RA 5212 – Mass and Centre of Gravity Determination

Rationale

The handling qualities of an aircraft are affected by the mass and Centre of Gravity (CG), which are used to determine the approved flight characteristics. Misrepresentation of the mass and CG of an aircraft is likely to have an adverse impact on the handling qualities of the aircraft. In order to ensure the approved flight characteristics are maintained it is essential that the mass and CG limits are accurately established and recorded. RA 5212 details the regulatory requirements regarding aircraft mass and CG.

Contents

5212(1): Mass and Centre of Gravity Determination
5212(2): Measurement of Mass and Centre of Gravity

Regulation

5212(1) The Contractor shall determine the mass and CG of each aircraft by weighing before final delivery of the initial production or Major Change\(^1\) in Type Design.

Mass and Centre of Gravity Determination

1. The mass and CG position relating to the basic and all-up mass conditions (allowing for equipment deviations) should be reported to the Type Airworthiness Authority (TAA).
2. The longitudinal and lateral CG positions should be measured on each aircraft to allow validation of mass, CG and inertia calculations.
3. For rotary wing aircraft stability and certain fixed wing aircraft ie with short take-off and vertical landing capability, the vertical CG position should be measured on one of the first ten representative aircraft and thereafter as requested by the TAA to validate CG calculations.
4. The Contractor should ensure that:
   a. For fixed wing aircraft\(^2\):
      1. The measured basic mass of the aircraft (ie less fuel, payload and/or items of equipment), is accurate within ± 0.3%.
      2. The horizontal CG position, measured normal to the vertical datum line is accurate to within ± 5% of the CG determined by the Design Organization.
      3. The vertical CG position is measured to an accuracy agreed between the Contractor and the TAA.
   b. For rotary aircraft:
      1. The measured basic mass of the aircraft is accurate within ± 0.3%.
      2. The horizontal CG position is measured normal to the vertical datum line to the accuracy given in Annex A.
      3. The vertical CG position is measured normal to the horizontal datum line to the accuracy given in Annex A.
      4. The lateral CG position is measured normal to the longitudinal axis of the aircraft to the accuracy given in Annex A.
5. To provide information on the weighing of aircraft in the field, one aircraft should be weighed using suitable weighing equipment. The Contractor should liaise

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\(^1\) As defined in RA 5820 – Changes in Type Design (MRP 21 Subpart D).

\(^2\) Including Category II and III Remotely Piloted Air Systems (fixed wing and rotary wing), refer to RA 1600 – Remotely Piloted Air Systems.
with the TAA to facilitate the attendance of the relevant In-Service aircraft weighing

6. The position of the datum lines and points of origin should be quoted in the

Guidance Materials

5212(1)

Mass and Centre of Gravity Determination

7. The Contractor may use any suitable method of weighing that achieves the

Regulation

5212(2)

Measurement of Mass and Centre of Gravity

5212(2) The TAA shall promulgate the required detail to ensure that

Acceptable Means of Compliance

5212(2)

Measurement of Mass and Centre of Gravity

9. Reports should be supplied to the TAA in an agreed timescale and frequency.

10. The ADS should identify the basic mass for each aircraft type and list the

11. The ADS should identify the datum positions from which the moment is

12. The periodicity for routine check weighs should be promulgated.

13. Any additional occasions for weighing should be identified.

14. The ADS should identify the process for preparing the aircraft to be weighed.

15. The ADS should identify the mass and moment arm for equipment which is

16. Permissible tolerances between mass and CG obtained during an aircraft weigh

and those recorded in relevant technical records should be promulgated.

Guidance Materials

5212(2)

Measurement of Mass and Centre of Gravity

17. RA 49476 places responsibilities on the Military Continuing Airworthiness

Management Organization (CAMO) regarding aircraft mass and CG; consequently

close engagement between TAAs and CAMOs will be required to manage issues

through life such as agreeing the required technical records (F751 or equivalent) to

record mass and CG changes. Where discrepancies are identified between the

calculated mass and CG and actual measured values the TAA and CAMO are to

agree actions for resolution.

18. Aircraft preparation includes fitting and/or removing equipment to ensure the

correct configuration and fitting of any specialist ground equipment such as slings or

lifting beams. These items are included in AP119W-0001-17.

3 Refer to RA 5880 – Military Permit to Fly (MRP 21 Subpart P).
4 Refer to RA 1310 – Air System Document Set.
5 Refer to RA 5601 – Propulsion System Design and Certification.
6 Refer to RA 4947 – Continuing Airworthiness Management - MRP Part M Sub Part G
7 Refer to AP119W-0001-1 – General Procedures for Aircraft Weighing.
19. Examples of additional occasions for weighing an aircraft will include, but are not limited to, those listed below. Specific requirements will be promulgated by the TAA as required:
   a. After a Major Change.
   b. After significant repair or replacement of surface finish.
   c. On replacement of large components.
   d. When requested by the CAMO to resolve mass and CG anomalies.

20. Periodic check weighs constitute a routine Maintenance task which may be extended in accordance with the standard procedure and latitude promulgated by the TAA.
## ANNEX A

### ACCURACY OF CG MEASUREMENT FOR ROTARY WING AIRCRAFT

**Metric Design**

<table>
<thead>
<tr>
<th>All-up mass</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 2,300 kg</td>
<td>Within ± 5% of ‘d’ *.</td>
</tr>
<tr>
<td>2,300 to 9,000 kg</td>
<td>Within ± 5% of ‘d’ or ± 6 mm whichever is the smaller.</td>
</tr>
<tr>
<td>over 9,000 kg</td>
<td>Within ± 5% of ‘d’ or ± 6 mm whichever is the greater.</td>
</tr>
</tbody>
</table>

* ‘d’ = practical cg range in the appropriate direction

**Imperial Design**

<table>
<thead>
<tr>
<th>All-up mass</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 5,000 lb</td>
<td>Within ± 5% of ‘d’ *.</td>
</tr>
<tr>
<td>5,000 to 20,000 lb</td>
<td>Within ± 5% of ‘d’ or ± 0.25 in whichever is the smaller.</td>
</tr>
<tr>
<td>Over 20,000 lb</td>
<td>Within ± 5% of ‘d’ or ± 0.25 in whichever is the greater.</td>
</tr>
</tbody>
</table>

* ‘d’ = practical cg range in the appropriate direction