Mass and Balance

Study Guide

Influence FWD & AFT CG position

FWD CG position

Increased stall speed
Increased fuel consumption
Increased longitudinal stability
Increased take off distance
Increased drag

Heavier elevator control
Decreased absolute ceiling
Decreased endurance
Decreased controllability
Decreased rate of climb capability

AFT CG position

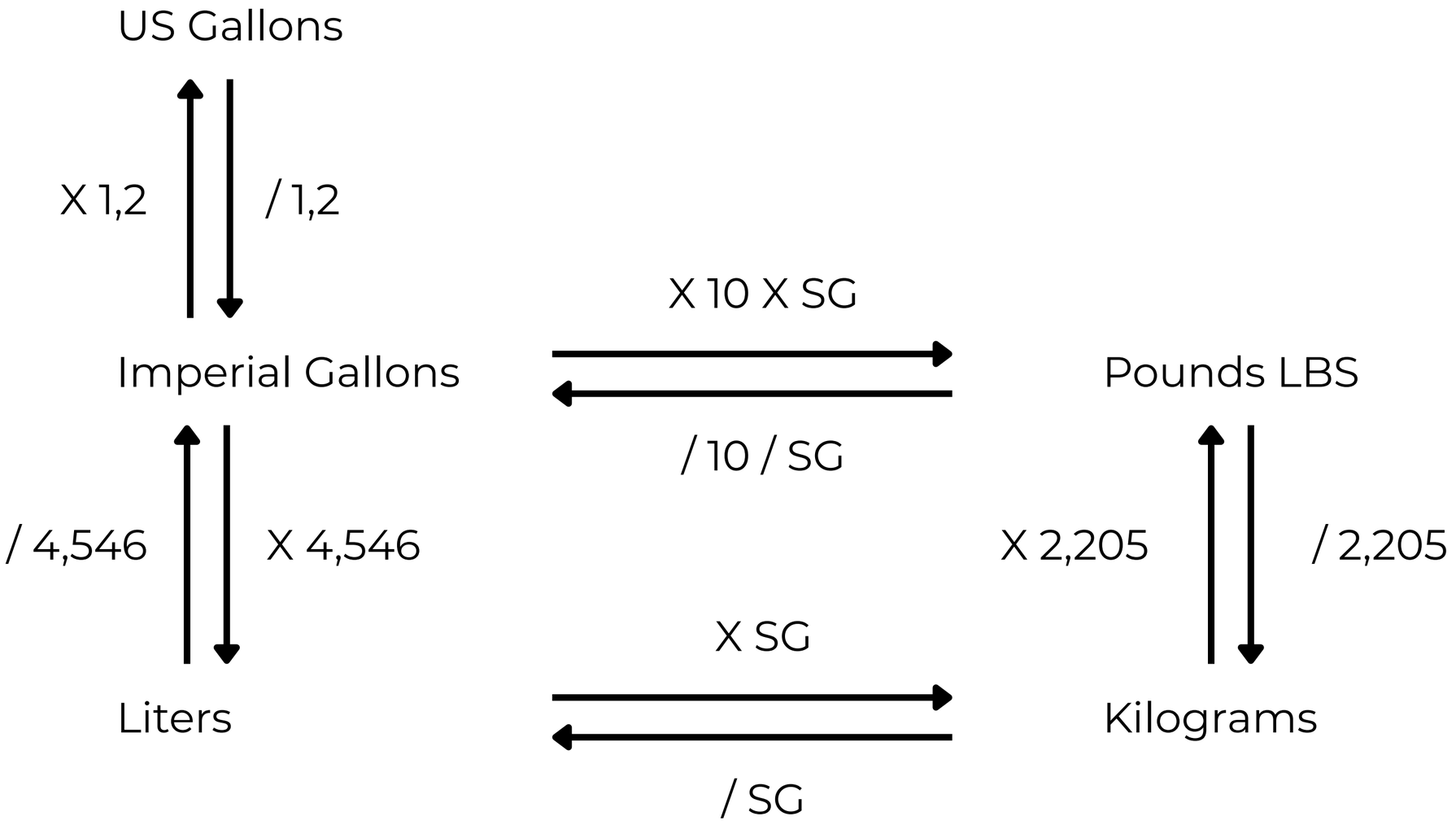
Decreased stall speed
Decreased fuel consumption
Decreased longitudinal stability
Decreased take off distance
Decreased drag

Lighter elevator control
Increased absolute ceiling
Increased endurance
Increased controllability
Increased rate of climb capability

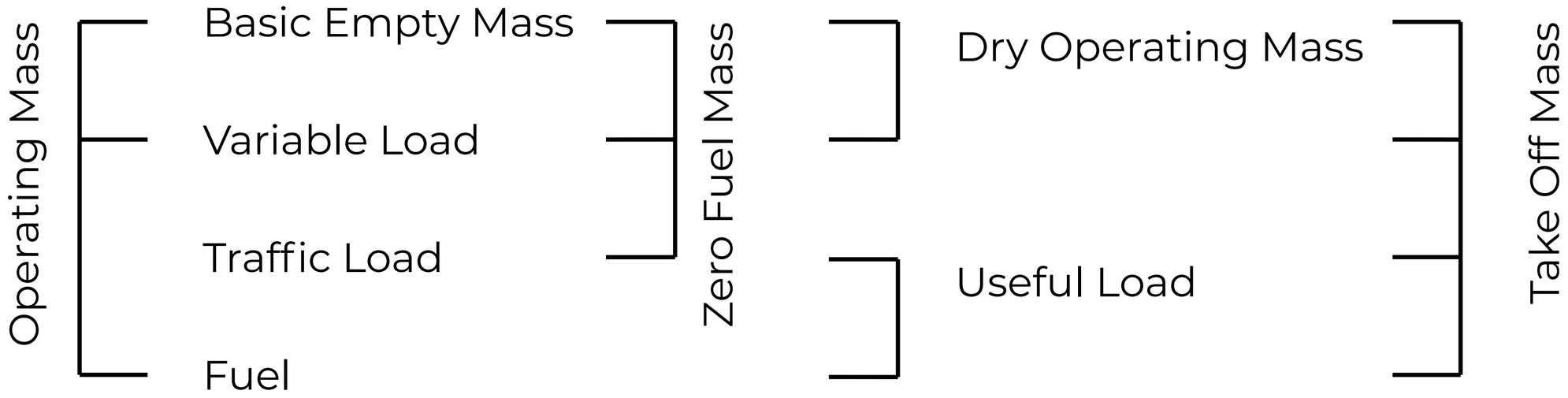
Masses and Definitions

PLLM	performance limited landing mass	the landing mass subjected to airport normal conditions
MSLM	maximum structural landing mass	maximum permissible total aeroplane mass on landing in normal circumstances, a fixed value listed in the Flight Manual
RLM	regulated landing mass	lowest of PLLM and MSLM
RTOM (ATOM)	regulated take off mass	lowest of PLTOM and MSTOM
PLTOM	performance limited takeoff mass	take off mass subject to departure aerodrome conditions
MSTOM	maximum structural take off mass	maximum permissible total aeroplane mass on take off, a fixed value listed in the flight manual
MTOM	maximum structural take off mass	It is the maximum permissible total aeroplane mass at the start of the take off run
MCTM	maximum certified taxi (ramp) mass	the structural limit on the ramp
MZFM	maximum zero fuel mass	maximum permissible mass of an aeroplane with no usable fuel

Conversion table



Take Off Mass



Variable load = crew, their baggage, removable equipment that is required

Basic Empty Mass = airframe, engines, fixed ballast, unusable fuel, full operating fluids, emergency oxygen equipment, pyrotechnics.

Good-To-Know

Stall speed is determined with the CG at the FWD limit
Minimum control speed is determined with the CG at the AFT limit

CG = center of gravity = the point from which the weight is considered to act.

CP = center of pressure = the point where the total lift is considered to act.

If the CP is behind the CG, the aircraft is stable, if the CP is ahead of the CG, the aircraft is unstable

Take off fuel = trip fuel + contingency fuel + alternate fuel + final reserve fuel + extra fuel

Bending moment at wing root is biggest with high ZFM and low fuel

Mass limits

MTM is the lowest of:

- MSTOM
- PLTOM
- PLLM + Trip Fuel

MTOM is the smallest of:

- MSTOM
- MLM + trip fuel
- MZFM + TO fuel

Maximum possible extra fuel:

Lowest of:

- MTOM - ATOM
- MLM-ALM
- Fuel tank capacity - min block fuel

Mass and Balance details

Datum = the point on the aircraft designated by the manufacturers from which all center of gravity measurements and calculations are made.

MAC = Mean aerodynamic chord = the average length of the chord lines of a wing, representing the wing as a hypothetical rectangular wing with the same area and aerodynamic characteristics.

LeMAC = Leading edge of the Mean Aerodynamic Chord

% of MAC = ((CG-LeMAC)/MAC) * 100

Weight (N) = mass (kg) * acceleration (m/s)

Moment = weight * arm

CG = moment / mass CG = total moment / total mass

Aircraft weighing

Needed to determine the basic mass and the DOM

Initially weighed when manufactured, thereafter:
Every 4 years when the aircraft are considered individually
Every 9 years if the fleet averages are used

Weighing should be accomplished in an enclosed building.

Weighing must be performed whenever the cumulative change to the DOM exceeds +- 0.5% of the MLM.

Determination of CG position

DOI = Dry Operating Index = the index for the position of the CG at the DOM.

Index method is used to simplify calculations

DOI = DOM moment (DOM * CG arm) / a constant

Mass change / total mass = change of CG / distance

$$M * D = d * m$$

M = total mass
m = mass to be moved
D = relevant movement of moved mass
d = CG movement required

Mass change / old total mass = change of CG / distance from mass to new CG

Cargo Handling

Containers

- Lock into restraint system
- Have own manifest
- Better protection

Pallets

- Multiple cargo boxes stored in cargo holds
- More suitable for occasional or larger cargo items

Floor strength is given in a mass per surface area (kg/square meter)

surface area = length * width

Running load = load / length of load

Bulk cargo is typically restrained by a net. It contains rush bash, pushchairs, crew and late arrival bags.