



GENERAL

ADVISORY

CIRCULAR

CIVIL AVIATION AUTHORITY OF BOTSWANA

CAAB Document GAC-018

APPROVAL OF MASS AND BALANCE REPORT

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1. PURPOSE

This General Advisory Circular (GAC) provides information and guidance for the development of a mass and balance data control system by the air operator and evaluation for approval by the Authority.

2. STATUS OF THIS ADVISORY CIRCULAR

This General Advisory Circular is an original issuance.

3. EFFECTIVE DATE

This AAC becomes effective immediately.

4. APPLICABILITY

This guidance is applicable to all operators, organizations and other entities operating commercial aircraft in Botswana.

5. RELATED REGULATIONS

Copies may be obtained from the Government Printer.

- Civil Aviation (Air Operator Certification and Administration) Regulations
- Civil Aviation (Airworthiness) Regulations

6. RELATED PUBLICATIONS

For further information on this subject, operators are advised to review the following ICAO publications -

- Annex 6 – Aircraft Operations
- Doc 9760 – Airworthiness Manual

Copies may be obtained from Document Sales Unit, ICAO, 999 University Street, Montreal, Quebec, Canada H3C 5H7.

7. DEFINITIONS AND ACRONYMS

7.1 The following key terms and phrases are used in this circular:

Empty mass: The mass of the airframe, engines, propellers, rotors and fixed equipment. Excluding the mass of the crew and payload but including the mass of all fixed ballast, unusable fuel, un-drainable oil, and total quantity of hydraulic fluid. The empty mass of an aircraft is the maximum certificated mass less the following:

1. All drainable fuel and oil, except system fuel and oil. System fuel and oil are the amounts required to fill both systems and the tanks, where applicable, up to the outlets to the engines. When oil is used for propeller feathering, such oil is included as system oil.
2. Other drainable fluids, including portable water and lavatory servicing fluid, thrust augmentation, and de-icing fluids.
3. Crew and crew baggage, Passengers and cargo (revenue and non-revenue).
4. Removable passenger service equipment, food, magazines, etc., including services carts, dishes, trays and beverages, removable emergency equipment, other equipment variable for flights and spare parts.

Advisory Circulars (ACs) are intended to provide advice and guidance to illustrate a means, but not necessarily the only means, of complying with the regulations, or to explain certain regulatory requirements by providing informative, interpretative and explanatory material. Where a regulation contains the words "prescribed by the Authority," the AC may be considered to prescribe a viable method of compliance, but status of that "prescription" is always "guidance" (never regulation).

Operating mass: The basic operating mass established by the operator for a particular model aircraft should include the following standard items in addition to the empty mass of the aircraft or as otherwise specified by the operator.

1. Normal oil quantity
2. Lavatory servicing fluid, portable water, etc.
3. Drainable unusable fuel, crew and crew baggage, required emergency equipment for all flights, spare parts normally carried on-board and not accounted for as cargo.
4. All other items considered standard.

Structural limits: Mass and CG limits are established at the time of aircraft certification. They are specified in, or referenced by, the applicable Type Certificate Data Sheet or aircraft specifications. The operator's mass and balance program should provide for maintaining these limits and should stress the point that the aircraft must be operated at or below its maximum certificated operating mass. The following are general definitions of structural mass limits normally considered in mass and balance program.

1. Maximum zero fuel mass: means maximum permissible mass of an aircraft with no disposable fuel and oil.
2. Maximum landing mass: means the maximum mass at which the aircraft can be normally landed. Some aircraft are equipped to jettison fuel to reduce aircraft mass down to the landing limit in an emergency situation.
3. Maximum take-off mass: this is maximum allowable, total loaded aircraft mass at the start of the take-off run.
4. Maximum ramp mass: this is the maximum allowable total loaded aircraft mass for taxi.

7.2 The following acronyms are used in this circular

AC Advisory Circular

AOC Air Operator Certificate

BCARs Botswana Civil Aviation Regulations

CAAB Civil Aviation Authority of Botswana

CG Centre of Gravity

ICAO International Civil Aviation Organization

8. GENERAL

- 8.1 Approved mass and balance control procedures are the only means for an operator/applicant to authorize the use of other than known weights for crew, passengers, baggage, or cargo. The mass and balance control program, including loading schedules and charts, are approved on operations specifications by the Authority. This program must be included in the operator/applicant's policies and procedures manual.
- 8.2 The mass and balance control system encompasses the following:
- a. Methods for establishing, monitoring and adjusting individual aircraft or fleet empty mass and centre of gravity (CG) in conjunction with the initial and periodic re-weighing of aircraft.
 - b. A loading schedule composed of graphs, tables, and computations and/or computer programs, etc., whereby the various mass and balance conditions of an aircraft may be established based on pertinent data for use in loading that particular aircraft in a satisfactory manner.
 - c. Procedures for using the loading schedule to establish that the loaded condition of the aircraft is within approved mass and CG limits.
 - d. A load manifest to document loading information by personnel responsible for mass and balance control and procedures for its preparation.
 - e. Procedures for all applicable personnel concerned with aircraft loading and operations, giving complete details regarding distribution of passengers, fuel, cargo, and necessary restrictions to passenger movement on the ground and during flight.
 - f. Operational performance factors such as takeoff and landing mass accountability; extension and retraction of landing gear, flaps, slats, and thrust reversers; and en route and taxi fuel burn-off, should be provided for the program.
- 8.3 The operator/applicant may develop and submit for approval any method or procedure by which it can show that an aircraft:
- a. Is properly loaded according to approved configuration (loading schedules or charts);
 - b. Will not exceed authorized weight and balance limitations during all ground and flight operations;
 - c. Will be periodically reweighed and its data re-evaluated;
 - d. Will have its data re-calculated, if changes necessitate.
- 8.4 The operator/applicant's weight and balance control procedures may either be an independently controlled document which includes all the instructions and procedures for maintenance, operations, and baggage/cargo control, or it may be included in the manual.
- 8.5 Upon the application for issuance or renewal of Certificate of Airworthiness the operator would be required to provide current mass and balance report of the aircraft.

9. LOADING PROCEDURES

- 9.1 Use of Average Passenger Weights. For some types of regular operations, average passenger and baggage weights may be authorized.
- (a) Average weights may be determined by actually weighing passengers and baggage and documenting the weights. Average weights must be based on acceptable data collected during actual operations.

- (b) Generally, average weights for operations in warm climates are lighter than those in colder climates. In establishing average passenger and baggage weights, operating environment must be considered. For example, clothing worn or carried in colder climates may affect the established weight

NOTE: The average passenger and baggage weights found in the BCAR (AOC) Regulations 15th Schedule, Aircraft Mass and Balance Control system is for guidance and an assessment must be made whether to apply them or get the actual measurements by individual operators when the need arises.

- 9.2 Non-standard Weight Groups. Average weights are not suitable for groups that tend to be heavier or lighter than the average. The operator/applicant must use actual weights for loading non-standard weight groups and their baggage (such as athletic squads, and children's groups etc.).
- 9.3 Carry-on Baggage. Procedures must be provided for controlling carry-on baggage.
- (a) Carry-on baggage must be limited to articles that may be placed in overhead compartments or under seats. No article may be placed in an overhead compartment that causes the weight limit of the compartment to be exceeded.
- (b) Carry-on baggage weight must either be accounted for in the same manner as checked baggage or be added to the passenger weight.
- (c) Operators using average weights for computing weight and balance should re-evaluate carry-on baggage weight at least once per year

10. LOADING SCHEDULES

- 10.1 Should be simple and orderly, based on sound principles, thus reducing the elements of human error. Loading schedules may be applied to individual aircraft or to a complete fleet. When an operator utilises several types or models of aircraft, a loading schedule, which may be index-type, tubular-type, or a computer, should be identified with the type or model of aircraft for which it is designed.
- 10.2 The loading schedule should be kept with the aircraft, forming a part of the aircraft flight manual. It should include instructions on the proper load distribution such as filling of fuel tanks and oil tanks, passenger movement, distribution of cargo, etc. A check should be made to determine if the schedule will allow computation of separate loading conditions when the aircraft is to be loaded in other than the specified conditions shown in the loading schedule.
- 10.3 Information on which to base records of mass and balance changes to the aircraft may be obtained from the pertinent aircraft specifications, aircraft flight manual and the aircraft mass and balance report. Operators should maintain records of all known mass and centre of gravity changes which occur after the aircraft mass has been determined.
- 10.4 A mass and centre of gravity schedule should be provided for each aircraft. Each schedule should be identified by the aircraft designation, nationality and registration marks. The date of issue of the schedule should be given and the schedule should be signed by an approved representative of the organization or a person suitably qualified or acceptable to the CAAB. A statement should be included indicating that the schedule supersedes all earlier issues

11. LOADING PROVISIONS

- 11.1 All seats, compartments and other loading stations should be properly marked and the identification used should correspond with instructions established for computing mass and balance of the aircraft. When the loading schedule provides for blocking off seats or compartments in order to remain within the CG limits, effective means should be provided to ensure that such seats or compartments are not occupied during operations specified.
- 11.2 In such cases, instructions should be prepared for crewmembers, load agents, cargo handlers and other personnel concerned, giving complete information regarding distribution of passengers, cargo, fuel and other items. Information relative to maximum capacities and other pertinent limitations affecting the mass and balance of the aircraft should be included in these instructions. When it is possible by adverse distribution of passengers and/or cargo to exceed the approved CG limits of the aircraft, special instructions should be issued to the pilot in command and appropriate personnel so that the load distribution can be maintained within the approved limitation.
- 11.3 A commercial scale should be available at all times for use when passengers, baggage and cargo mass are otherwise undeterminable.

12. AIRCRAFT MASS

12.1 Weighing of Aircraft

The frequency of weighing aircraft operated under BCAR (AOC) regulations may be set at intervals of 4 years. Both the operator/applicant's operations specifications and manual must reflect this requirement.

12.2 Use of Fleet Weights.

A fleet generally is considered to be three or more aircraft of the same model and configuration. This allows realistic averages to be determined.

- (1) Aircraft operating under fleet weights must be weighed in accordance with the operator/applicant's instructions. The operating weights and centre of gravity position must be within established limits. The use of fleet weights is authorized by operations specifications.
- (2) An operator's empty fleet weight is determined by averaging aircraft weights as follows:

Fleet Size	Weighing Policy
3 aircraft	Weigh all aircraft
4 to 9 aircraft	Weigh 3 aircraft plus at least 50 percent of the number over 3
Over 9 aircraft	Weigh 6 aircraft plus at least 10 percent of the number over 9.

- (3) Scales used to weigh passengers, aircraft, cargo, and baggage must be calibrated and traceable to a national standard or recognised international standard. Calibration and use must be performed in accordance with the manufacturer's instructions. The frequency of testing depends on use and handling.

- (4) Normal precautions, consistent with good practices in the mass determination procedures, should be taken, such as:
 - a) Aircraft and equipment should be checked for completeness;
 - b) Fluids should be properly accounted for;
 - c) Mass determination should be carried out in an enclosed building, to avoid the effect of wind.
- (5) An aircraft mass summary should be completed and certified by the person supervising the measurement. Data recorded should be sufficient to enable the empty mass and empty mass centre of gravity position to be accurately determined.
- (6) The empty mass and empty centre of gravity position should be determined by the owner or operator of the aircraft in accordance with the recorded results of the measurements.

13. CONTRACTORS

- 13.1 An operator/applicant may use a contractor to weigh items required to be weighed. However, the operator/applicant is responsible for ensuring the contractor complies with the operator/applicant's approved weight and balance control program. This includes ensuring scales are calibrated and tested in accordance with the operator/applicant's Policies and Procedures Manual.

14. EVALUATION PROCEDURES

- 14.1 Coordination With Operator/Applicant. Operator/applicant must submit the following for review:
 - a. Manual or revision
 - b. Weight and Balance Program document (if not part of manual)
 - c. Pertinent company procedures.
 - d. Instructions for completing forms used in aircraft weight control and aircraft loading.
 - e. Mathematical justification for loading provisions or schedules.
- 14.2 Review the Operator/Applicant's Manual/Program Document. The manual must include procedures, levels of authority, and information appropriate to (BCARs). In addition, the following must be included:
 - (1) Manual introduction, to include:
 - a. Description of the philosophy and the goals of the manual
 - b. Description of the division of contents between volumes, if more than one volume.
 - c. List of effective pages, including dates.
 - (2) Manual revision and distribution procedures, to ensure:
 - a. Current information is provided to all manual holders;
 - b. Manuals are available to maintenance, operations and ground personnel and are furnished to the Director
 - (3) Definitions of all significant terms used in the program. The definitions must reflect their intended use. Acronyms or abbreviations unique to the manual must also be defined.

- (4) Description of the organizational unit responsible for the control and maintenance of the weight and balance program, to include:
 - a. Definitions of lines of authority.
 - b. Description of the support structure.
- (5) Job descriptions for all elements.
- (6) Training programs that include the following:
 - a. Maintenance personnel.
 - b. Operations and dispatch personnel.
 - c. Ground handling personnel.
- (7) A means of documenting and retaining individual training records.
- (8) Procedures for:
 - a. Determining standards and schedules for calibration of aircraft scales
 - b. Pre-weighing instructions and requirements
 - c. Determining which aircraft are to be weighed
 - d. Establishing and maintaining equipment lists for each aircraft
 - e. Recording the type and serial number for each scale used, the airplane weight, residual fluids, and scale tare weights.
 - f. Initial weighing of aircraft.
 - g. Monitoring and adjusting individual aircraft or fleet, empty weight and centre of gravity;
 - h. Periodic re-weighing of aircraft
 - i. Ensuring aircraft are configured in accordance with approved data
- (9) A loading schedule consisting of graphs/tables or a special loading schedule for a calculator or computerized program. These schedules must ensure pertinent data is available concerning all probable weight and balance conditions of the aircraft.
- (10) A load manifest on which all required loading information shall be entered by personnel responsible for weight and balance control, including procedures for:
 - a. Completing the load manifest;
 - b. Ensuring load manifest is carried on the aircraft;
 - c. Retaining the load manifest for the time periods specified in the (BCAR);
 - d. Distribution of the load manifest in accordance with (BCAR).
- (11) Procedures to be used by crew members, cargo handlers, and other personnel concerned with aircraft loading, for the following:
 - a. Distribution of passengers;
 - b. Distribution of fuel;
 - c. Distribution of cargo;
 - d. Verification and acceptance of actual cargo weights as listed on a bill of lading;
 - e. Restriction of passenger movement during flight, if applicable;
 - f. Hazardous material requirements, if applicable.
- (12) A drawing of each cargo and/or passenger configuration to include emergency equipment locations.

- (13) Mathematical justification for loading provisions or schedules. This may be included under separate cover and not as part of the company manual.
 - (14) An alternate procedure for allowing manual computations, if a computerized weight and balance program is utilized.
 - (15) Procedures for a weight range system, if applicable, that ensures:
 - (a) The range is typical of passengers carried on similar operations
 - (b) Computations for critical load considerations support the ranges
 - (c) Personnel responsible for loading the aircraft are required to prepare appropriate loading records
 - (d) The system includes methods for loading passengers whose weights are outside the range
 - (e) Loading records indicate the number of passengers within the stated range and account for passengers that do not fall within the range.
 - (16) A system for loading non standard weight groups, such as athletic squads or military groups and their baggage, which must utilize actual weights for both passengers and baggage.
 - (17) Procedures to verify actual weight of cargo.
 - (18) Standards and schedules for calibration of commercial scales used to determine baggage/cargo weights.
 - (19) Procedures to ensure that carryon baggage is limited to articles which may be placed in overhead compartment or under seats. Carry-on baggage weight must be accounted for in the same manner as checked baggage or added to the average passenger weight.
 - (20) Review Operator/Applicant's Operations Specifications. Review the draft operations specifications to ensure that operations specifications Paragraph/Part E include the following:
 - (1) Aircraft make/model/series
 - (2) Type of loading schedule
 - (3) Loading schedule instructions for:
 - a. Passenger and crew (average or actual weight)
 - b. Baggage (average or actual weight) and cargo (actual)
 - c. Nonstandard weight groups
 - (4) Weight and balance control procedures
- NOTE:** The above items must be referenced by indicating the locations of the same items in the operator/applicant's manuals, e.g., volume, chapter, etc.
- (21) Analyze the Results. Upon completion of review, analyze the results and determine whether the Operator/applicant's manual and operations specifications meet all requirements

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For Civil Aviation Authority of Botswana

Date: 18/01/2013

End of Advisory Circular



APPENDIX 1

SAMPLE MASS AND BALANCE REPORT MASS CONTROL CERTIFICATE

1. DATE ISSUED:		2. DATE/TIME OF FIRST FLIGHT:	
Aircraft mass and centre of gravity determination			
3. Certificate No.:	4. Aircraft registration:	5. Aircraft Serial No.:	
6. Name of Operator:	7. Place of mass Determination:	8. Reasons for mass determination	
9. Performed by:	10. Checked by:	11. Date of calibration of measuring equipment:	
12. Place of equipment calibration:	13. Calibration Standard of measuring equipment:	14. Empty mass:	
15. Empty CG from Datum line:	16. Index	17. Approved by: (Authorised personnel)	

MASS CONTROL CALCULATION

Empty mass lever arms

1. Aircraft type	2. Aircraft Reg.		
3. Reaction (wheel, jack, point)	4. Average scale reading (kg)	5. Arm (cm)	6. Moment (cm-kg)
7. Left main gear			
8. Right main gear			
9. Sub – total			
10. Nose/tail gear			
11. Total (as amended)			
Items included in Empty mass:			
1.			
2.			
3.			
4.			
Remarks:			

MASS CONTROL CALCULATION

Aircraft mass and centre of gravity determination

COLUMN I				COLUMN II			
Items included but not part of empty weight	Mass (kg)	Arm (cm)	Moment (cm-kg)	Basic items not included when determining mass	Mass (kg)	Arm (cm)	Moment (cm-kg)
TOTAL				TOTAL			

Aircraft mass record

Description	Net mass (kg)	Arm (cm)	Moment (cm-kg)
Total (as measured)			
Less total mass from column I			
Plus total mass from column II			
Net empty mass			

CG limitation:

Forward:cm

Aft.....cm} from reference line

Index formula:

INDEX: _____

-END-