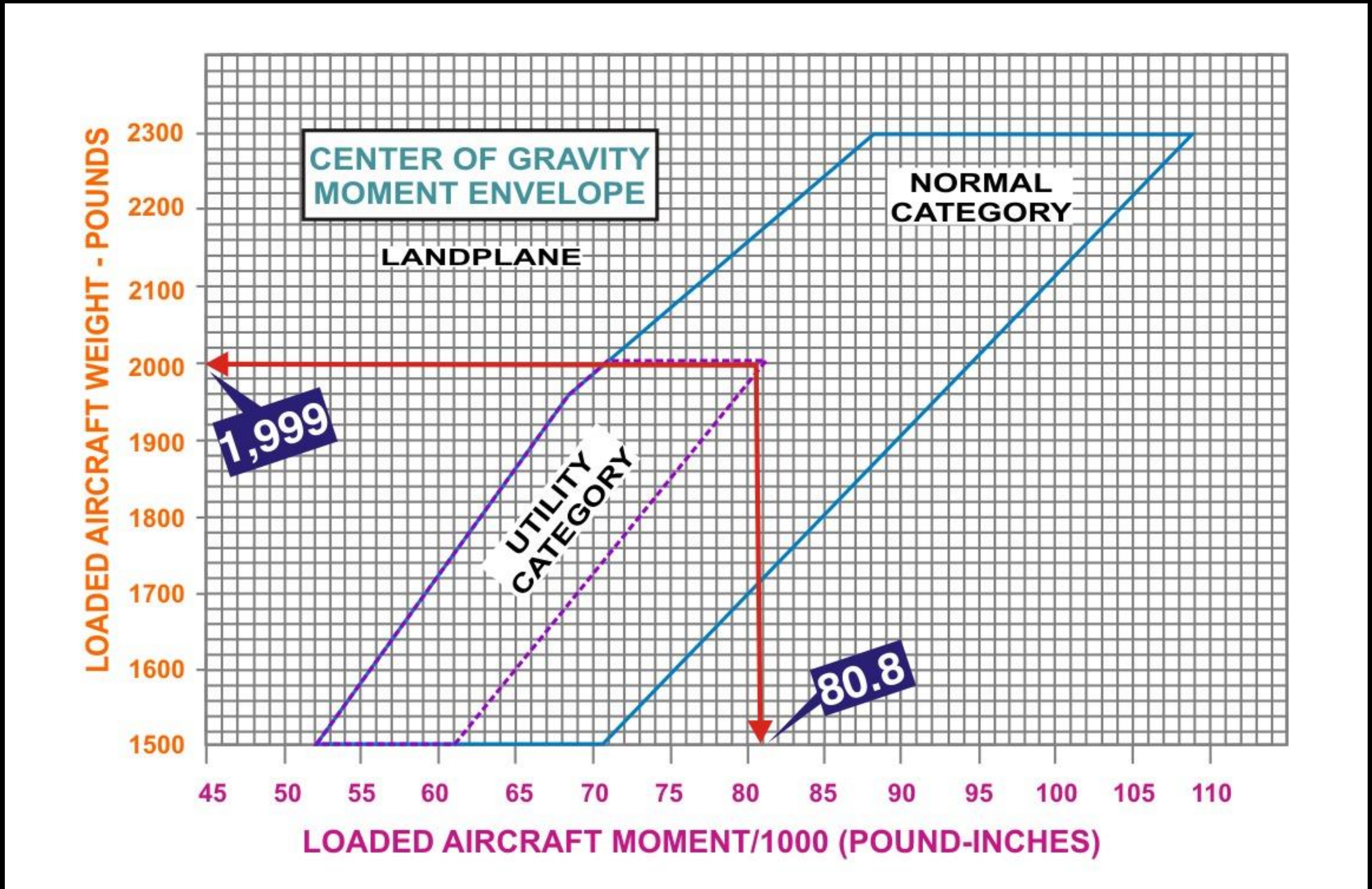
  Fuel (38 gallons)
  Weight: 38 x 6 = 228 lb
  Fuel moment: 11.0
- Total Weight and Moment columns
  Total Weight: 1,999 lb
  Total Moment: 80.8 in-lb/1000



	Weight	X Arm	= Moment/1000
E - Empty weight	1,350 lb	..........in	51.5
P - Pilot & front seat occupants	310 lb	..........in	11.5
R - Rear seat occupants	96 lb	..........in	7.0
F - Fuel 38 gal. (6lb x 38 gal = 228 lb)	228 lb	..........in	11.0
B - Baggage	(no bags) lb	..........in	....
O - Oil (8 quarts)	15 lb	..........in	-0.2
Step 2. Add the totals **Totals**	1,999 lb		80.8 lb-in / 1000

W/B Problem – Graph

- Total Weight: 1,999 lb Total Moment: 80.8 in-lb/1000
- Find intersection of 1,999 and 80.8
- Result is within Utility Category



W/B Problem – Graph 2

- ***Determine the maximum amount of baggage that can be carried in the airplane after all the other items have been loaded***
- Empty weight/CG given
- Find moments for:
  Front seat
  Rear seat
  Fuel (30 gallons)
- Bottom of chart shows Note 2: Engine Oil 8 qt = 15 lb at
  -0.2 Moment/1000

WEIGHT AND BALANCE PROBLEM NO. 7

	Weight	X Arm =	Moment/1000
E - Empty weight	1,350 lb	..........in	51.5
P - Pilot & front seat occupants	250 lb	..........in	....
R - Rear seat occupants..................	400 lb	..........in	....
F - Fuel (30 gallons)	...........lb	..........in	....
B - Baggage	...........lb	..........in	....
O - Oil (8 quarts)	15 lb	..........in	-0.2

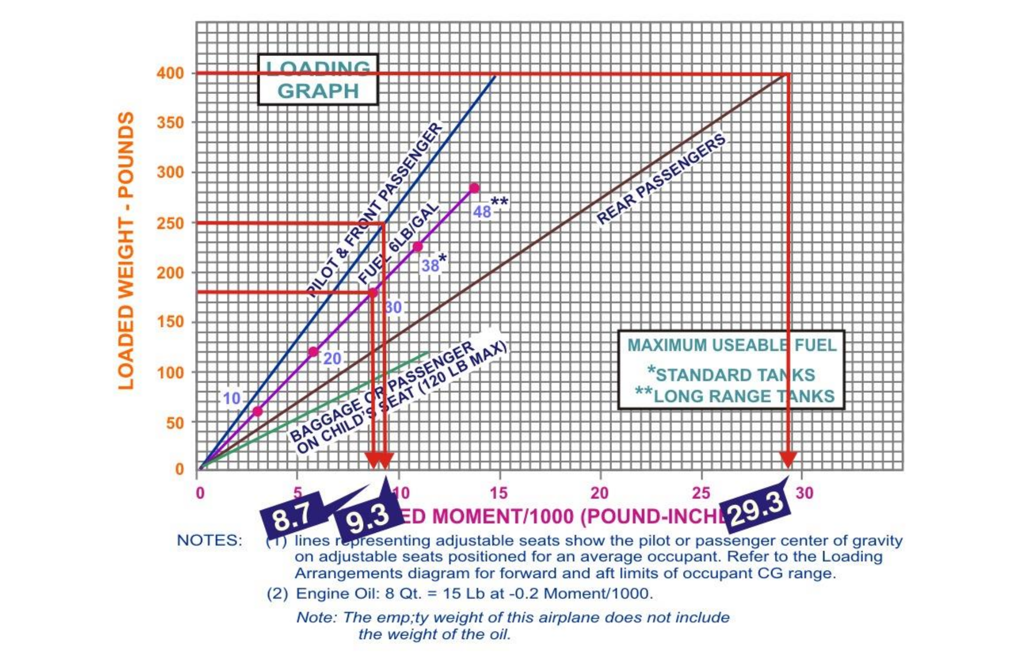
SOLUTION TO PROBLEM NO. 7

	Weight	X Arm =	Moment/1000
E - Empty weight	1,350 lb	..........in	51.5
P - Pilot & front seat occupants	250 lb	..........in	9.3
R - Rear seat occupants	400 lb	..........in	29.3
F - Fuel 30 gal. (6lb x 30 gal = 180 lb)	180 lb	..........in	8.7
B - Baggage (this is unknown).......	? lb	..........in	?
O - Oil (8 quarts)	15 lb	..........in	-0.2
Step 2. Add the totals **Totals**	**2,195 lb**		**98.6 lb-in / 1000**

W/B Problem – Graph 2

- Find moments for:
  Front seat: 9.3
  Rear seat: 29.3

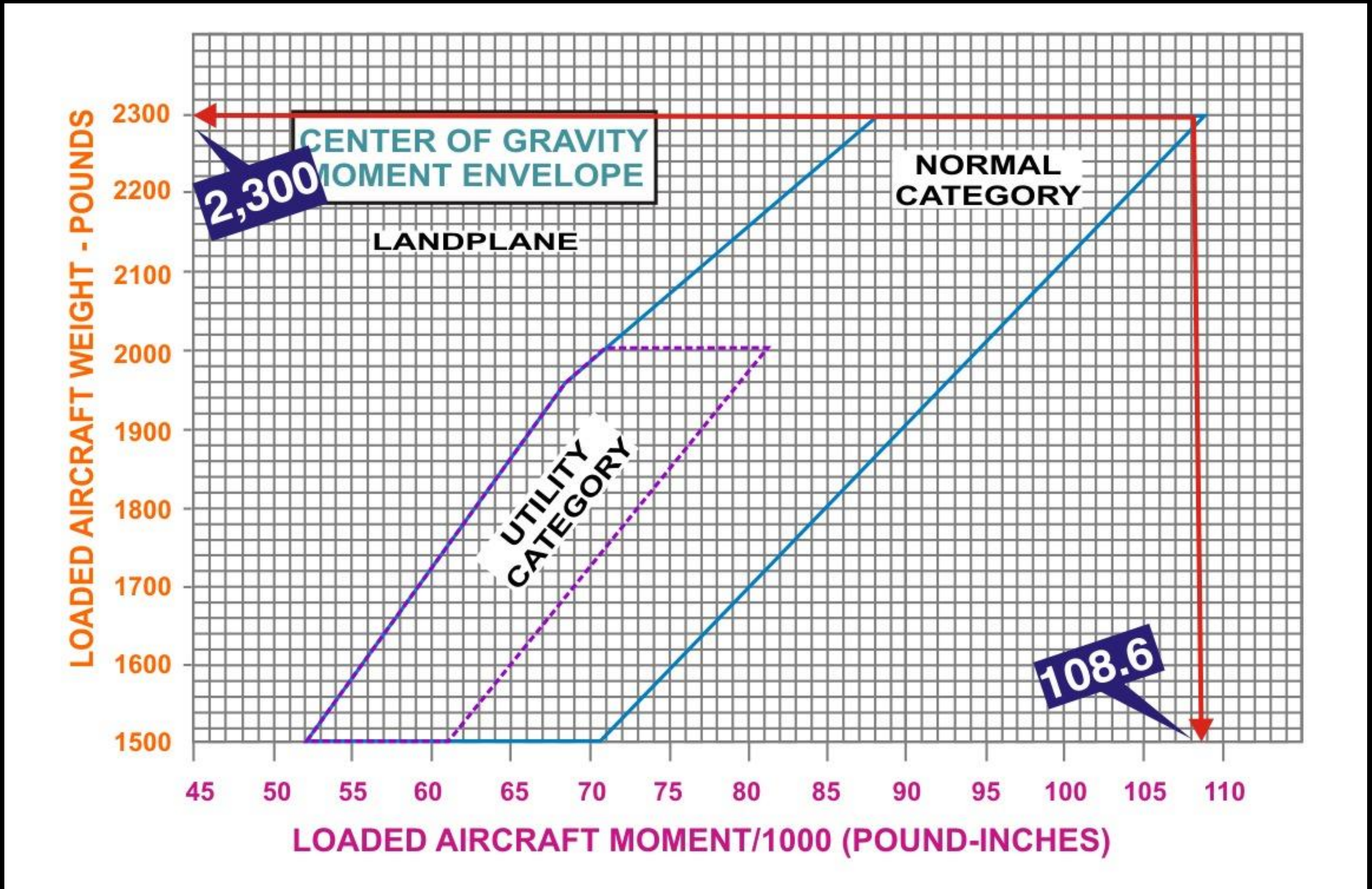
  Fuel (30 gallons)
  Weight: 30 x 6 = 180 lb
  Fuel moment: 8.7
- Total Weight and Moment columns
  Total Weight: 2,195 lb
  Total Moment: 98.6 in-lb/1000



	Weight	X Arm	= Moment/1000
E - Empty weight	1,350 lb	..........in	51.5
P - Pilot & front seat occupants	250 lb	..........in	9.3
R - Rear seat occupants	400 lb	..........in	29.3
F - Fuel 30 gal. (6lb x 30 gal = 180 lb)	180 lb	..........in	8.7
B - Baggage (this is unknown).......	? lb	..........in	?
O - Oil (8 quarts)	15 lb	..........in	-0.2
Step 2. Add the totals **Totals**	**2,195 lb**		**98.6 lb-in / 1000**

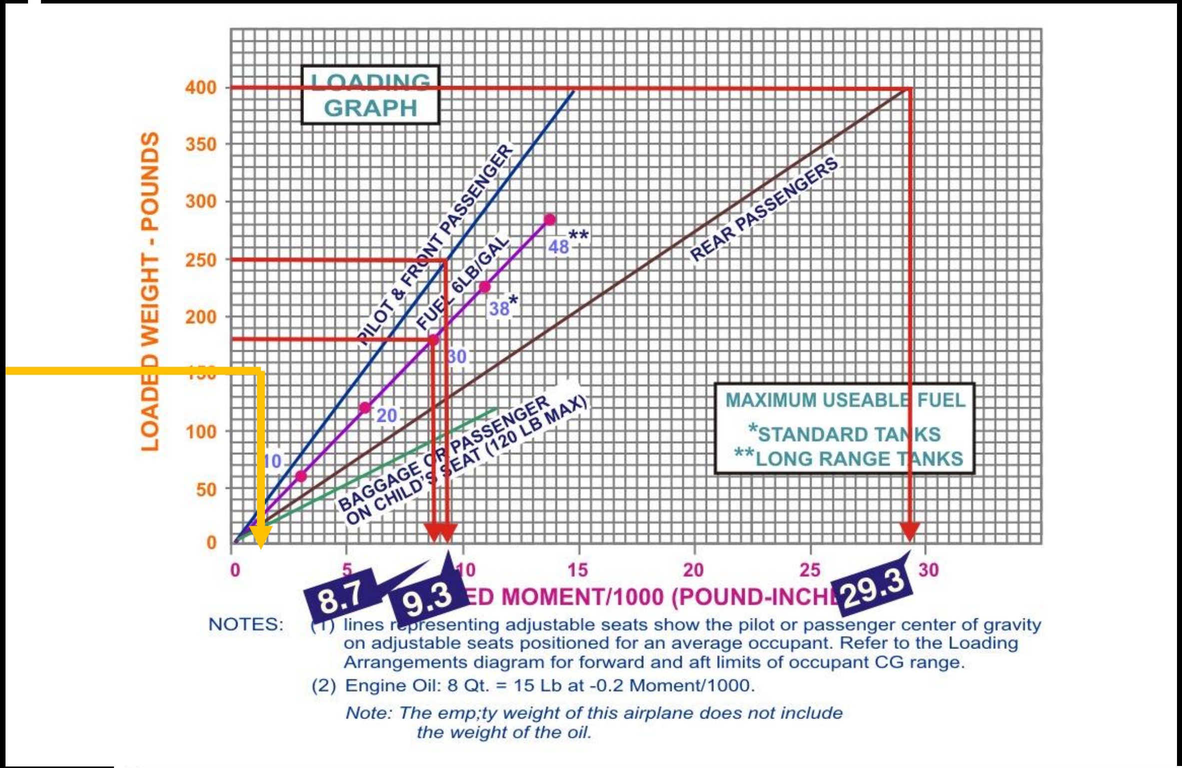
W/B Problem – Graph 2

- Total Weight: 2,195 lb
- The airplane's maximum allowable gross weight is 2,300 lb (upper limit of the CG/Moment Envelope)
- Find the current loaded weight of the airplane and subtract that from the maximum allowable weight:
- 2,300 - 2,195 = 105 lb
- Baggage: 105 lb



W/B Problem – Graph 2

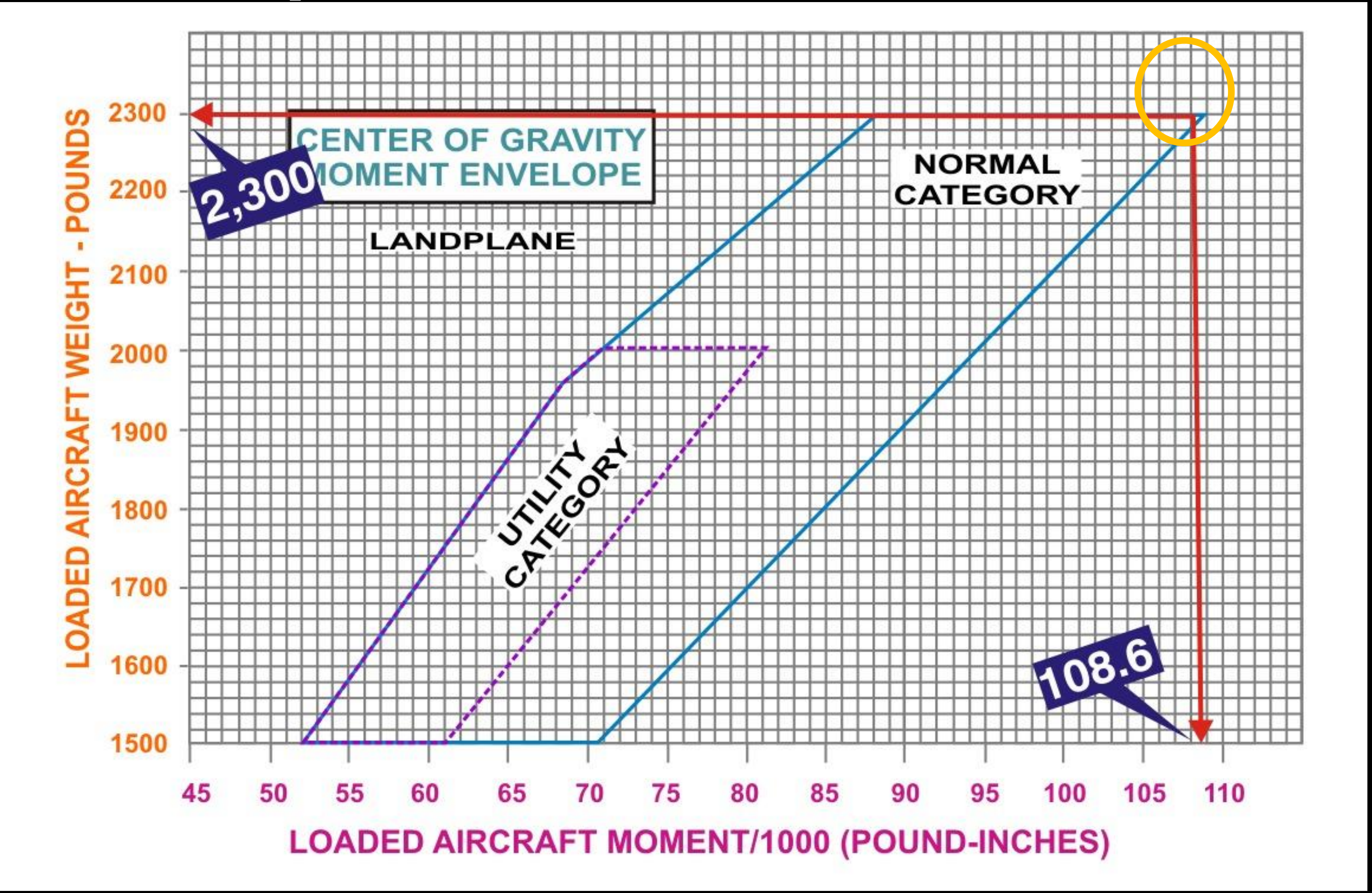
- Baggage: 105 lb
- Find moments for:
  Baggage: 10.0
- Add the weight of the baggage and its moment to the totals
- Total Weight: 2,195 + 105 = 2,300 lb
  Total Moment: 98.6 + 10.0 = 108.6



	Weight	X Arm	= Moment/1000
E - Empty weight	1,350 lb	..........in	51.5
P - Pilot & front seat occupants	250 lb	..........in	9.3
R - Rear seat occupants	400 lb	..........in	29.3
F - Fuel 30 gal. (6lb x 30 gal = 180 lb)	180 lb	..........in	8.7
B - Baggage (this is unknown).......	? lb	..........in	?
O - Oil (8 quarts)	15 lb	..........in	-0.2
Step 2. Add the totals — Totals	2,195 lb		98.6 lb-in / 1000

W/B Problem – Graph 2

- Total Weight: 2,195 + 105 = 2,300 lb
  Total Moment: 98.6 + 10.0 = 108.6
- The airplane is just barely within its proper CG limits (at the upper edge of the envelope)



W/B Problem – Graph 3

- ***Determine the maximum amount of fuel that can be carried aboard the aircraft for takeoff***
- Find the current loaded weight of the airplane without fuel and subtract that from the maximum weight allowable for that airplane
- The difference is the amount of fuel that can be carried on board

SOLUTION TO PROBLEM NO. 8

Fig. 26

	Weight	X Arm	= Moment/1000
E - Empty weight	1,350 lb	..........in	51.5
P - Pilot & front seat occupants	340 lb	..........in	12.6
R - Rear seat occupants	310 lb	..........in	22.6
F - Fuel 38 gal. (6lb x 38 gal = 228 lb)	? lb	..........in	?
B - Baggage	45 lb	..........in	4.2
O - Oil (8 quarts)	15 lb	..........in	-0.2
Totals	2,060 lb		90.7 lb-in/1000

W/B Problem – Graph 3

- *Determine the maximum amount of fuel that can be carried aboard the aircraft for takeoff*
- Empty weight/CG given
- Find moments for:
  Front seat
  Rear seat
  Baggage
- Bottom of chart shows
  Note 2: Engine Oil 8 qt = 15 lb at
  -0.2 Moment/1000

SOLUTION TO PROBLEM NO. 8

Fig. 26

	Weight	X Arm	= Moment/1000
E - Empty weight	1,350 lb	..........in	51.5
P - Pilot & front seat occupants	340 lb	..........in	12.6
R - Rear seat occupants	310 lb	..........in	22.6
F - Fuel 38 gal. (6lb x 38 gal = 228 lb)	? lb	..........in	?
B - Baggage	45 lb	..........in	4.2
O - Oil (8 quarts)	15 lb	..........in	-0.2
Totals	2,060 lb		90.7 lb-in / 1000

W/B Problem – Graph 3

- Find moments for:
  Front seat: 12.6
  Rear seat: 22.6
  Baggage: 4.2

- Total Weight and Moment columns
  Total Weight: 2,060 lb
  Total Moment: 90.7

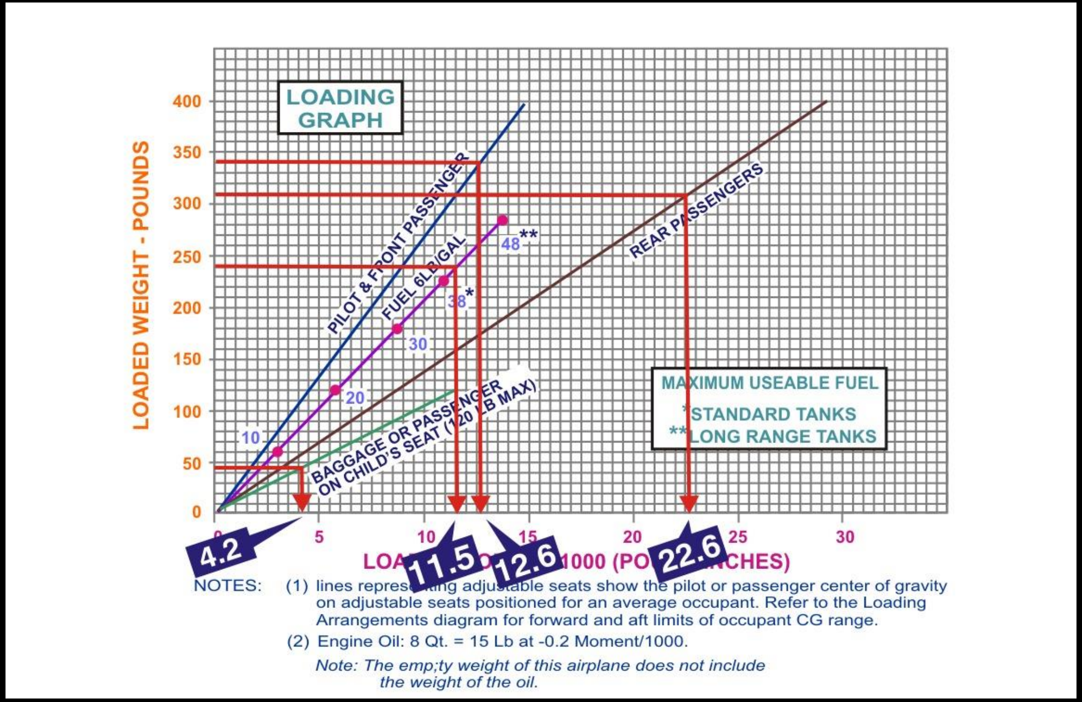
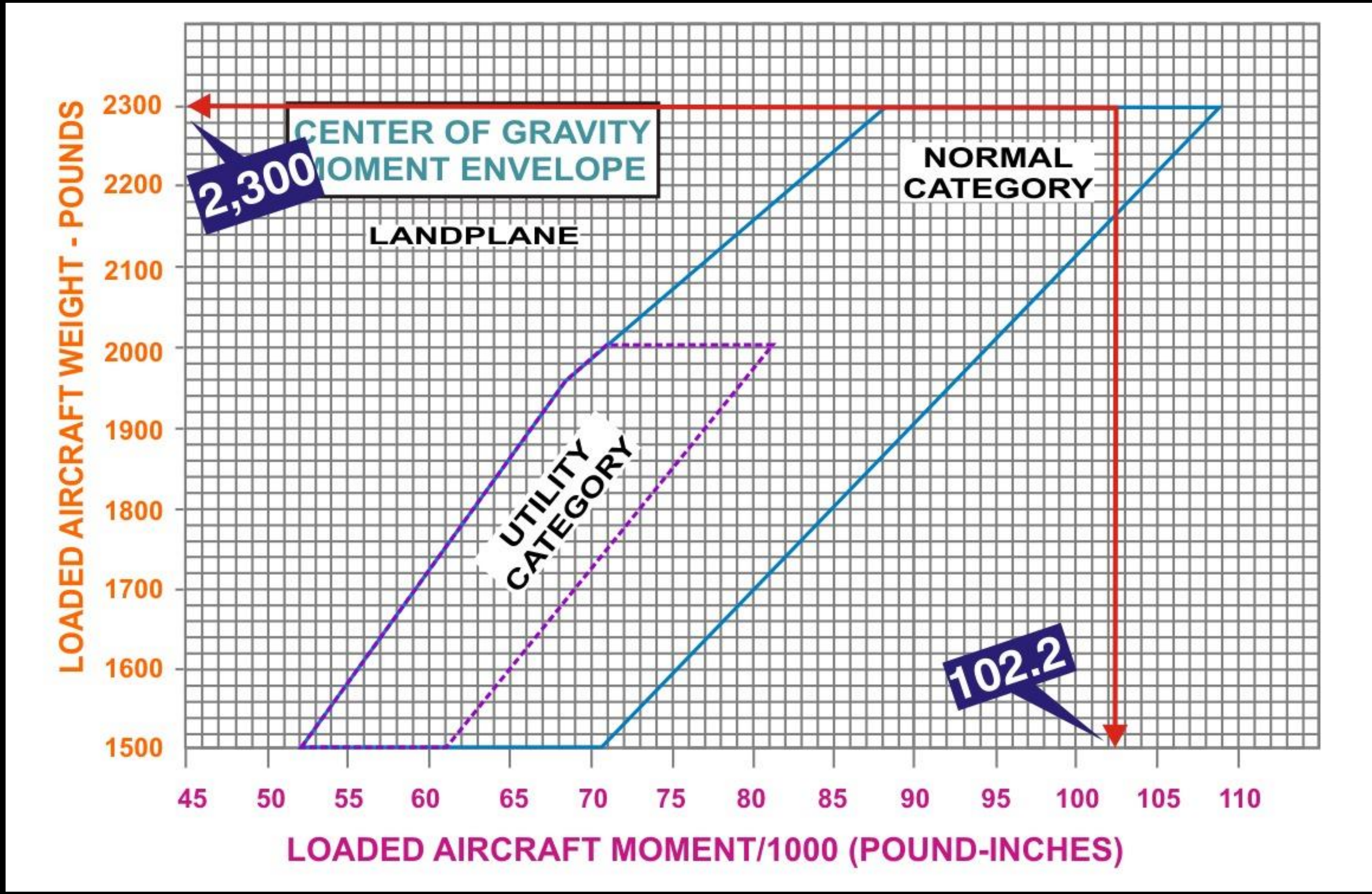


Fig. 26

	Weight	X Arm	= Moment/1000
E - Empty weight	1,350 lb	..........in	51.5
P - Pilot & front seat occupants	340 lb	..........in	12.6
R - Rear seat occupants	310 lb	..........in	22.6
F - Fuel 38 gal. (6lb x 38 gal = 228 lb)	? lb	..........in	?
B - Baggage	45 lb	..........in	4.2
O - Oil (8 quarts)	15 lb	..........in	-0.2
Totals	2,060 lb		90.7 lb-in / 1000

W/B Problem – Graph 3

- Total Weight: 2,060 lb
- The airplane's maximum allowable gross weight is 2,300 lb (upper limit of the CG/Moment Envelope)
- Find the current loaded weight of the airplane and subtract that from the maximum allowable weight:
- 2,300 - 2,060 = 105 lb
- Fuel: 240 lb



W/B Problem – Graph 3

- Fuel: 240 lb
- Find moments for:
  Fuel: 11.5
- Add the weight of the baggage and its moment to the totals
- Total Weight: 2,060 + 240 = 2,300 lb
  Total Moment: 90.7 + 11.5 = 102.2

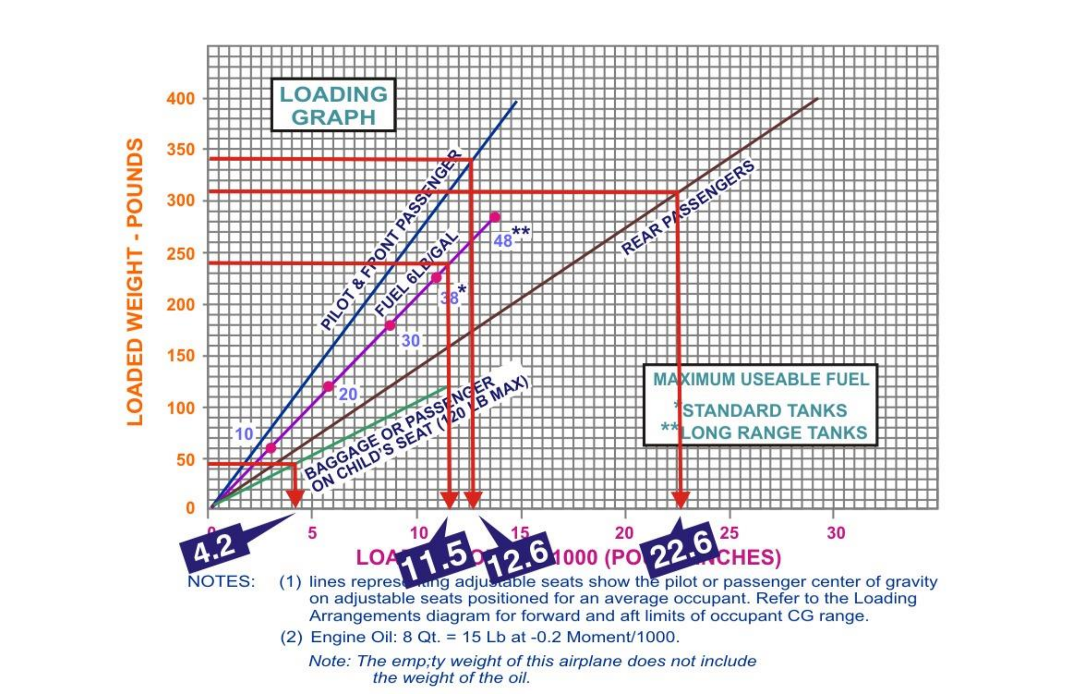
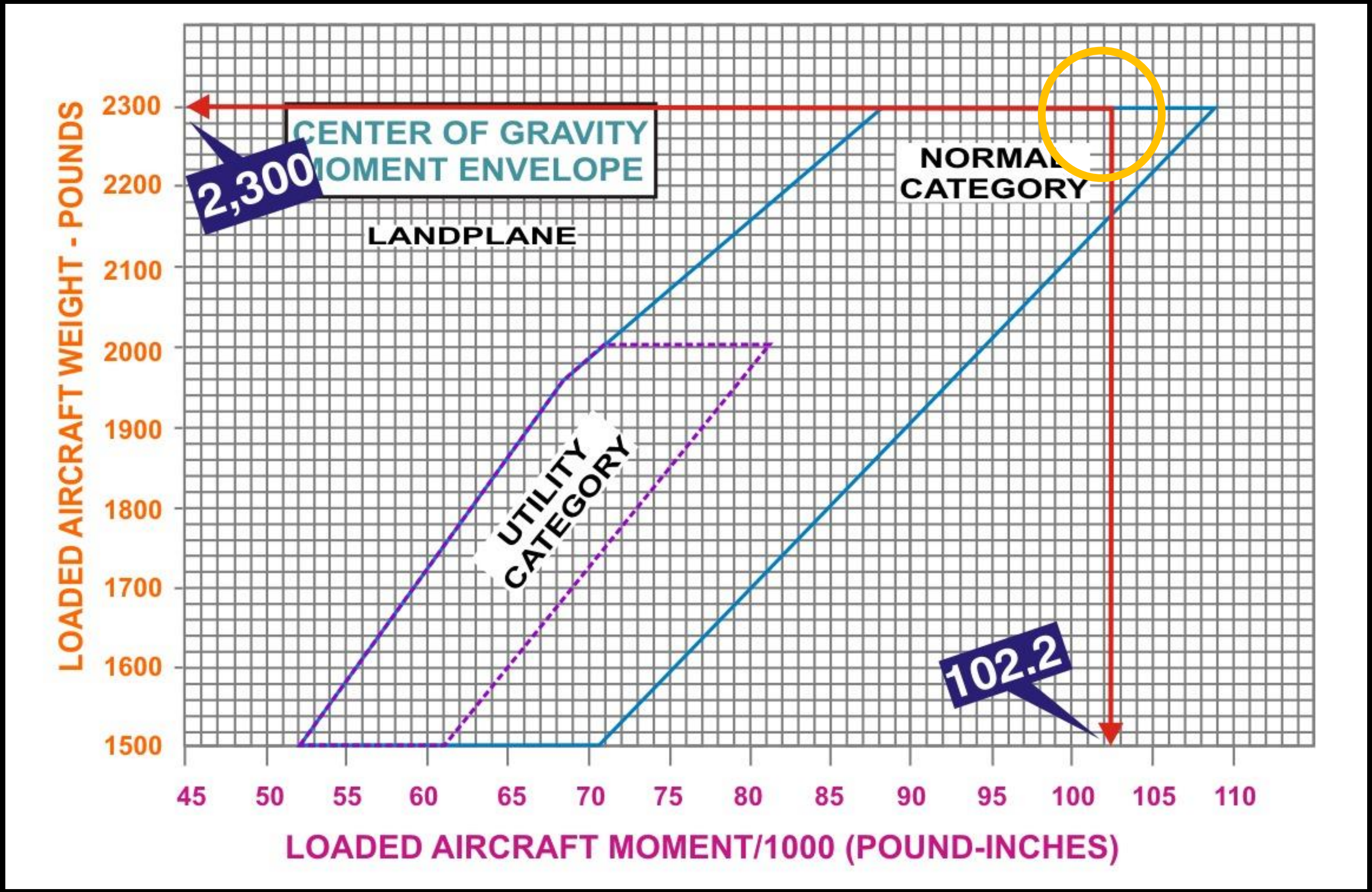


Fig. 26

	Weight	X Arm	= Moment/1000
E - Empty weight	1,350 lb	..........in	51.5
P - Pilot & front seat occupants	340 lb	..........in	12.6
R - Rear seat occupants	310 lb	..........in	22.6
F - Fuel 38 gal. (6lb x 38 gal = 228 lb)	? lb	..........in	?
B - Baggage	45 lb	..........in	4.2
O - Oil (8 quarts)	15 lb	..........in	-0.2
Totals	2,060 lb		90.7 lb-in/1000

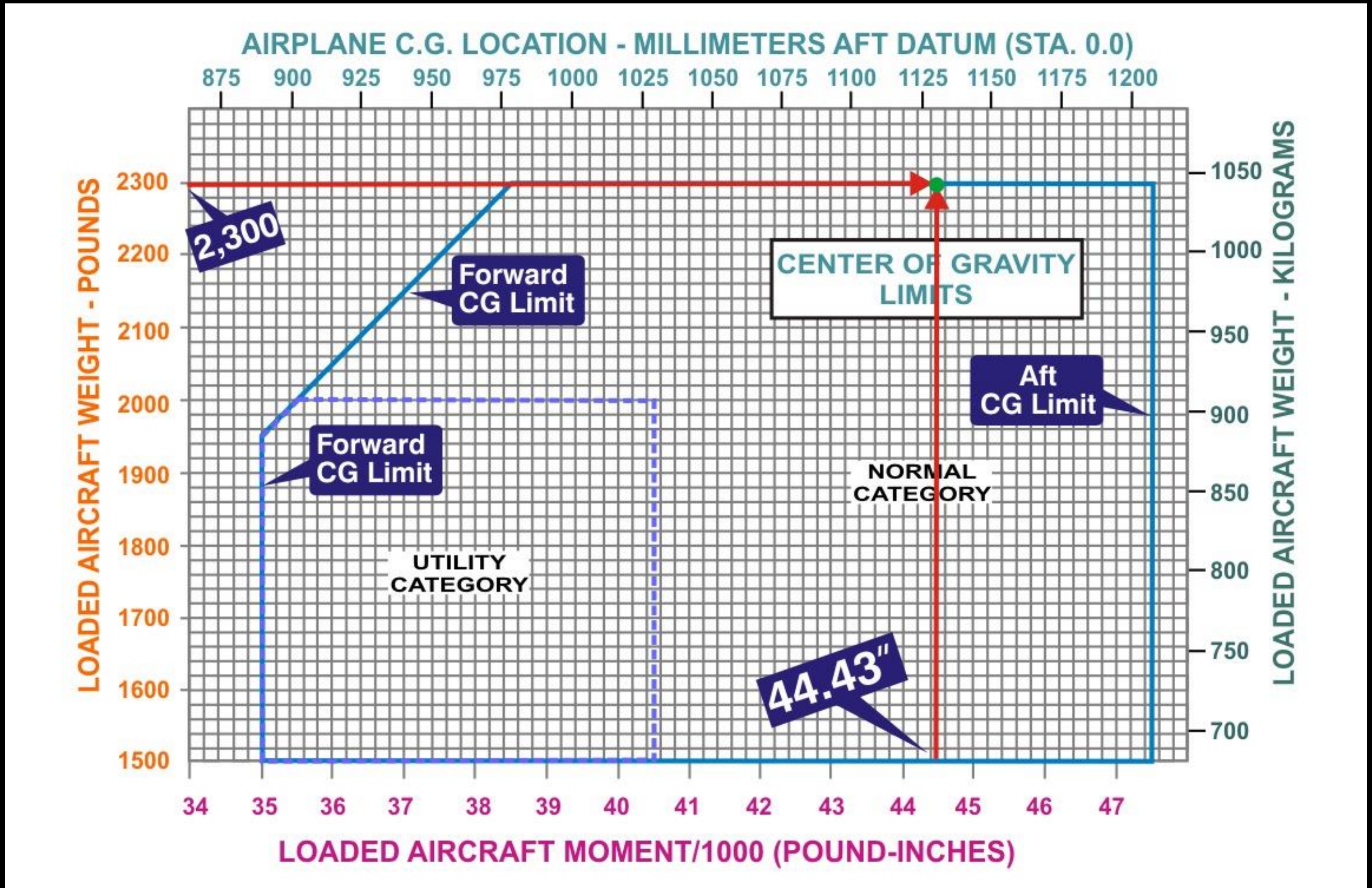
W/B Problem – Graph 3

- Total Weight: 2,060 + 240 = 2,300 lb
  Total Moment: 90.7 + 11.5 = 102.2
- Center of gravity is within proper limits for safe flight



W/B Problem – Graph 3 Another Way

- Cessna aircraft use the Center of Gravity Limits Chart
- Total Weight: 2,300 lb
  Total Moment: 102.2/1000 in lb
- Calculate airplanes CG by dividing total moments by total weight
- CG = (102.2 x 1000) / 2,300 = 44.43
- Airplane falls within allowable CG limits



FAA Exam Charts

- Empty weight data and fuel chart

Empty Weight Data

*Oil is included in empty weight	Empty Weight (pounds)	Empty Weight Moment (/100)
Certificated Weight	2,110	1,652

Fuel

ARM 75 inches

Gallons	Weight (pounds)	Moment (in-ib)	Gallons	Weight (pounds)	Moment (in-lb)
5	30	23	45	270	203
10	60	45	49	294	221
15	90	68	55	330	248
20	120	90	60	360	270
25	150	113	65	390	293
30	180	135	70	420	315
35	210	158	75	450	338
40	240	180	80	480	360

FAA Exam Charts

- Front and rear occupants' charts

Occupants				
Front seats		Rear seats		
ARM 85 inches			Fwd Position ARM 111 inches	Alt Position ARM 136 inches
Weight (pounds)	Moment (in-lb)	Weight (pounds)	Moment (in-lb)	Moment (in-lb)
120	102	120	133	163
130	111	130	144	177
140	119	140	155	190
150	128	150	167	204
160	136	160	178	218
170	145	170	189	231
180	153	180	200	245
190	162	190	211	258
200	170	200	222	273

FAA Exam Charts

- Fuel chart

Fuel					
ARM 75 inches					
Gallons	Weight (pounds)	Moment (in-ib)	Gallons	Weight (pounds)	Moment (in-lb)
5	30	23	45	270	203
10	60	45	49	294	221
15	90	68	55	330	248
20	120	90	60	360	270
25	150	113	65	390	293
30	180	135	70	420	315
35	210	158	75	450	338
40	240	180	80	480	360

FAA Exam Charts

- Baggage charts

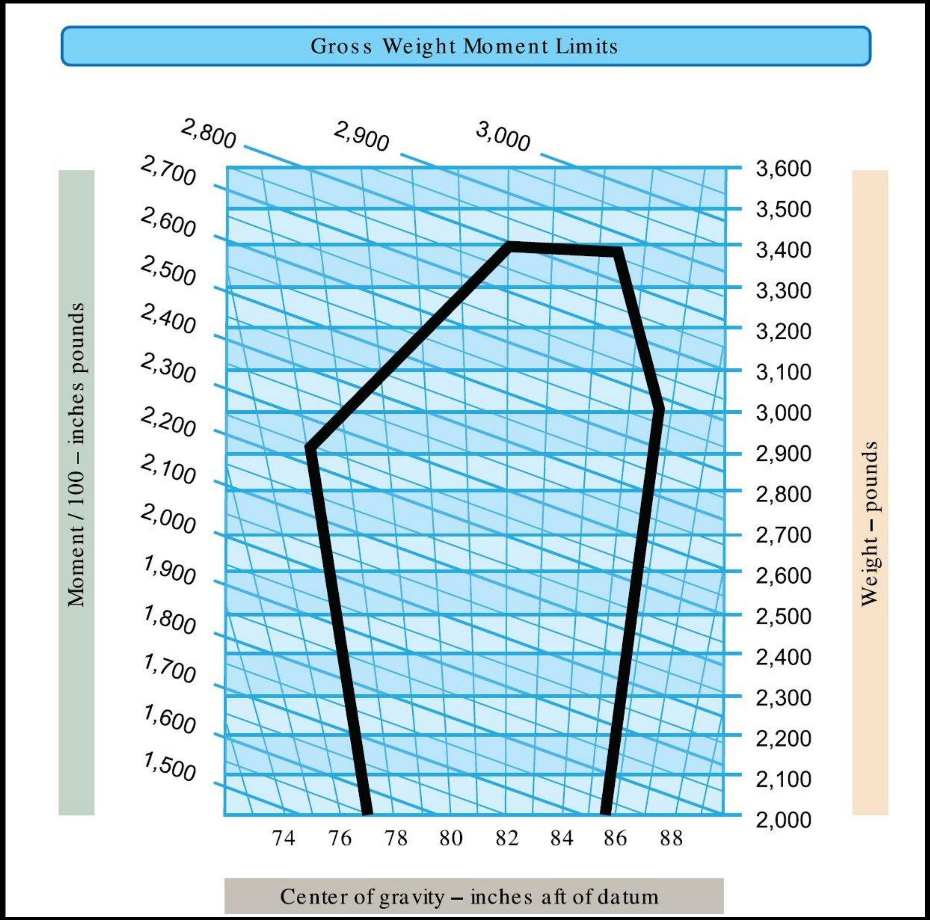
Baggage	
ARM 150	
Weight (pounds)	Moment (in-lb)
10	15
20	30
30	45
40	60
50	75
60	90
70	105
80	120
90	135
100	150

Baggage	
ARM 150	
Weight (pounds)	Moment (in-lb)
110	165
120	180
130	195
140	210
150	225
160	240
170	255
180	270
190	285
200	300

Baggage	
ARM 150	
Weight (pounds)	Moment (in-lb)
210	315
220	330
230	345
240	360
250	375
260	390
270	405

FAA Exam Charts

- Weight and balance envelope allows you to match the airplane's total weights with total moments and evaluate the airplane's center of gravity condition



Practice #1

If an aircraft is loaded 90 pounds over maximum certificated gross weight and fuel (gasoline) is drained to bring the aircraft weight within limits, how much fuel should be drained?

- Total weight to be removed: 90 lb
- Weight per gallon of gasoline: 6 gal/lb
- Calculate the amount of gasoline to be drained:
- Gallons = Pounds ÷ Pounds/Gallon
- 90 ÷ 6 = 15 gallons

Practice #2

- Given the following information, how far aft is the CG located from the datum? Full fuel

ITEM	WEIGHT	ARM	MOMENT
Empty Weight	1495	101.4	151,593.0
Pilot & Passenger	380	64	
Fuel (30 gal)		96	

Practice #2

ITEM	WEIGHT	ARM	MOMENT
Empty Weight	1495	101.4	151,593.0
Pilot & Passenger	380	64	24,320.0
Fuel (30 gal)	180	96	17,280.0

Practice #2

ITEM	WEIGHT	ARM	MOMENT
Empty Weight	1,495	101.4	151,593.0
Pilot & Passenger	380	64	24,320.0
Fuel (30 gal)	180	96	17,280.0
Total	2,055.0	94.01	193,193.0

Knowledge Check

How can you fix having a CG forward of limit and under maximum weight?

A. Increase weight forward of the CG
B. Move weight forward of the CG
C. Adding weight aft of CG or moving weigh aft of CG
D. Reducing weight aft of CG or move weight forward of CG

Knowledge Check

How can you fix having a CG forward of limit and under maximum weight?

A. ~~Increase weight forward of the CG~~
B. ~~Move weight forward of the CG~~
C. Adding weight aft of CG or moving weigh aft of CG
D. ~~Reducing weight aft of CG or move weight forward of CG~~

Knowledge Check

Which is the formula for CG?

A. (Total Moment) / (Total Weight)
B. (Total Weight) / (Total Moment)
C. (Arm x Total Moment) / (Total Weight)
D. (Total Weight) / (Arm x Total Moment)

Knowledge Check

Which is the formula for CG?

A. (Total Moment) / (Total Weight)
~~B. (Total Weight) / (Total Moment)~~
~~C. (Arm x Total Moment) / (Total Weight)~~
~~D. (Total Weight) / (Arm x Total Moment)~~

Knowledge Check

How much does a gallon of AVGAS (100LL) weigh?

A. 7 lbs.
B. 5 lbs.
C. 6 lbs.
D. 9 lbs.

Knowledge Check

~~How much does a gallon of AVGAS (100LL) weigh?~~

~~A. 7 lbs.~~
~~B. 5 lbs.~~
C. 6 lbs.
~~D. 9 lbs.~~

Knowledge Check

An increase in airplane weight will result in what performance?

A. An increase in performance
B. Depends on CG location, forward or aft of limits
C. A decrease in performance
D. Not enough information

Knowledge Check

An increase in airplane weight will result in what performance?

A. ~~An increase in performance~~
B. ~~Depends on CG location, forward or aft of limits~~
C. A decrease in performance
D. ~~Not enough information~~

Knowledge Check

As AOA increase, the center of pressure moves aft?

A. True
B. False

Knowledge Check

As AOA increase, the center of pressure moves aft?

A. ~~True~~

B. False

Knowledge Check

If an airplane has a maximum certificated takeoff weight of 2,000 lbs. and is loaded to MTOW, but is exposed to 2g of forces, is it within limits? (2g places a force of 4,000lbs)

A. True
B. False

Knowledge Check

If an airplane has a maximum certificated takeoff weight of 2,000 lbs. and is loaded to MTOW, but is exposed to 2g of forces, is it within limits? (2g places a force of 4,000lbs)

A. True
B. ~~False~~