GUIDANCE ON WEIGHT AND BALANCE

For use with Form LAA/WB

- These notes are for use with forms LAA/WB (IMPERIAL) or (METRIC) which may be downloaded from the LAA website. You may use either imperial or metric units as long as you do not mix them. If you only have a Metric form and wish to use Inches & Lbs., you may simply alter the captions but please do not mix metric and imperial measure. ie, use lbs.inches or kg.mm but not lbs.mm or kg.inches.

Weighing and measuring

- The aircraft must be weighed professionally by a specialist company or on calibrated scales, approved by your inspector. Use the **correction column** for any known deviations of the scales. The aircraft must be weighed in the attitude called for by the designer – normally the flying attitude, verified by a specified level datum. For tailwheel types you will need to raise the tailwheel to this attitude, whereas nosewheel aircraft will require little adjustment to be levelled. Remember to note the positions of where the weights were measured, usually the wheel axle centres, whilst in the attitude that the aircraft was weighed. This is most easily done by dropping a plumb line from the axle centre to the floor and making a mark on it so that measurements can be made after the aircraft has been moved out of the way.

Calculating empty weight and CG

- Usually you can calculate the aircraft empty CG from the weights and wheel positions (**arms**) recorded, however you may have to compensate for any usable fuel left in the tanks to arrive at the empty weight. Note that empty weight should *include* unusable fuel and that more accurate results are usually obtained when the aircraft is weighed with only unusable fuel in the tanks.

- Few LAA types carry **ballast** but you should record any in the **fixed ballast** line, in case it has to be adjusted.

- **Optional equipment** left in the aircraft during weighing should be recorded as it may be taken out at a later date, in which case the Weight & Balance Report would need to be amended. There is also a table overleaf to record **changes in service**, but as all the figures would change slightly, it would be preferable to complete a new form. (available from the LAA website, www.laa.uk.com)

- The aircraft's **Operating Limitations** document states the *datum* for all distances for fixed and variable loads to be measured from. If the datum is forward of any part of the structure, then all the arm figures will be positive. If, as is common, the datum is the wing leading edge then arms forward of this will have a negative value. For instance, weight on the nosewheel would have a negative arm value and therefore a negative moment if the datum was the wing leading edge.

- **Moment** is calculated by multiplying the **weight** of each item by its **arm**. All the moments are added giving the **total moment**, which is divided by the total weight to give the **empty CG position,** relative to the *datum.* ie, Forward or Aft of it. It is not appropriate to quote %MAC (Mean Aerodynamic Chord) if the CG range on the **Operating Limitations** document is not quoted using this method**.**

Calculating worst forward and aft CG cases

- Weighing the aircraft and calculating its empty centre of gravity does not provide sufficient information to establish whether the aircraft can be easily operated within safe limits for flight. To do this you must carry out some loading calculations. On the reverse side of the

report sheet is a table to record the maximum weight, arm and moment for **Variable Load Items**; items such as occupants, fuel and baggage. These figures are usually obtained from the Pilot's Operating Handbook, or by measurement as a last resort. If determination of variable load arm positions by measurement is necessary, note that the pilot CG position is more likely to be nearer his navel rather than the seat back.

- Using the data from the Variable Load Items table we can calculate 'worst' forward and aft CG cases for the aircraft. It is necessary to carry out several loading examples to check that the aircraft will stay within weight and CG limits.

- For checking compliance with the design codes CS-VLA and BCAR Section S, standard occupant weights are used for example loading calculations. Of course, for weight and CG calculations before a flight, you must use actual occupant weights.

- Load cases should be checked using a pilot weight of both 55kgs (121lbs) and 86kgs (189lbs) and with either no passengers or those that weigh 86kgs (189lbs) each. For vintage aircraft it is permissible to use a maximum occupant weight of 77kgs (170lbs) instead of 86kgs (189lbs). For aerobatic aircraft, add 9kgs (20lbs) to the standard occupant weight for each parachute.

- Add the occupant's plus various payload weights to the aircraft empty weight as appropriate and add all the moments together. Divide the total moments by the total weight to give the **loaded CG.** position.

- To check the worst forward CG case, enter the maximum weight of all variable load items that are forward of the aircraft's empty CG (not datum) and leave out all items that fall behind it. If the pilot sits aft of the empty CG, use the 55kg pilot weight; if he sits forward of it you should use the 86kg pilot weight. Likewise, with passengers, either leave them out or use 86kg (189lbs) each depending on where they sit relative to the aircraft's empty CG.

- To check the worst aft CG case, enter the maximum weight of all variable load items that are aft of the aircraft's empty CG (not datum) and leave out all items that fall ahead of it. If the pilot sits forward of the empty CG, use the 55kg pilot weight; if he sits aft of it you should use the 86kg pilot weight. Likewise, with passengers, either leave them out or use 86kg (189lbs) each depending on where they sit relative to the aircraft's empty CG.

- Check both CG cases each with both zero fuel and full fuel to check whether the weight and CG remain within the limits irrespective of fuel uplift.

- Should it be shown that a CG limit has been exceeded in any of the loading case checks, it may be possible to correct this by moving a heavy item (eg battery) or by adding fixed ballast to the aircraft (in a manner agreed by LAA Engineering). Otherwise, it will be necessary to bring the pilot's attention for the potential to exceed a weight or CG limit by the installation of an appropriately worded and placed placard.

- To show compliance with CS-VLA and BCAR Section S, for two seaters a minimum of 1 hour's fuel with the engine running at maximum cruise power must be able to be loaded with two occupants of 86kg each – (refer below for the correct values to use for certain engines). For single seaters, full fuel and an 86kg pilot must be able to be loaded.

  Jabiru 2200 10kgs (22lbs), Rotax 582 18kgs (40lbs), Rotax 447 11kgs (24lbs),
  Rotax 618 23kgs (51lbs), Rotax 912 10kgs (22lbs), Rotax 912S 13kgs (29lbs),
  Rotax 503 15kgs (33lbs), Rotax 532 15kgs (33lbs).

- It is mandatory that microlights are re-weighed at intervals not exceeding 5 years.

- It is recommended that group 'A' aircraft are re-weighed at intervals not exceeding 10 years.

- Aircraft must be re-weighed and a new weight and balance report should be created after significant modification or after re-covering or painting and at intervals to monitor weight growth.