



ESWATINI CIVIL AVIATION AUTHORITY

# Advisory Circular

CAA-AC-AWS016A

April 2021

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## AIRCRAFT MASS AND BALANCE SCHEDULE REPORT

### 1.0 PURPOSE

This Advisory Circular (AC) is issued to give information and guidance to operators of all aircraft registered in Eswatini on the regulatory requirements and general basic procedures to establish the mass of the aircraft and preparation of the aircraft Mass and Centre of Gravity Schedule Report.

### 2.0 REFERENCE

2.1 Regulation 32 of the Civil Aviation (Airworthiness) Regulations.

### 3.0 GUIDANCE AND PROCEDURES

#### 3.1 General Information

##### 3.1.1 Definitions:

- a) **Basic Equipment** – Is the unusable fluids and equipment which is common to all roles for which the aircraft shall be used for.
- b) **Basic Mass** – Is the mass of the empty aircraft and all its basic equipment plus that of the declared mass of unusable fuel, unusable oil.
- c) **Variable Load** – Is the mass of the crew and of items such as crew baggage, removable units and other equipment the carriage of which depends on the role for which the aircraft is to be used for a particular flight.
- d) **Disposable Load** – Is the mass 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 Mass Authorised (MTMA)** – Is the Maximum Total Mass 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 and Flight Manual.

f) **Reaction** – Is the load at each separate weighing point.

**3.1.2** Aircraft must be weighed to determine their basic weight and the corresponding Centre of Gravity (C of G) position when all manufacturing processes have been completed. Aircraft exceeding 5700 kg (12500 lb) MTMA must be re-weighed 2 years after the date of manufacture and their after at intervals not exceeding 5 years and at such times as the Authority may require. Aircraft not exceeding 5700 kg (12500 lb) shall be weighed at intervals not exceeding 5 years and at such times as the Authority may require.

**3.1.3** In making the decision on weighing the aircraft the Authority considers the history of the aircraft, its flying performance, and the probable effects on the mass after a major overhaul, or embodiment of a modification, repair, or replacement.

**3.1.4** Certain types of aircrafts may be weighed on a sampling basis i.e. a representative aircraft as weighed would be acceptable for the others of the same standard in the operators fleet. However, such an arrangement requires prior Authority approval.

**3.1.5** When an aircraft is weighed, the equipment and other item of load such as fluids in the tanks must be recorded. This recorded load should not differ significantly from the standard Basic Equipment List associated with the Centre of Gravity Schedule.

**Note:**

*Each schedule must be identified by the aircraft designation, nationality and registration marks, if these are not known yet by the constructors serial number. It must bear the date of issue and should be signed by an authorised representative of an organization with approved capability to weigh and prepare a centre of gravity schedule. Where applicable the document shall bear a statement that "This Schedule supersedes all earlier issues. A typical Mass and Centre of Gravity Schedule for an aircraft not exceeding 2730 kg (6000 lb) MTMA is shown in the Appendix to this AC for illustration.*

**3.1.6** The need for accuracy when weighing aircraft is extremely important. Incorrect data could cause subsequent overloading and/or incorrect loading distribution of the aircraft, resulting in increased structural loads and reduction in performance.

**3.1.7** The Mass and Balance Report is intended to record essential loading data to enable a particular aircraft to be correctly loaded, and to include sufficient information for an operator to produce loading instructions

**3.1.8** The operational limitations for the fore and aft positions of the C of G are defined in the aircraft Flight Manual (Pilots Hand Book, Operators Hand Book or Aircraft Type Certificate Data Sheet as applicable).

**3.1.9** An aircraft shall not fly when any of the items or equipment as are required to be in place for aircraft weighing for purposes of Issuing a Weight and Balance Certificate has been removed.

## **3.2 Weighing Equipment**

**3.2.1** The most common types of aircraft weighing equipment are Weighbridge scales, hydrostatic weighing units, electrical and electronic weighing equipment based on the strain gauge principle. However, whatever type of equipment is used, its capacity should be compatible with the weight of the aircraft being weighed. It should be checked, calibrated and certified by a competent approved organization at periods not exceeding one year.

## **3.3 Preparation for Weighing**

**3.3.1** The aircraft should be in the configuration described in the Mass and Centre of Gravity Schedule, the fluids such as engine oil, fuel or hydraulic quantity should be as required by the manufacturer, and equipment positioned at its normal operational location.

**3.3.2** Aircraft weighing should be carried out on a level site inside a closed hanger. Aircraft must be dry, free of dew accumulated moisture, dirt and frost.

**3.3.3** Mass readings should be taken when the aircraft is in level configuration in both longitudinal and lateral planes recommended by the manufacturer.

**3.3.4** When weighing aircraft on jacks, it is important to observe the aircraft jacking procedure, and to fit appropriate jack adapters to the aeroplane jacking points to accommodate the weighing units

**3.3.5** When using electronic weighing cells, it is recommended that they are switched on 30 minutes (or in accordance with the manufactures instructions) before weighing commence in order for the circuits to stabilize.

## **3.4 Taking Mass Readings**

It is recommended that several readings are taken at each reaction point to obtain a reliable average figure.

## **3.5 Calculation of C of G**

**3.5.1** The recommended formula should be applied when computing the Mass and Balance calculations to establish the C of G. These calculations should be done by appropriately trained competent person Aircraft Maintenance Engineer Licensed (AMEL) and/or Approved Maintenance Organisation (AMO) authorised person.

**3.5.2** The authorised person shall certify and issue a Mass and Balance Schedule for the aircraft (or a fleet type of aircraft).

## WEIGHT AND BALANCE TERMINOLOGY

### GENERAL.

The removal or addition of equipment results in changes to the center of gravity (c.g.). The empty weight of the aircraft and the permissible useful load are affected accordingly. Investigate the effects of these changes, since the aircraft flight characteristics may be adversely affected. Information on which to base the record of weight and balance changes to the aircraft may be obtained from the pertinent Aircraft Specifications, Type Certificate Data Sheet (TCDS), prescribed aircraft operating limitations, aircraft flight manual, aircraft weight and balance report, and maintenance manual. Removal of standard parts with negligible weight or addition of minor items of equipment such as nuts, bolts, rivets, washers, and similar standard parts of negligible weight on fixed-wing aircraft do not require a weight and balance check. Rotorcrafts are, in general, more critical with respect to control with changes in the c.g. position. Refer to the procedures and instructions in that particular model's maintenance or flight manual.

### TERMINOLOGY

The following terminology is used in the practical application of weight and balance control.

**a. Maximum Weight.** The maximum weight is the maximum authorized weight of the aircraft and its contents as listed in the specifications.

**b. Empty Weight.** The empty weight of an aircraft includes all operating equipment that has a fixed location and is actually installed in the aircraft. It includes the weight of the airframe, power plant, required equipment, optional and special equipment, fixed ballast, full engine coolant, hydraulic fluid, residual fuel, and oil. Additional information regarding fluids that may be contained in the aircraft systems and must be included in the empty weight will be indicated in the pertinent Aircraft Specifications or TCDS.

**c. Negligible Weight Change.** Is any change of one pound or less for aircraft whose weight empty is less than 5,000 pounds; two pounds or less for aircraft whose weight empty is more than 5,000 and 50,000 pounds; and five pounds or less for aircraft whose weight empty is more than 50,000 pounds. Negligible c. g. change is any change of less

than 0.05% MAC for fixed wing aircraft, 0.2 percent of the maximum allowable c. g. range for rotary wing aircraft.

**d. Useful Load.** The useful load is the empty weight subtracted from the maximum weight of the aircraft. This load consists of the pilot, crew (if applicable), maximum oil, fuel, passengers, and baggage unless otherwise noted.

**e. Weight Check.** The weight check consists of checking the sum of the weights of all items of useful load against the authorized useful load (maximum weight less empty weight) of the aircraft.

**f. Datum.** The datum is an imaginary vertical plane from which all horizontal measurements are taken for balance purposes with the aircraft in level flight attitude. The datum is indicated in most Aircraft Specifications or TCDS. On some of the older aircraft, when the datum is not indicated, any convenient datum may be selected. Once the datum is selected, all moment arms and the location of the permissible c.g. range must be taken with reference to it.

## APPENDIX

### TYPICAL MASS AND CENTRE OF GRAVITY SCHEDULE

Reference: -----  
Produced by: -----  
Aircraft Designation: -----  
Nationality and Registration: -----  
Manufacture: -----  
Manufactures Number: -----  
Maximum Total Mass Authorised (MTMA): -----  
Centre of Gravity limits: -----

### PART "A" BASIC MASS

The Basic Mass of the aircraft (as calculated from  
Mass and Balance Report / Weighing record Ref: .....

Dated -----) is: -----

The C of G of the aircraft (in the same condition at this Mass and with the landing gear extended) is: ----- inches aft of datum

The total momentum about datum in this condition lb/100: -----

**Note:** The datum is at fuselage station 0 situated ---- inches forward of the wing leading edge. This is the datum defined in the Operators Hand Book. All lever arms are in inches aft of datum.

The Basic Mass includes the mass of --- gallons of un usable fuel, one gallon of unusable oil and the weight of the following items which comprise the list of Basic Equipment:-

Item	Mass (lb)	Lever Arm (in)
2 Marzell propellers type BL-H3Z30	127 each	76
2 Engine driven 100 amp alternators	27 each	117
1 13 Ahr. Ni-Cd battery CB-7	31 each	153

Etc. - As specified in the relevant aircraft basic equipment reference document.

### PART "B" VARIABLE LOAD

The mass and lever arm of the Variable Load are shown below. The variable load depends upon the equipment carried for the particular role.

Item	Mass (lb)	Lever Arm (in)	Moment (lb in/100)
Pilot (one)	108		
De-icing fluid 1 gal	12	140	17
Life – jackets (seven)	14	135	19
Row 1 Pax seats (two)	60	173	104
Row 2 Pax seats (two)	60	215	129
Row 3 Pax seat (two)	60	248	149
Table	8	256	20
One stretcher (in place of Two seat rows 2&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:-

Item	Mass (lb)	Lever Arm (in)	Cap (imp gal)
Fuel in tank 1 & 2	1368*	145	190
Engine oil	50*	70	5.5
Forward baggage		21	
Rear baggage		261	
Passengers Row 1 seats			171
Passengers Row 2 seats			213
Passengers Row 3 seats			246
Patient on stretcher		223	

\* Densities: Petrol 7.2 lb/imp gal; Kerosene 8.1 lb/imp gal; Oil 9.0 lb/imp gal.

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

Signed .....Inspector / Engineer

On behalf of (name of approved maintenance organisation)  
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Approval Ref: No. ....