What are 3 effects of operating an aircraft overweight?

Potential structural overload
Increased take-off distance
Reduced climb performance
Shorter range
High stall speed
Longer landing distance
Lower operating ceiling

Weight and balance is considered in certification standards for what 3 reasons?

Strength / structural
Performance
Flight handling

Centre of gravity primarily affects what?

Flight Handling / Stability

What problems are associated with a forward centre of gravity?

Inability to raise the nose on take-off
Inability to flare the aircraft to landing attitude
Tailplane loading

What problems are associated with an aft centre of gravity?

Stability
Stalling characteristics
Spin recovery may be difficult or impossible

What is the ARM?

Arm is the horizontal distance measured in mm from the reference datum to the centre of gravity of the item.

What algebraic sign is the arm if measured AFT of the datum?

Positive (+)

What algebraic sign is the arm if measured FORWARD of the datum?

Negative (-)

What algebraic sign is the arm if measured LEFT of the butt line?

Negative (-)

What algebraic sign is the arm if measured RIGHT of the butt line?

Positive (+)

What is the Centre of Gravity?

The Centre of Gravity is the point about which the aircraft would balance if it were possible to suspend it at that point. The weight of an aircraft may be assumed to be concentrated at its CofG

What is the Centre of Gravity Datum?

The Centre of Gravity Datum is an imaginary plane from which all measurements of arm are measured.

What are Centre of Gravity Limits?

The centre of gravity limits are the most forward and rearward positions at which an aircraft may be operated. Limits are normally expressed as a distance (mm) forward or aft of the datum but for fixed wing aircraft may be expressed as a percentage of the mean aerodynamic chord.

What is the Centre of Gravity Range?

The Centre of Gravity Range is the distance between the forward and aft centre of gravity limits.

What is the Mean Aerodynamic Chord?

The Mean Aerodynamic Chord is the average chord of an imaginary wing having the same aerodynamic characteristics as the actual wing.

What is the Moment?

The Moment is the product of the weight multiplied by its arm.

What is the Total Moment of an aircraft?

The total moment of an aircraft about the datum is the weight of the aircraft multiplied by the horizontal distance from the centre of gravity of the aircraft to the datum.

What is a Moment Index?

Moment Index or index is a moment divided by a constant such as 1,000, 10,000 or 100,000. An index is considered to consist of a number of index units.

What is Removable Equipment?

Removable equipment is equipment carried on some or all operations but which is not included in the empty weight.

What is a Station?

A station is a location in the aircraft which is identified by a number designating its distance from the datum. The datum is station zero. Station and arm are usually identical.

What is Empty Weight?

Empty weight is the measured or calculated weight of an aircraft including all items of fixed equipment and other equipment that is mandatory for all operations, fixed ballast, unusable fuel, undrainable oil, total quantity of hydraulic fluid, but excluding all other items of disposable load.

What is Maximum Landing Weight?

Maximum landing weight is the maximum weight, according to the certificate of airworthiness or aircraft flight manual at which the aircraft may usually be landed.

What is the Maximum Take-off Weight?

The Maximum Take-off Weight (MTOW) is the maximum weight, according to the certificate of airworthiness or aircraft flight manual at which the aircraft is permitted to take-off.

What is the Maximum Zero Fuel Weight?

Maximum Zero Fuel Weight (MZFW) is the maximum weight approved for the aircraft not including fuel load.

What is Operating Weight?

Operating weight in relation to a particular type of operation is the empty weight of the aircraft plus those items of removable equipment and disposable load that remain constant for the type of operation being conducted.

What is Ramp Weight?

Ramp Weight is the maximum allowable weight for take-off plus the fuel burned during taxi and run-up.

How must empty weight and centre of gravity be determined?

Empty weight and centre of gravity must be determined either by weighing or for small new aircraft by suitable computations by the manufacturer.

What is the specific gravity of 100/130 AVGAS?

0.71

What is the specific gravity for all grades of AVGAS lower than 100/130?

0.72

What is the specific gravity of AVTUR?

0.79

What is the specific gravity of mineral based oil?

0.90

What is the specific gravity of synthetic based oil?

0.96

What is the conversion factor for pounds to kilograms?

0.4536

What is the conversion factor for inches to millimetres?

25.4

What is the conversion factor for imperial gallons to litres?

4.546

What is the conversion factor for US gallons to litres?

3.79

Where do you find the details of the aircraft datum and levelling points?

Type Certificate Data Sheet

Why is weighing a helicopter different to a fixed wing aircraft?

For helicopters, lateral as well as longitudinal centre of gravity need to be calculated.

Where do you find standard passenger weights?

CAAP 235 or in the operator's Operations Manual based on a passenger survey.

Why do you measure the distance between the datum, jack points and wheel positions when reweighing an aircraft?

The TCDS specified the weight and centre of gravity envelope relative to the datum. This data is needed to determine the CofG.
Wheel positions vary considerably depending on oleo extension.
Jack points are not always located as per the TCDS.

When must a new Load Data Sheet be issued for a helicopter?

When the weight changes by more than 1% of MTOW or 10 kg whichever is greater; or
When the centre of gravity changes more than 10 mm or 10% of the permissible CofG range whichever is less

When must a new Load Data Sheet be issued for an aeroplane?

When the weight changes by more than 0.5% of MTOW or 10 kg whichever is greater; or
When the centre of gravity changes more than 5 mm or 2% of the permissible CofG range whichever is greater

What is a hydrometer used for?

To measure specific gravity of a liquid?

In relation to aircraft weight and balance when must a hydrometer be used?

A hydrometer **must** be used to measure the specific gravity of the fuel on board an aircraft if during a weighing procedure there is more than 700 litres of fuel on board.

Where are aircraft reweigh intervals specified?

CAO 100.7

What regulation imposes a requirement for the empty weight of an aircraft to be known?

CAR 235

What are 4 types of operational equipment?

Fly away kit
Winch
Stretcher
Medical kit
Potable water
Galley Equipment
Spray Equipment
Buckets or Sling loads

After the first of an aircraft the scales do not return to a zero reading.
What is this called and how is it handled in the weight calculations?

Zero Set
Change the sign, divide by two and add it to the first weighing result.

How do you check a spirit level for accuracy?

Find a level in one direction then rotate it 180 degrees

Why do some aircraft have multiple load data sheets?

Multiple load data sheets are often used to cater for different operational configurations of the same aircraft.
i.e. pax charter with seats installed, cargo config with only 2 seats, air ambulance with a stretcher, photography

What details must a weight and balance report contain?

List of limits (MTOW, MLW, MZFW, RW)
Approved CofG range
Weighing details including all relevant calcs
Equipment list
Load data sheet
Loading system
Other instructions necessary to ensure the safe loading of the aircraft

What is a typical range of Centre of Gravity in terms of the mean aerodynamic chord (MAC)?

15 – 30%

If not required sooner because of weight or centre of gravity changes, when must a multi-engine aeroplanes which is used for commercial purposes and which has a MTOW of more than 2800kg be reweighed?

1st maintenance release inspection or
1st scheduled maintenance inspection following the 3rd anniversary of the day on which the aeroplane was last weighed
UNLESS PART OF A FLEET

If not required sooner because of weight or centre of gravity changes, when must a rotorcraft which is used for commercial purposes and which has a MTOW of more than 2800kg be reweighed?

1st maintenance release inspection or
1st scheduled maintenance inspection following the 3rd anniversary of the day on which the aeroplane was last weighed
UNLESS PART OF A FLEET

If not required sooner because of weight or centre of gravity changes, when must a multi-engine aeroplane which is used for commercial purposes and which has a MTOW of more than 2000kg but less than or equal to 2800kg be reweighed or have its weight validated?

1st periodic inspection or
1st maintenance release inspection following the 3rd anniversary of the day on which the aeroplane was last weighed or had its weight validated
UNLESS PART OF A FLEET

If not required sooner because of weight or centre of gravity changes, when must a rotorcraft which is used for commercial purposes and which has a MTOW of more than 2000kg but less than or equal to 2800kg be reweighed or have its weight validated?

1st periodic inspection or
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UNLESS PART OF A FLEET

What restrictions are placed on private use aircraft that have not been reweighed or have their weight revalidated in accordance with the schedules specified in CAO 100.7

Must not be used for commercial purposes until after it has been reweighed or had its weight revalidated.

What must a Certificate of Registration holder do if an aircraft has not been reweighed in accordance with the CAO 100.7 schedule?

The CofR holder must ensure that the aircraft and load data sheet are endorsed with the words "…restricted to private use" until it has been reweighed.

What is the procedure for validating the weight of an aircraft?

- Examine the aircraft and the logbook
- Examine the weighing summary and equipment list
- Check if records of weight and CofG changes are accurate and complete
- If considered accurate declare in writing that the record shows the empty weight and CofG
- Issue a new load sheet
- Note in the A/C logbook that the load sheet has been prepared by validation and not weighing

What constitutes a fleet for the purposes of weight and balance control?

Two or more aeroplanes of the same type and configuration used by the same operator.

What aeroplanes may not be included in a fleet?

Aeroplanes that may not be included in an operator's fleet include those whose:
weight varies from the average operating weight by more than 0.5% of the landing weight; or
actual CofG is different from the fleet value by more than 0.5% of the MAC

Under what conditions may an aeroplane whose CofG varies by more than 0.5% of the MAC be included in a fleet?

The aeroplane's actual CofG must be used

How often must fleet CofG values be re-established?

At least every four years

Every aeroplane in a fleet be reweighed at least how often?

At least every 9 years

What are the accuracy requirements for scales used for weighing aircraft?

+/- 0.2% of the applied load or +/- 2 kg whichever is greater

How often must scales used for weighing aircraft be calibrated?

Scales must have been calibrated within 1 year unless otherwise approved

What are the requirements in relation to consecutive weighings?

Calculations must be done using the results of two consecutive weighings
Load must be completely removed from the scales between weighings
The difference between consecutive weighings must be no more than 0.2% of the mean weight or 10 kg whichever is greater.

Under what conditions is it permissible not to prepare a loading system?

It can be shown that the weight and CofG cannot fall outside of the approved range if all compartment and seating limitations are observed.

What details must a load data sheet contain?

Empty weight, empty weight CofG
If operating weight is used – the operating weight and operating weight CofG
List of removable equipment and disposable load included in the operating weight
If reweighing or revalidation is required the date of the 3rd anniversary of the last reweighing or validation

Certain aircraft may have the loading system set out in placards. What are the requirements of the aircraft?

MTOW of less than 5700kg

What units of measure must be used in the loading data?

Kilograms (kg) except where the aircraft flight manual is in pounds in which case the loading data **may** be in pounds.

For aeroplanes, load data sheets must be renewed before further flight whenever what occurs?

The weight alterations record shows changes exceeding 0.5% of MTOW or 10kg whichever is greater or 5mm or 2% of the maximum permissible CofG range whichever is greater

For rotorcraft, load data sheets must be renewed before further flight whenever what occurs?

The weight alterations record shows changes exceeding 1.0% of MTOW or 10kg whichever is greater or 10mm or 10% of the maximum permissible CofG range whichever is less

What does empty weight include?

All items of fixed equipment
Mandatory equipment
Fixed ballast
Unusable fuel
Total quantities of oil, engine coolant, & hydraulic fluid
Excludes all other items of disposable load

Ballast weight formula

Ballast weight = $\frac{\text{A/C Empty Weight x Distance out of balance}}{\text{Distance between ballast \& desired CofG}}$

What rotorcraft are exempt from periodic reweighing?

MTOW under 2000 kg

What aeroplanes are exempt from periodic reweighing?

Single engine aeroplanes
Multiengine aeroplanes under 2000 kg MTOW

When weighing an aircraft what is required in relation to the lateral and longitudinal axes?

Both the lateral and longitudinal axes must be level

Who is authorised to control the weighing of an aircraft?

A Weight Control Officer whose appointment covers the activity

If an aircraft's empty or operating weight changes due to changes in equipment what documents must be updated?

The aircraft equipment list and weight alteration record