



Barbados Civil Aviation
Department

BCAD Document AAC-007

AIRWORTHINESS

ADVISORY

CIRCULAR

WEIGHT AND CENTRE OF GRAVITY CONTROL PROCEDURES

WEIGHT AND CENTRE OF GRAVITY CONTROL PROCEDURES

1. Introduction.....	4
2. Definitions.....	4
3. Requirements.....	4
4. Weight and Balance Report – Aircraft Exceeding 5700 kg.....	6
5. Weight and Centre of Gravity Schedule – Aircraft Exceeding 5700 kg.....	6
6. Weight and Centre of Gravity Schedule – Aircraft Not Exceeding 5700 kg.....	9
7. Procedures.....	11
Appendix 1 - Weight and Centre of Gravity Schedule for Aircraft Exceeding 5700 kg.....	12

WEIGHT AND BALANCE CENTRE OF GRAVITY PROCEDURES

I. INTRODUCTION.

Airworthiness Regulation 32A requires that every aircraft for which a Certificate of Airworthiness is in force, shall be weighed and the position of its centre of gravity determined, at such times and in a manner approved by the DCA. Upon the aircraft being weighed, the Operator of the aircraft shall prepare a weight schedule acceptable to the DCA. The purpose of this Advisory Circular is to provide guidance to operators on all matters concerning the Weight and Centre of Gravity of Aircraft.

2. DEFINITIONS.

The following is a list of definitions of the terms used in this Advisory Circular:

(a). **Basic Equipment.** This is the un-consumable fluids (e.g. coolant and hydraulic fluid) and equipment, which is common to all roles for which the Operator intends to use the aircraft.

(b). **Basic Weight/Empty Mass.** This is the weight of the aircraft and all its Basic Equipment, plus that of the declared quantity of un-usable fuel and unusable oil. In the case of turbine-engined aircraft and aircraft the Maximum Total Weight Authorised (MTWA) of which does not exceed 5700 Kg (12500 lb), it may also include the weight of usable oil.

(c). **Variable Load.** This is the weight of the crew and of items such as crew baggage, removable units, and other equipment, the carriage of which depends upon the role for which the operator intends to use the aircraft for a particular flight.

(d). **Disposable Load.** This is the weight of all persons (e.g. passengers) and items of load, including fuel and other consumable fluids carried in the aircraft, other than the Basic Equipment and Variable Load.

(e). **Maximum Total Weight Authorised (MTWA).** This is the Maximum Total Weight Authorised for the aircraft and its contents, at which the aircraft may take off anywhere in the world, in the most favourable circumstances in accordance with the Certificate of Airworthiness or Flight Manual.

(f). **Reaction.** This is the load at each separate weighing point.

3. REQUIREMENTS.

3.1 (a). All aircraft shall be weighed when all manufacturing processes have been completed.

(b). Aircraft the MTWA of which exceeds 5700 kg shall be re-weighed within two years after the date of manufacture, and subsequent check weighing shall be

made at intervals not exceeding five years, and at such times as the DCA may require.

(c). Aircraft the MTWA of which does not exceed 5700 kg shall be re-weighed at such times as the DCA may require.

(d). In making decisions on weighing, the history of the aircraft, its flying performance, and the probable effect on the weight after a major overhaul, or embodiment of a modification, repair, replacement or painting will be considered.

(e). Aircraft coming on to the Barbados register must be weighed and the weight and Centre of Gravity established prior to the issue of the Certificate of Airworthiness. The weighing does not have to be carried out within Barbados if the operator can show that the weighing was carried out by an organisation acceptable to the DCA.

(f). Fleet Mass, Establishment and Changes. For a fleet of aircraft of the same model and configuration, an operating fleet weight may be utilised in accordance with the procedures detailed in paragraph 6 of Operations Advisory Circular, OAC003, "Aircraft Mass and Balance Data Control Systems".

- 3.2. When an aircraft is weighed, the condition of the aircraft (i.e. the equipment and other items of load such as fluids in tanks) shall be recorded. The equipment Installed should not differ from that included in the declared list of Basic Equipment associated with the Weight and Centre of Gravity Schedule.
- 3.3. The Basic Weight and the corresponding c.g. position shall be determined and entered in the Weight and Centre of Gravity Schedule.
- 3.4. A Weighing Record containing records of the weighing and the calculations involved shall be made available to the DCA and such records shall be retained by the operator. When the aircraft is again weighed, the previous weighing records must be retained with the aircraft records for a period of six months. Operators must maintain records of all known weight and c.g. changes which occur after the aircraft has been weighed.
- 3.5. **Weighing Procedure.** Normal precautions, consistent with good practices, shall be taken such as checking to ensure the aircraft has the required items of installed equipment as specified in its Basic Weight, determining that the fluids are properly accounted for, that the aircraft is clean, and that weighing is accomplished in an enclosed building. Any acceptable scales may be used for weighing provided they are properly calibrated, zeroed and used in accordance with the manufacturers instructions. Each scale should be calibrated, either by the manufacturer or by a recognised facility periodically as recommended in the manufacturer's calibration schedule. In the absence of a manufacturers calibration schedule the DCA will require calibration on an annual basis unless the operator can justify a longer period.

4. WEIGHT AND BALANCE REPORT – Aircraft exceeding 5700 kg.

- 4.1. A Weight and Balance Report shall be produced for all aircraft the MTWA of which exceeds 5700 kg.
- 4.2. The Weight and Balance Report shall record such loading data as is essential to enable the particular aircraft to be correctly loaded, and shall include sufficient information for an operator to produce written loading information in compliance with the requirements of Aircraft Operations Regulation 100 and Air Operator Certification & Administration Regulation 48 and Operations Advisory Circular OAC-003 “Aircraft Mass and Balance Data Control Systems”.
- 4.3. The Weight and Balance Report shall apply to the aircraft in the condition in which it is to be delivered to the user.
- 4.4. One copy of the Weight and Balance Report shall be sent to the BCAD as part of the documentation required for the issue of the Certificate of Airworthiness.
- 4.5. The Weight and Balance Report shall include the following items:-
 - (a) Reference number and date.
 - (b) Designation, nationality and registration marks of the aircraft, or if these are not known, the constructors serial number.
 - (c) A copy of the Weighing Record, produced in accordance with Paragraph 3.4 of this AIGM.
 - (d) A copy of the Weight and Centre-of-Gravity Schedule including the list of Basic Equipment, If this is separate from Part A of the Schedule (see 5.8.2).
 - (e) A diagram and a description of the datum points which are used for weighing and loading and an explanation of the relationship of these points to the fuselage frame numbering system or other identifiable points, and, where applicable, to the standard mean chord (SMC).
 - (f) Information on the lever arms appropriate to items of Disposable Load. This should include the lever arms of fuel, oil and other consumable fluids or substances in the various tanks (including agricultural material in hoppers) which, if necessary, should be shown diagrammatically or graphically; lever arms of passengers in seats appropriate to the various seating layouts; mean lever arms of the various baggage holds or compartments).
 - (g) Details of any significant effect on the aircraft c.g. of any change in configuration, such as retraction of the landing gear.

5. WEIGHT AND CENTRE-Of-GRAVITY SCHEDULE - AIRCRAFT EXCEEDING 5700 KG

- 5.1 A Weight and Centre-of-Gravity Schedule shall be provided for all aircraft, the Maximum Total Weight Authorised of which exceeds 5700 kg. The information contained In Parts B and C of the Schedule may, for a new aircraft, be given as part of the Weight and Balance Report.

NOTES: *(1)The Weight and Centre-of-Gravity Schedule should be in the form set out in appendix 1 of this AIGM, but variations are permitted within the requirements.*

(2) Where reference is made in Appendix No.1, to the Flight Manual, but such a document has not been issued, it will be necessary to refer to the Certificate of Airworthiness.

- 5.2** Each Schedule shall be identified by the aircraft designation, nationality and registration marks, or if these are not known, by the constructor's serial number. The date of issue of the Schedule shall be given and the Schedule shall be signed by a representative of an Approved Maintenance Organisation or a person acceptable to the DCA. A statement shall be included indicating that the Schedule supersedes all previous issues.
- 5.3.** The date and reference number of the Weight and Balance Report or, for aircraft with a MTWA below 5700Kg the Weighing Record, upon which the Schedule is based, shall be given.
- 5.4.** A copy of each issue of the Schedule shall be retained by the operator, and where the Schedule is re-issued the previous issue shall be retained with the aircraft records for a period of six months. A copy of the current Schedule and any related list of Basic Equipment (see 5.8) shall be sent to the BCAD.
- 5.4.1. For aircraft the Maximum Total Weight Authorised of which does not exceed 5700 kg, a copy of the Schedule shall be included in the Flight Manual, if a Flight Manual is applicable, or if this is not the case, displayed or retained in the aircraft in a suitably identified stowage.
- 5.5.** Operators shall issue a revised Weight and Centre-of-Gravity Schedule when the weight and c.g. is known to have changed.
- 5.6.** If the aircraft has not been re-weighed, the revised Weight and Centre-of-Gravity Schedule shall contain a statement that calculations have been based on the Last Weight and Balance Report, or other information (see 5.3), and the known weight and cg. changes.
- 5.7.** The datum to which the c.g. limits relate is defined in Part A (see 5.8) and this may be different from the datum defined in the Certificate of Airworthiness or Flight Manual. When a different datum is used it shall be adequately defined, its precise relationship to the datum in the Certificate of Airworthiness or Flight Manual shall be given, and any lever arms and moments which appear in any part of the Schedule shall be consistent with the datum so declared.

NOTE: *In the case of helicopters, it may be necessary to present lever arms and moments about more than one axis, depending on the c.g. limits specified in the Flight Manual.*

5.8. Part A Basic Weight. The Basic Weight and the associated position of the c.g. of the aircraft as derived from the most recent Weight and Balance Report or other information together with any subsequent weight and c.g. changes, shall be stated. The position (retracted or extended) of the landing gear associated with this information shall be stated.

5.8.1. Where the MTWA does not exceed 5700 kg, Part A shall also include the list of Basic Equipment showing the weight and lever arm of each item, or this information may form separate pages attached to the Weight and Centre-of-Gravity Schedule, with a suitable reference in Part A of the Schedule to this procedure.

5.8.2. Where the MTWA exceeds 5700 kg, Part A shall include the list of Basic Equipment showing the weight, lever arm and moment of each item, or shall make reference to the document in which such a list is included.

5.9. Part B Variable Load. The variable Load may be detailed for as many roles as the operator wishes, but for every role the weights and moments shall be given. Weights of crew members may be assumed to be not less than the weights shown in the Operations Advisory Circular, OAC-003, "Aircraft Mass and Balance Data Control Systems" paragraph 9 "Standard passenger Mass", provided that the Maximum Total Weight Authorised exceeds 5700 kg, or the aircraft has a total seating capacity for 12 or more persons. Otherwise the weight of each person must be determined by weighing.

5.10. Part C Loading Information. This shall include all relevant information so that, knowing the Disposable Load which is intended to be carried, the weight and the position of the centre of gravity of the aircraft can be calculated. At least the following shall be given:-

- (a) The lever arm of the c.g. of a passenger in each seat.
- (b) The mean lever arm of each compartment or area in the aircraft where Disposable Load, such as luggage or freight may be placed.
- (c) Any significant change in the c.g. of the aircraft (change in moment) which will result from a change in configuration, such as the retraction and extension of the landing gear.
- (d) The lever arm of the c.g. of fuel, oil and other consumable fluids or substances in each tank, including any significant variation of the lever arm with the quantity loaded.
- (e) The maximum total usable capacities of the tanks for fuel, oil and other consumable fluids or substances and the weight of fluids or substances when the tanks are filled to their capacities assuming typical densities.

5.11. A statement shall be made in the Schedule to the effect that it is a requirement of the Barbados Civil Aviation Regulations that the Commander satisfies himself before take-off that the load is of such weight, and is so distributed and secured that it may safely be carried on the intended flight.

5.12. The weights, distances moments and quantities may be given in any units provided that these are used consistently and do not conflict with the markings and placards on the aircraft.

6. WEIGHT AND CENTRE-OF-GRAVITY SCHEDULE - AIRCRAFT NOT EXCEEDING 5700 kg

For aircraft the Maximum Total Weight Authorised of which does not exceed 5700 kg, either a Weight and Centre-of-Gravity Schedule which complies with 3.6 and 5, or a Loading and Distribution Schedule which complies with 6.1 shall be provided.

6.1 Loading and Distribution Schedule .

6.1.1 The Loading and Distribution Schedule (hereinafter in this paragraph 6.1 referred to as the Schedule') shall contain the following information.

6.1.2 Each Schedule shall be identified by the aircraft designation, nationality and registration marks, or if these are not known, by the constructors serial number

6.1.3 A copy of each issue of the Schedule shall be retained by the operator, and when the Schedule is re-issued the previous issue shall be retained with the aircraft records. A copy of the current Schedule and any related list of Basic Equipment shall be sent to the BCAD.

(a) A copy of the Schedule shall be included in the Flight Manual, if a Flight Manual is applicable, or, if this is not the case the Schedule shall be displayed or retained in the aircraft in a suitably identified stowage.

6.1.4 Operators shall issue a revised Schedule when:-

(a) The Basic Weight of the aircraft is known to have undergone changes in excess of 0.5% of the Maximum Total Weight Authorised, or

(b) the total moment applicable to the Basic Weight is known to have changed to an extent greater than that which has been agreed by the BCAD as applicable to a particular aircraft type.

6.1.5 If the aircraft has not been re-weighed, the revised Schedule shall contain a statement that calculations have been based on the last Weighing Record and the known weight and moment changes.

6.1.6 Instructions for the use of the Schedule, together with the Loading Graphs, shall be included.

6.1.7 A statement shall be given in the Schedule to the effect that it is a requirement of the Barbados Civil Aviation Regulations that the Commander satisfies himself before the aircraft takes off that the load is of such a weight, and is so distributed and secured that it may safely be carried on the intended flight.

6.1.8 The weight, distances, moments and quantities may be given in any units provided that these are used consistently and do not conflict with the markings and placards on the aircraft.

6.1.9 **Part A Basic Data.** Part A shall contain the following:—

- (a) The Basic Weight and the associated moment, and c.g. position of the aircraft, as derived from the most recent Weighing Record, together with any subsequent changes.
- (b) The Maximum Total Weight Authorised appropriate to each permitted use (e.g. aerobatics).
- (c) The definition of the c.g. datum.
- (d) The date and reference number of the Weighing Record and list of Basic Equipment upon which the Schedule is based.
- (e) The date and reference of the Loading Graphs of the Loading and Distribution Schedule shall be given.
- (f) A statement of the date of preparation and validity of the Schedule signed by a representative of an Approved Maintenance Organisation, or a person acceptable to the DCA. A statement shall also be included indicating that the Schedule supersedes all previous issues.

6.1.10 **Part B Loading.** Columns shall be provided which list all standard items of Variable Load and make provision for the associated weight and c.g. moments to be recorded and totalled for a particular flight. Columns shall also be provided for recording an example of a typical aircraft loading calculation. This example shall employ the same weight and c.g. moment Figures as recorded in the Loading Graphs.

6.1.11 **Part C Loading Graphs.** Graphs, sufficient to ascertain moments, and to enable the operator to determine that the aircraft loaded weight and c.g. moment are within the prescribed limits shall be provided. The graphs shall be identified by aircraft designation, date of compilation and source. Suitable sources are the aircraft constructor or other competent person. An example application shall be included using the same figures as employed in the Loading and Distribution Schedule example.

6.2 Weight and Centre-of-Gravity Schedule. In addition to compliance with 5, the Weight and Centre-of-Gravity Schedule for aircraft the Maximum Total Weight Authorised of which does not exceed 5700 kg, shall contain instructions for the determination of the loaded weight, the total load moments and resultant c.g. positions. An acceptable means of compliance would be to include in the schedule, instructions on the following lines.

SPECIMEN INSTRUCTIONS

1. By reference to the Weight and Centre of Gravity Schedule, ascertain the lever arm of each item (Basic Weight, Variable Load, Disposable Load)
2. To obtain moment of an item, multiply the weight of the item by the corresponding lever arm, and record the moment for each load, giving the moment a positive sign if the item is aft of the datum, and a negative sign if it is forward of the datum. Enter the weight of the item in the weight column.
3. Total the weight column.
4. Total the moment columns. If (+) and (-) moments are recorded, total each column and obtain the total resultant moment by subtracting the lesser from the greater.
5. Divide the total (or total resultant) moment by the total weight to obtain the c.g. position positive or negative, relative to the datum, and check that this is within the prescribed c.g. limits.
6. To check that the fuel consumed during a flight does not cause the c.g. position to be outside the prescribed limits, re-total the weights in 3 and the moments in 4, but omitting the total fuel weight and the corresponding moments respectively. Add the weight and moment of the fuel expected to remain in the tanks at the end of the flight. Divide the final total resultant moment by the final total weight to obtain the c.g. position, and check that it is within the prescribed c.g. limits.

Note; Where there are any other significant quantities of consumable fluids or substances (e.g. crop spraying), similar account should be taken.

7. Procedures.

- 7.1. Operators will be required to produce procedures for the proper control of aircraft weight and balance. These procedures can form part of the Maintenance Procedures Manual or the Maintenance Control manual and will be approved by the DCA.
- 7.2. The requirements for weight and balance procedures are part of the Check Lists for the review of the MPM and MCM.
- 7.3. New aircraft coming on to the Barbados Register must have their weight and balance checked as part of the investigation for the issue of the Certificate of Airworthiness and this is part of the Compliance Statement check list.
- 7.4. Aircraft in service must have their weight and balance checked as part of the renewal of the Certificate of Airworthiness and this is part of the Engineers Report check list.

APPENDIX NO.1 TO AAC-007

WEIGHT AND CENTRE-OF-GRAVITY SCHEDULES FOR AIRCRAFT EXCEEDING 5700 kg

INTRODUCTION This Appendix presents a specimen Weight and C.G. Schedule which, constitutes an acceptable means of compliance with the appropriate requirements of the Barbados Civil Aviation Regulations and this AAC.

NOTE; *Imperial units are shown on this schedule. Where it is decided to use other units, these should be used throughout.*

SPECIMEN SCHEDULE

Reference	NAI.2
Produced by	Generic Maintenance Ltd.
Aircraft Designation	Flynow 2E
Nationality and Registration Marks	8P-XXXX
Constructor	F.L.Y. Co. Ltd.
Constructor 's Serial No	44
Maximum Total Weight Authorised	7300 lb
Centre-of-Gravity Limits	Refer to Flight Manual reference number 90/946

PART A BASIC WEIGHT

The Basic Weight of the aircraft as calculated from Weight and Balance Report/Weighing Record* NAL/W/95 dated 31st August 2003 is 5516 lb

The c.g. of the aircraft in the same condition at this weight and with the landing gear extended is: 127 in aft of datum

The total moment about the datum in this condition in Ib in/100 is: 7015

NOTE; *The datum is at fuselage station 0, situated 114 inches forward of the wing leading edge. This is the datum defined in the Flight Manual. All lever arms are distances in inches aft of datum.*

**Delete as appropriate.*

The basic Weight includes the weight of 5 gal unusable fuel and 1 gal unusable oil and, the weight of the following items which comprise the list of Basic Equipment:-

	WEIGHT (lb)	LEVER ARM (in)
Two Marzell propeller type BL-H3Z30	127 each	76
Two engine driven 100 ampere alternators		
Type GE-361	27 each	117
One 13 Ah Ni-Cd battery CB-7 31 153		
etc.	etc.	etc.

PART B VARIABLE LOAD

The weight, lever arms and moments of items of Variable load are shown below. The variable Load depends upon the equipment carried for the particular role.

	WEIGHT (lb)	LEVER ARM (in)	MOMENT (100 lb in)
Pilot (one)		108	
De-icing fluid 1.5 gal.	12	140	17
Life-Jackets (7)	14	135	19
Row 1 passenger seats (two)	60	173	104
Row 2 passenger seats (two)	60	215	129
Row 3 passenger seats (two)	60	248	149
Table	8	256	20
One stretcher and attachments (in place of seat rows 2 and 3)	45	223	100
Medical stores	15	250	37

PART C LOADING INFORMATION (DISPOSABLE LOAD)

The total moment change when the landing gear is retracted in lb in/100 is: -18.
the appropriate lever arms are:—

	WEIGHT (lb)	LEVER ARM (In)	CAPACITY (Imp.gal)
Fuel in tanks I and 2	1368*	145	190
Engine Oil	50*	70	5.5
Forward Baggage		21	

Rear baggage	261
Passengers in Row I seats	171
Passengers in Row 2 seats	213
Passengers in Row 3 seats	246
Patient in stretcher	223

NOTE: To obtain the total weigh of the aircraft, add to the Basic Weight, the weights of the items of Variable and Disposable Load to be carried for the particular role.

This Schedule was prepared (date)..... and supersedes all previous issues.

Signed.....Inspector/Engineer

on behalf of.....

Approval Reference

NOTE: (Not part of the specimen Schedule) In Part B Variable Load, of this Schedule the actual weight of the pilot is required in accordance with the Barbados Civil Aviation Regulations. Hence the pilot's weight and calculated moment are omitted in the example.

* Densities — Aviation Gasoline 7.2 lb Imp. gal; Kerosene 8.1 lb Imp. gal; Oil 9.0 lb Imp. Gal .