Trinidad and Tobago
Civil Aviation Authority

TTCAA Advisory Circular

Subject: CONTROL OF AIRCRAFT MASS
TTCAA Advisory Circular TAC- 006C
Date: 05/04/25

PURPOSE

1. (1) The purpose of this TTCAA Advisory Circular (TAC) is to give guidance to operators of all aircraft registered in Trinidad and Tobago and to specify in detail the procedures to be followed by all operators or owners in connection with the determination of mass of such aircraft.

(2) This TAC is based on ICAO Document 9760, FAA Advisory Circular AC 120-27D and JAR Ops Subpart J.

(3) TAC-006C replaces and supercedes TAC-006B which is now cancelled and should be destroyed.

DEFINITIONS

2. Wherever the following terms are used in this TAC, they have the meanings shown:

(a) **Aircraft.** Any machine that can derive support in the atmosphere from the reactions of the air other than the reactions of the air against the earth's surface;

(b) **Aircraft component.** Any equipment, instrument, system or portion of an aircraft which, when fitted to an aircraft, is essential to the operation of the aircraft;

(c) **Approved.** Approved by or on behalf of the Civil Aviation Authority in accordance with the pertinent requirements of the Trinidad and Tobago Civil Aviation Regulations (TTCARs);

(d) **Authorized signatory.** A person nominated by an operator or owner and authorized by the Civil Aviation Authority to sign on its behalf for certification of the aircraft mass;

(e) **Centre of Gravity.** An imaginary point about which the nose heavy and tail heavy moments are equal in magnitude;

(f) **Dry Operating Mass.** The total mass of the aeroplane ready for a specific type of operation excluding all usable fuel and traffic load. This mass includes items such as:

(i) Crew and crew baggage;

(ii) Catering and removable passenger service equipment; and

(iii) Potable water and lavatory chemicals;

(h) E**mpty mass.** The mass of the aircraft in empty condition as specified in its appropriate approved manuals. This includes all operating equipment that has a fixed location and is installed in the aircraft;

(i) **Maximum Structural Landing Mass.** The maximum permissible total aeroplane mass upon landing under normal circumstances;

(j) **Maximum Structural Take Off Mass.** The maximum permissible total aeroplane mass at the start of the take-off run;

(k) **Maximum take-off mass.** The maximum authorized mass of the aircraft and its contents, as specified in its appropriate approved manuals;

(l) **Maximum Zero Fuel Mass.** The maximum permissible mass of an aeroplane with no usable fuel. The mass of the fuel contained in particular tanks must be included in the zero fuel mass when it is explicitly mentioned in the Aeroplane Flight Manual limitations;

(m) **Modification.** Any change in the design and construction of an aircraft component or its power-unit;

(n) **Passenger classification.**

(i) Adults, male and female, are defined as persons of an age of 12 years and above;

(ii) Children are defined as persons of an age of two years and above but who are less than 12 years of age;

(iii) Infants are defined as persons who are less than 2 years of age;

(o) **Person.** Any individual, organization or enterprise;

(p) **Power-unit.** A system of one or more engines and ancillary parts which are together necessary to provide thrust, independently of the continued operation of any other power-unit(s), but not including short period thrust producing devices;

(q) **Repair.** The restoration of an aircraft, aircraft component or power-unit to a condition for safe operation after damage or deterioration;

(r) **To certify.** To accept responsibility for the completion of specified maintenance work in accordance with sound engineering practice and the requirements of State regulations; and

(s) **Traffic Load.** The total mass of passengers, baggage and cargo, including any nonrevenue load.

ABBREVIATIONS

3. Wherever the following abbreviations are used in this TAC, they have the meaning shown:

(a) **CG***:* centre of gravity;

(b) **EMCG***:* empty mass CG;

(c) **FOEM:** fleet operating empty mass;

(d) **MAC***:* mean aerodynamic chord: used to locate the CG range of the aircraft. The location and dimension of the MAC are given in the aircraft specifications;

(e) **OEM:** operating empty mass;

(f) **TOM***:* take-off mass;

USE OF KILOGRAM AS THE UNIT OF MASS

4. (1) In accordance with ICAO Annex 5 and the International System of Units (SI), the actual and limiting masses of aircraft, the payload and its constituent elements, the fuel load, etc are expressed in TTCARs in kilogram as the unit of mass. However, in many approved Flight Manuals and other operational documentation, these quantities are published as weights in pounds in accordance with the common language.

(2) Guidance on the application of the SI in Annex 5 to the Convention on International Civil Aviation states –

(a) In science and technology, the term weight has usually meant the force that, if applied to the body, would give it an acceleration equal to the local acceleration of free fall. Thus, because weight is a force = mass x acceleration due to gravity, a person's weight is conditional on his location, but mass is not.

(b) Since weight is a force, in the SI system its unit of measurement is the Newton.

Note: *The S.I .unit of measurement of "weight" is the "Newton"*

(3) In common use, the term weight nearly always means mass. In the SI system, where kilogram is used it properly expresses mass. For example a maximum authorized takeoff weight of 5700kg, should more properly be expressed as a maximum takeoff mass of 5700 kg.

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SECTION 2

ADMINISTRATION AND PROCEDURES — PERIODIC DETERMINATION OF MASS

General

1. (1) Except as specified in (2), the mass of each aircraft should be determined prior to the initial issue of the Airworthiness Certificate.

(2) Determination of the mass of an aircraft prior to the initial issue of an Airworthiness Certificate may not be required in the case of:

(a) An aircraft in respect of which the mass has been determined prior to importation and in respect of which any subsequent changes in mass have been duly computed and recorded;

(b) A newly manufactured aircraft having a maximum TOM not exceeding 5 700 kg, the empty mass of which has been established in accordance with information and computations supplied by the manufacturer; or

(c) If the basic mass is estimated to have changed by not more than 0.5 per cent of the maximum take-off mass, and if the CG is estimated to have changed by not more than 0.5 per cent of the MAC.

Periodic Determination Of Mass

2. (1) Unless otherwise approved by the TTCAA, further determination of mass should be carried out subsequent to the initial determination of mass, at intervals of 36 calendar months. An operator may, however, extend this weighing period for a particular model aircraft when the pertinent records of actual routine weighing during the preceding period of operation show that the mass and balance records maintained are sufficiently accurate to indicate that aircraft mass and CG positions are within the cumulative limits specified for establishment of OEM. Such applications should be substantiated in each instance with at least two aircraft weighed. Under an individual aircraft weighing programme, an increase should not be granted which would permit any aircraft to exceed 48 calendar months since the last weighing, including when an aircraft is transferred from one operator to another. In the case of helicopters, increases should not exceed a time that is equivalent to the aircraft overhaul period.

(2) **Fleet Weighing.** An operator may choose to weigh only a portion of the fleet and apply the unaccounted mass and moment change determined by the sample to the remainder of the fleet. The following are some considerations in fleet weighing:

(a) A fleet is composed of a number of aircraft of the same model (For example, B747-200s in a passenger configuration and B747-200 freighters should be considered different fleets. Likewise, B737-700s and B737-800s should be considered different fleets). The primary purpose of defining a fleet is to determine how many aircraft should be weighed in each weighing cycle. A fleet may be further divided into groups to establish FOEMs;

(b) In choosing the aircraft to be weighed, the aircraft in the fleet having the most hours flown since last weighing should be selected; and

(c) An operator should establish a time limit such that all aircraft in a fleet are eventually weighed. Based on the length of time that a fleet of aircraft typically remains in service with an operator, the time limit should not exceed 18 years (six 3-year weighing cycles). It is not intended that an operator be required to weigh any remaining aircraft in the event that business conditions result in retirement of a fleet before all aircraft have been weighed.

(3) **Weighing Aircraft Modifications.** For most aircraft modifications, computing the mass and balance changes is practical. For some modifications, such as interior reconfigurations, the large number of parts removed, replaced, and installed make an accurate determination of the mass and balance change by computation impractical. It would be potentially unsafe to fail to reestablish the aircraft mass and balance, by actually reweighing the aircraft, in situations where the cumulative net change in the mass and balance log exceeds-

(a) In the case of aeroplanes, plus or minus one-half of 1 percent (0.5 percent) of the maximum landing mass, or whenever the cumulative change in the CG position exceeds one-half of 1 percent (0.5 percent) of the MAC;

(b) In the case of helicopters and aeroplanes that do not have a MAC-based CG envelope (e.g., canard equipped aeroplane), whenever the cumulative change in the CG position exceeds one-half of 1 percent (0.5 percent) of the total CG range.

NOTE: *In the situations specified in paragraphs 2(3)(a) and (b) above, the operator should weigh two or more aircraft in a fleet, as required in Table 2-2, to get consistent results. The operator may choose to weigh the aircraft before and after the modification, or just after the modification.*

Procedures For Determining Mass

3. (1) Weighing must be accomplished either by the manufacturer or by an approved maintenance organization.

(2) An operator should take precautions to ensure that he weighs an aircraft as accurately as possible. These precautions include checking to ensure that all required items are aboard the aircraft and the quantity of all fluids aboard the aircraft is considered. An operator should weigh aircraft in an enclosed building because scale readings stabilize faster in the absence of drafts from open doors.

(3) An operator should establish and follow instructions for weighing the aircraft that are consistent with the recommendations of the aircraft manufacturer and scale manufacturer. The operator should ensure that all scales are certified and calibrated by the manufacturer or a certified laboratory, such as a civil department of weights and measures, or the operator may calibrate the scale under an approved calibration programme. The operator should also ensure that the scale is calibrated within the manufacturer's recommended time period, or time periods, as specified in the operator's approved calibration programme.

(4) Aircraft mass determination will be supervised by either an airworthiness official of the TTCAA or an aircraft mass control design signatory. Aircraft should be presented for mass determination in a condition acceptable to the TTCAA. Aircraft mass would be determined on scales approved by the TTCAA.

(5) Sufficient personnel and equipment, such as slings, ballast and trestles, should be provided by the owner or operator of the aircraft to complete the mass determination satisfactorily. The TTCAA will not be responsible for the safety of the aircraft or personnel performing the measurements.

(6) Unless otherwise approved by the TTCAA, two independent determinations should be made and the aircraft longitudinal datum line should be horizontal in at least one of these determinations. The load should be completely removed from the equipment between determinations. Any discrepancy between the aircraft gross mass as determined by the two measurements should not exceed 0.2 per cent or 10 kg, whichever is the greater. If this tolerance is exceeded, the measurements should be repeated until the gross mass, as determined by two consecutive and independent measurements, agrees with that tolerance .

(7) 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) Ensuring that the aircraft is clean;

(c) Fluids should be properly accounted for;

(c) Mass determination should be carried out in an enclosed building, to avoid the effect of wind;

(d) The scales used should be properly calibrated and used in accordance with the manufacturer's instructions; and

(e) Each scale should have been calibrated, either by the manufacturer or by the appropriate State authority, or other body authorized and approved by the Authority within one year prior to the mass determination of the aircraft.

(8) An aircraft mass summary should be completed and a copy, certified by the person supervising the measurement, submitted to the TTCAA. Data recorded should be sufficient to enable the empty mass and empty mass CG position to be accurately determined.

Note- *If there is any doubt about the accuracy of the measurement, the TTCAA may require the measurements to be repeated.*

(9) The empty mass and empty CG position should be determined by the owner or operator of the aircraft in accordance with the recorded results of the measurements.

Loading Data

4. (1) The loading schedule is used to document compliance with the certified mass and balance limitations contained in the manufacturer’s aircraft flight manual and mass and balance manual.

(2) The loading schedule is developed by the operator based on his specific loading calculation procedures and provides the operational limits for use with the operator’s mass and balance programme approved by the TTCAA. These approved operational limits are typically more restrictive but do not exceed the manufacturer’s certified limits. This is because the loading schedule is generally designed to check only specific conditions (e.g., takeoff and zero fuel) known prior to takeoff, and must account for variations in mass and balance in flight. It must also account for factors selected to be excluded, for ease of use, from the calculation process. Loading the aircraft so that the calculated mass and balance is within the approved limits will maintain the actual mass and balance within the certificated limits throughout the flight.

(3) 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.

(4) 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 CG changes which occur after the aircraft mass has been determined.

(5) A mass and CG 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 TTCAA. A statement should be included indicating that the schedule supersedes all earlier issues.

Periodic Sampling

5. (1) Periodic mass determination of aircraft on a sampling basis is necessary to determine if major mass changes have taken place which might indicate a trend or a condition prevalent in the entire fleet. The following table shows a periodic sampling procedure, indicating the number of aircraft to be included in mass determination every 24 calendar months:

Number in fleet	*Minimum number to be used*
3	3
4 or 5	4
6 or 7	5
8 to 13	6
14 to 23	7
24 and over	6, plus 10% of the number of aircraft over 9

(2) The sampling rate may be reduced by approval of the TTCAA where it can be shown that the variation in fleet mass is small from year to year. Extensions should not be granted which would permit any aircraft to exceed 48 calendar months since the last mass determination. A rotation programme should be established, so that the mass of all aircraft in the fleet can be periodically determined.

(3) The mass and balance control system should include methods by which the operator will complete a current and continuous record of the mass and CG of each aircraft. Such records should reflect all alterations and changes affecting either the mass or balance of the aircraft and should include a complete and current equipment list. When fleet mass is used, pertinent computations should be available in individual aircraft files.

(4) The operator should take into account all probable loading conditions which may be experienced and show that the loading schedules may be applied to individual aircraft or to a complete fleet. When an operator uses several types or models of aircraft, the loading schedule (which may be index type, tabular type, or a computer used) should indicate the type or model of aircraft for which it is designed.

Preparation and Approval of Loading Data

6. (1) Loading data prepared in accordance with the provisions of this sub-section should be approved by an appropriately authorized aircraft mass control design signatory or by the TTCAA. Where the applicable flight manual pages are used as the load data sheet and to specify any required loading system, the completed pages should be submitted to the TTCAA for incorporation in the aircraft flight manual.

(2) The operator will be responsible for the preparation of a load data sheet for each aircraft based on the empty mass and empty CG position. Unless otherwise approved by the TTCAA, the flight manual page titled “Aircraft Mass” should be used as the load data sheet in the case of aeroplanes of maximum TOM not greater than 5 700 kg.

(3) The operator will be responsible for the preparation of a loading system for each aircraft based on the empty mass and empty CG position, unless it can be shown that the aircraft cannot be loaded so that its CG falls outside the approved range.

Note *— When the necessary loading limitations can be conveniently presented in placard form, such placards, prominently displayed in the aircraft, will be an acceptable type of loading system.*

(4) One copy of each data sheet and loading system approved by an aircraft mass control design signatory should be submitted to the TTCAA, except that where flight manual pages are used as the load data sheet or to specify the loading system, two copies should be supplied. Alternatively, two copies of all calculations, load data sheet, loading system or flight manual pages as appropriate should be submitted to the TTCAA for approval.

(5) Load data sheets approved by an aircraft mass control design signatory should be validated by the signatory for a period expiring not later than the time at which the next mass determination is to be done.

Equipment Lists

7. (1) Prior to the initial issue of an Airworthiness Certificate for each aeroplane and rotorcraft, a list of equipment included in the empty mass should be submitted to the TTCAA. If an operating mass is used, a similar list of removable equipment and disposable load included in the operating mass should also be submitted to the TTCAA.

(2) Where a change occurs in the items included in either the empty mass or, if applicable, the operating mass of an aircraft, the appropriate list should be amended by the operator and a copy submitted to the TTCAA.

(3) At each mass determination of an aircraft, it should be the responsibility of the operator to check whether the list of equipment requires revision. A copy of any revised list should be supplied to the TTCAA.

OPERATION AND APPROVAL

Record Of Mass Alterations

8. (1) A complete, current, and continuous record of changes in empty mass and empty CG position should be maintained for each aircraft. This record should contain details of all alterations affecting either the mass or balance of the aircraft.

Note*— A number of alterations performed at the same time may be recorded collectively.*

(2) Under the provisions of the preceding paragraph, a record of mass and CG alterations is required; a record should be raised after each determination of mass and a copy of the renewed document should be supplied to the TTCAA.

Mass Control During Modification

9. (1) It is the responsibility of the operator of an aircraft to renew the load data sheet when a loading system has been issued, if the system applicability limits are exceeded as the result of a modification or, as shown in the record of mass alterations, changes have occurred in the empty mass or empty CG position as follows:

(a) For aeroplanes:

(i) The empty mass has changed by more than 0.5 per cent of the maximum TOM; or

(ii) The empty CG position has changed by more than 0.5 per cent of the mean aerodynamic chord;

(b) For rotorcraft:

(i) The empty mass has changed by more than 1 per cent of the maximum TOM; or

(ii) The empty CG position has changed by more than 1 cm or 10 per cent of the maximum permissible CG range, whichever is the less.

(2) Further to the provisions of 8 (1), if the TTCAA or an aircraft mass control design signatory is of the opinion that adequate mass control has not been exercised over an aircraft during the modification, the TTCAA or the aircraft mass control design signatory may require that a new empty mass and empty CG position be determined.

(3) Where a loading system has not been required previously, it is the responsibility of the operator to check the need for a loading system in the circumstances specified in paragraph 8 (1) and, where necessary, provide a loading system.

(4) Loading data renewed in accordance with paragraph 8 (1) should be based on the new empty mass and empty center of gravity position and should be prepared and approved in accordance with paragraph 8 (1).

Aircraft Fleets

10. Three or more aeroplanes or rotorcraft of the same type under the control of one operator may, with the approval of the TTCAA, be treated as a fleet for the purposes of preparation and approval of loading data, provided the specifications listed in paragraph 2 are met.

Calibration of Scales

11. Scales used to weigh passengers, aircraft, cargo, and baggage must be calibrated and traceable to a national standard. Calibration must be performed in accordance with the civil authority for mass and measures having jurisdiction over the area in which the scales are used. The frequency of testing depends on use and handling.

Load Sheets

12. Except where the aircraft load sheets are used by an operator, any document intended as a load sheet should be submitted to the TTCAA for approval before use, or should be approved by an aircraft mass control design signatory. If approved by an aircraft mass control design signatory, a copy of the approved load sheet form should be supplied to the TTCAA.

Aircraft Loading

13. (1) Under TTCAR No.2:100, the loading of an aircraft may be delegated by the pilot in command to suitably qualified persons provided by the operator, who shall be responsible for supervising the loading.

(2) Loading of freight must be consistent with the data used for the calculation of the aircraft mass and balance.

(3) An operator must comply with additional structural limits such as floor strength limitations, the maximum load per running metre, the maximum mass per cargo compartment and the maximum seating limits as determined by the aircraft flight manual or manufacturer's specifications.

Centre of Gravity Limits

14. (1) Under TTCAR No.2:100, an aircraft shall not be operated unless the calculations for mass and center of gravity location of the aircraft indicate that the flight can be conducted safely, taking into account the flight conditions expected.

(2) **Operational Centre of Gravity Envelope.** Unless seat allocation is applied and the effects of the number of passengers per seat row, of cargo in the individual cargo compartments and of fuel in the individual tanks is accounted for accurately in the balance calculation, operational margins must be applied to the certified centre of gravity envelope. In determining the CG margin possible deviations from the assumed load distribution must be considered. If free seating is applied, the operator must introduce procedures to ensure corrective action by flight or cabin crew if extreme longitudinal seat selection occurs. The CG margins and associated operational procedures, including assumptions on passenger seating must be acceptable to the Authority.

(3) **In Flight Centre of Gravity.** The operator must show that the procedures fully account for the extreme variation in CG travel during flight caused by passenger or crew movement and fuel consumption or transfer.

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SECTION 3

MASS VALUES FOR PASSENGERS AND BAGGAGE

GENERAL

1. (1) An operator may compute the mass of passengers and checked baggage using either the actual weighed mass of each person and the actual weighed mass of baggage or the standard mass values specified in Tables 1 to 3 except where the number of passenger seats available is less than 10. In such cases, passenger mass may be established by use of a verbal statement by or on behalf of each passenger and adding to it a pre-determined constant to account for hand baggage and clothing. This constant should be determined by the operator on the basis of studies relevant to his particular routes, etc. and should not be less than 4 kg.

(2) Personnel boarding passengers on this basis should assess the passenger's stated mass and the mass of passengers' clothing to check that they are reasonable. Such personnel should have received instruction on assessing these mass values. The procedure specifying when to select actual or standard masses and the procedure to be followed when using verbal statements must be included in the Operations Manual.

(3) If determining the actual mass by weighing, passengers' personal belongings and hand baggage must be included. Such weighing must be conducted immediately prior to boarding and at an adjacent location.

STANDARD AVERAGE MASS

General

2. If determining the mass of passengers using standard mass values, the standard mass values in Tables 1 and 2 below should be used. The standard masses include hand baggage and the mass of any infant below 2 years of age carried by an adult on one passenger seat. Infants occupying separate passenger seats must be considered as children for the purpose of this TAC.

Mass values for Passengers –Aeroplane and Helicopters 20 Passenger Seats or Greater

3. (1) Where the total number of passenger seats available is 20 or greater, the standard masses of male and female in Table 1 are applicable for aeroplanes and in Table 1H for helicopters. As an alternative, in cases where the total number of passenger seats available is 30 or greater, the 'All Adult' mass values in Table 1 are applicable for aeroplanes and in Table 1H for helicopters.

Table 1 (Passenger Seats on Aeroplane 20 or greater)

Passenger Seats	20 and greater		30 and greater
	Male	Female	All Adult
All Flights	88 kg	70 kg	84 kg
Children	35 kg	35 kg	35 kg

Table 1H (Passenger seats on helicopter 20 or greater)

Passenger Seats	20 and greater		30 and greater
	Male	Female	All Adult
All Flights	81 kg	63 kg	77 kg
Children	35 kg	35 kg	35 kg
Hand Baggage	7 kg		
Survival Suit	3 kg		

Mass Values For Passengers – 19 Passenger Seats Or Fewer

4. (1) In the case of an aeroplane, where the total number of passenger seats available is 19 or fewer, the standard masses in Table 2 are applicable.

Table 2

Passenger seats	**1-5**	**6-9**	**10-19**
Male	104 kg	96 kg	92 kg
Female	86 kg	78 kg	74 kg
Children	35 kg	35 kg	35 kg

(2) On flights in aeroplanes where no hand baggage is carried in the cabin or where hand baggage is accounted for separately, 7 kg should be deducted from the male and female masses shown in the table. Articles such as an overcoat, an umbrella, a small handbag or purse, reading material or a small camera are not considered as hand baggage for the purpose of this sub-paragraph

(3) In the case of a helicopter the following apply:

(a) Where the total number of passenger seats is 10 – 19 inclusive, the standard masses in Table 2H are applicable; or

(b) Where the number of passenger seats available is 1 –5 inclusive or 6 – 9 inclusive, the standard masses in Table 3H are applicable.

Table 2 H (Passenger seats available on helicopter is 10-19)

Passenger Seats	10-19	
	Male	Female
All flights	85 kg	67 kg
Children	35 kg	35 kg
Hand Baggage	7 kg	
Survival Suit	3 kg	

Table 3 H (Passenger seats available on helicopter is 1-5 inclusive or 6-9 inclusive)

Passenger Seats	1-5	6-9
Male	97 kg	89 kg
Female	79 kg	71 kg
Children	35 kg	35 kg
Hand Baggage (where applicable)	7 kg	
Survival Suit (where applicable)	3 kg	

Mass values for Baggage- Aeroplane and Helicopter

5. (1) **Aeroplanes.** Where the total number of passenger seats available on an aeroplane is 20 or greater, the standard mass value of 16 kg is applicable for each piece of checked baggage. For aeroplanes with 19 passenger seats or fewer, the actual mass of checked baggage, determined by weighing, must be used.

(2) **Helicopters.** Where the total number of passenger seats available on a helicopter is 20 or greater, the standard mass value for each piece of checked baggage is 13 kg. For helicopters with 19 passenger seats or fewer, the actual mass of checked baggage, determined by weighing, must be used.

Mass Values for Crewmembers

5. (1) An operator may choose to use the standard crewmember mass shown in Table 3 or conduct a survey to establish average crewmember mass appropriate to his operation.

Table 3

Crewmember	**Average Mass**	**Average Mass with Bags**
Flight crewmember	85 kg	101 kg
Cabin crew	75 kg	87 kg
Male cabin crew	80 kg	92 kg
Female cabin crew	73 kg	85 kg
Crewmember roller bag	7 kg	NA
Pilot flight bag	9 kg	NA
Cabin crew kit	5 kg	NA

(2) The flight crewmember average mass with bags assumes that each flight crewmember has one crewmember roller bag and one pilot flight bag.

(3) The cabin crew mass with bags assume that each cabin crew has one crewmember roller bag and one cabin crew kit.

(4) An operator may include the mass of crewmembers in an aircraft's OEM or add the mass to the load manifest prepared for each flight.

Standard Average Mass For Special Passenger Groups

6. (1) **Sports Teams.** The following considerations apply to sports teams:

(a) Actual passenger mass should be used for nonstandard mass groups (sports teams, etc.) unless average mass have been established for such groups by conducting a survey in accordance with the procedures established in Section 4 of this TAC. When such groups form only a part of the total passenger load, actual mass, or established average mass for the nonstandard group, may be used for such exception groups and average mass used for the balance of the passenger load. In such instances, a notation should be made in the load manifest indicating the number of persons in the special group and identifying the group; e.g., football squad, etc.

(b) A standard allowance of 7 kg per person may be used to account for carry-on and personal items as provided in the operator's approved carry-on bag programme.

(c) If the carry-on bags are representative of the operator's profile but do not meet the number of bags authorized per person, the operator may count bags and use a 7 kg per bag allocation.

(d) Actual mass must be used in cases where the carry-on bags are not representative of the operator's profile.

(2) For groups that are predominantly male or female an operator should use the standard average mass for males or females provided in Tables 1 and 2.

Military Groups

7. Actual passenger and cargo mass should be used in computing the aircraft mass and balance for all military charter missions. TTCAA-approved mass and balance control programmes may be used to account for carry-on/personal items for mixed loads of military and their dependants. If aircraft operators perceive that the mass provided are understated, they should seek confirmation of the actual mass and should make reasonable upward estimations and adjustments to those passenger and/or bag mass.

Mass Values For Baggage

8. (1) If an operator chooses to use standard average mass for checked baggage such standard average mass should be 16 kg per piece. If an operator wishes to use a standard average mass of less than 16 kg for checked baggage, he must apply to the Authority for approval to do so, and present to the Authority a current valid survey report to support the lower mass.

(2) For aeroplanes with 19 passenger seats or fewer, the actual mass of checked baggage, determined by weighing, must be used.

Heavy Bags

9. (1) A heavy bag is considered any bag that weighs more than 23 kg but less than 45 kg. An operator should account for a heavy bag by using one of the following masses:

(a) A standard average mass of 27 kg;

(b) An average mass based on the results of a survey of heavy bags; or

(c) The actual mass of the heavy bag.

Note: *An operator that uses "double-counting" to treat a heavy bag as if it were two checked bags for mass purposes should ensure that the load manifest represents the actual number of bags for counting purposes. An operator should have a system in place to ensure that heavy bags are identified, although operators may not be required to weigh heavy bags on a scale.*

Non-luggage Bags

10. A non-luggage bag is any bag that does not meet the normal criteria for luggage. Examples include cricket gear, golf bags, fishing equipment packages, wheelchairs and strollers in their shipping configuration, windsurfing kits, boxed bicycles, steel band instruments, etc. For non-luggage bags, operators may use any appropriate combination of actual mass, average mass based on survey results, or standard average bag mass. Operators that wish to establish a standard average mass for a particular type of non-luggage bag, such as cricket gear bag, must conduct a survey in accordance with the procedures established in Section 4 of this TAC. Operators also should establish a method to calculate the effect on CG of a large non-luggage bag, such as a surfboard, that may occupy more than one compartment on the aircraft.

Company Materials And Mail

11. (1) **Company Material.** An operator should use actual mass for company material and aircraft parts carried aboard an aircraft.

(2) **Mail.** An operator should use the mass provided with manifested mail shipments to account for the mass of the mail. If an operator has to separate a shipment of mail, the operator may make actual estimates about the mass of the individual pieces, provided the sum of the estimated mass is equal to the actual manifested mass of the entire shipment.

Deviation from Standard Values of Mass

12. (1) On any flight identified as carrying a significant number of passengers whose masses, including hand baggage, are expected to exceed standard passenger mass, an operator must determine the actual mass of such passengers by weighing, or by adding an adequate mass increment. This requirement implies that the Operations Manual should contain appropriate directives to ensure that:

(a) Check-in, operations and cabin staff and loading personnel report or take appropriate action when a flight is identified as carrying a significant number of passengers whose masses, including hand baggage, are expected to exceed the standard passenger mass, and/or groups of passengers carrying exceptionally heavy baggage (e.g. military personnel or sports teams, or steel band groups); and

(b) On small aeroplanes, where the risks of overload and/or CG errors are the greatest, pilots in command pay special attention to the load and its distribution and make proper adjustments.

(2) If standard mass values for checked baggage are used and a significant number of passengers check in baggage that is expected to exceed the standard baggage mass, an operator must determine the actual mass of such baggage by weighing or by adding an adequate mass increment

(3) Whenever a non-standard method is used for determining the mass of the load, the pilot in command must be informed, and the method stated in the mass and balance documentation.

(4) If an operator wishes to use standard mass values other than those contained in Tables 1 and 2, 1H to 3H, or the standard mass value for baggage, he must advise the Authority of his reasons and gain its approval in advance. He must also submit for approval a detailed weighing survey plan and show the statistical analysis method applied. After verification and approval by the Authority of the results of the weighing survey, the revised standard mass values are applicable only to that operator. The revised standard mass values should only be used in circumstances consistent with those under which the survey was conducted. Where revised standard masses exceed those in Tables 1 and 2, 1H to 3H or the standard mass value for baggage, then such higher values must be used. Guidance on determining average mass based on survey results is at Section 4.

ACTUAL MASS PROGRAMMES

Determining The Actual Mass Of Passengers

13. (1) An operator may determine the actual mass of passengers by—

(a) Weighing each passenger on a scale before boarding the aircraft (types of mass scales and scale tolerances will be defined in the operator's approved mass and balance control programme); or

(b) Asking each passenger his or her mass. An operator should add to this asked (volunteered) mass at least 4 kg to account for clothing. An operator may increase this allowance for clothing on certain routes or during certain seasons, if appropriate.

Note: *If an operator believes that the mass volunteered by a passenger is understated, the operator should make a reasonable estimate of the passenger's actual mass and add 4 kg.*

(2) To determine the actual mass of a personal item, carry-on bag, checked bag, plane-side loaded bag, or a heavy bag, an operator should weigh the item on a scale.

(3) An operator using actual mass should record all masses used in the load buildup.

SECTION 4

AVERAGE MASS BASED ON SURVEY RESULTS

Designing A Survey

1. (1) This section provides operators with an acceptable survey method to use in determining average mass for a mass and balance control programme. This section also describes how an operator can conduct a survey to count personal items and carry-on bags to determine an appropriate allowance for those items to include in passenger mass. In addition, an operator may use the methods described in this section to conduct a survey to determine the percentage of male and female passengers, to calculate an average passenger mass.

(2) Surveys conducted correctly allow an operator to draw reliable inferences about large populations based on relatively small sample sizes. In designing a survey, an operator should consider—

(a) The sample size required to achieve the desired reliability;

(b) The sample selection process; and

(c) The type of survey (average mass or a count of items).

Determining Sample Sizes

2. Several factors must be considered when determining an adequate sample size. The more varied the population, the larger the sample size required to obtain a reliable estimate. A formula to derive the absolute minimum sample size to achieve a 95-percent confidence level is provided at Table 4 for those operators that wish to use calculations other than those listed in paragraph 3. Table 4 provides the operator with an acceptable number of samples that may be collected to obtain a 95-percent confidence level and lists the tolerable error associated with each category.

TABLE 4

Survey Subject	**Minimum Sample Size**	**Tolerable Error**
Adult (standard adult/male/female)	2,700	1%
Child	2,700	2%
Checked bags	1,400	2%
Heavy bag	1,400	2%
Plane-side loaded bags	1,400	2%
Personal items and carry-on bags	1,400	2%
Personal items only (for operators with no carry-on bag programme)	1,400	2%

Procedure When Sample Size Smaller than Table 4

3. If the operator has chosen to use a sample size that is smaller than that provided in Table 3-4, the operator should collect a sufficient number of samples to satisfy the following formulae:

$$s = \frac{\sqrt{\sum_{j=1}^{n} (x_j - \bar{x})^2}}{\sqrt{(n-1)}}$$

Where -

s is the standard deviation
n is the number of points surveyed
x_j is the individual survey mass

$\bar{x}$ is the sample average

$$e = \frac{1.96*s*100}{\sqrt{n}*\bar{x}}$$

Where -
e is the tolerable error.

Sampling Method

4. (1) An operator conducting a survey must employ random sampling techniques. Random sampling means that every member of a group has an equal chance of being selected for inclusion in the sample. If an operator conducts a survey that does not employ random sampling, the characteristics of the selected sample may not be indicative of the larger group as a whole. Because of this, any conclusions drawn from such a survey may not be valid.

(2) An operator may consult a basic textbook on statistics to determine appropriate random sampling methods. The following are two examples of random sampling methods that an operator may find appropriate for the type of survey conducted;

(a) **Simple random selection.** An operator should assign a sequential number to each item in a group (such as passengers waiting on a line or bag claim tickets). Then the operator randomly selects numbers and includes the item corresponding with the number in the sample. The operator repeats this process until it has obtained the minimum sample size.

(b) **Systematic random selection.** An operator should randomly select an item in sequence to begin the process of obtaining samples. The operator should then use a predetermined, systematic process to select the remaining samples following the first sample. For example, an operator selects the third person in line to participate in the survey. The operator then selects every fifth person after that to participate in the survey. The operator continues selecting items to include in the sample until it has obtained the minimum sample size.

(3) Regardless of the sampling method used, an operator has the option of surveying each passenger and bag aboard the aircraft and should always give a passenger the right to decline to participate in any passenger or bag mass survey. If a passenger declines to participate, the operator should select the next passenger based on the operator's random selection method rather than select the next passenger in a line. If a passenger declines to participate, an operator should not attempt to estimate data for inclusion in the survey.

Development and Submission Of A Survey Plan

5. (1) **Developing a survey plan.** Before conducting a survey, an operator should develop a survey plan. The plan should describe the dates, times, and locations the survey will take place. In developing a survey plan, the operator should consider its type of operation, hours of operation, markets served, and frequency of flights on particular routes. An operator should avoid conducting surveys on holidays unless it has a valid reason to request the particular date.

(2) **Submitting the survey plan to the TTCAA.** It is recommended that an operator submit its survey plan to the TTCAA at least 2 weeks before the survey is expected to begin. Before the survey begins, the TTCAA will review the plan and work with the operator to develop a mutually acceptable plan. During the survey, an assigned inspector will oversee the survey process to validate the execution of the survey plan. After the survey is complete, the inspector will review the survey results and issue the appropriate OpSpecs. Once a survey begins, the operator should continue the survey until complete, even if the initial survey data indicates that the average mass are lighter or heavier than expected.

General Survey Procedures

6. (1) **Survey locations.** An operator should accomplish a survey at one or more airports that represent at least 15 percent of an operator's daily departures. To provide connecting passengers with an equal chance of being selected in the survey, an operator should conduct its survey within the secure area of the airport. An operator should select locations to conduct its survey that would provide a sample that is random and representative of its operations. For example, an operator should not conduct a survey at a gate used by shuttle operations unless the operator is conducting a survey specific to that route or the operator only conducts shuttle operations. However, the location should be selected as close to the aircraft as possible at a point where a change in passenger mass is unlikely to occur as a result of the passenger disposing or acquiring more personal belongings before boarding the aircraft.

(2) **Weighing passengers.** An operator that chooses to weigh passengers as part of a survey should take care to protect the privacy of passengers. The scale readout should remain hidden from public view. An operator should ensure that any passenger mass data collected remains confidential.

(3) **Weighing bags.** When weighing bags on a particular flight, an operator should take care to ensure that he is properly accounting for all items taken aboard the aircraft.

(4) **Weighing machine.** The weighing machine used for passenger weighing should have a capacity of at least 150 kg. The mass should be displayed at minimum graduations of 500 grams. The weighing machine should be accurate to within 0.5 % or 200 grams whichever is greater.

(5) **Rounding sample results.** If the operator uses rounding in the mass and balance calculations, it is recommended that the operator round passenger mass to the nearest 500 grams and bag mass to the nearest 250 grams. An operator should ensure that rounding is done consistently in all calculations.

(6) **Surveys for particular routes.** An operator may conduct a survey for a particular route if the operator believes that the average mass on that route may differ from those in the rest of its operations. To establish a standard average passenger mass along the route, an operator may survey passengers at only one location. However, an operator should conduct surveys of personal items and bags at the departure and arrival locations, unless the operator can verify there is no significant difference in the mass and number of bags in either direction along the route.

Conducting A Count Survey

7. (1) An operator may conduct a survey to count certain items without determining the mass of those items. For example, an operator may determine that the standard average mass for male and female passengers is appropriate for his operations, but on some routes the passengers are predominantly male or female. In this case, an operator may conduct a survey to determine the percentage of male and female passengers. The operator could use the results of the survey to justify a mass other than the standard mass, which assume a 50-percent male and 50-percent female mix of passengers. Similarly, an operator may conduct a survey to determine the number of personal items and carry-on bags passengers carry aboard aircraft to determine if the allowance of 7 kg per passenger is appropriate to his operations.

(2) For example, an operator conducts a survey on a particular route (or multiple routes if amending the programme average mass) to count the percentage of passengers carrying personal items and carry-on bags. The operator finds that—

(a) Fifty percent of passengers carry one carry-on bag and one personal item.

(b) Thirty percent of passengers carry one carry-on bag or one personal item.

(c) Twenty percent of passengers carry neither a carry-on bag nor a personal item.

(d) The survey results show that the average passenger carries approximately 10 kg of personal items and carry-on bags rather than the standard allowance of 7 kg. In such a case, it would be irresponsible for the operator to fail to increase the standard average mass for that route(s) by 3 kg per passenger.

Revalidation of a Survey

8. In order to use survey-derived average mass, an operator must revalidate such survey data every 36 calendar-months or revert to the standard average mass, provided the new survey average mass results are within 2 percent of the standard average mass listed in this TAC.

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Ramesh Lutchmedial
Director General of Civil Aviation

SAMPLE MASS AND BALANCE REPORT

MASS CONTROL CERTIFICATE

Date issued . . . . . *Date/time of first flight . . . . . UTC

* IMPORTANT: This date/time must be later than the date of issue

Aircraft Mass and Centre of Gravity Determination

No. . . . . .

Date . . . . . .

Aircraft Registration . . . . . .

Aircraft Type . . . . . .

Aircraft Serial Number . . . . . .

Name of Operator . . . . . .

Place of Determination of Mass . . . . . .

Reason for Determination of Mass . . . . . .

Performed by:
Checked by:

Empty Mass
Empty CG from datum line
Index

Approved by: . . . . . .

. . . . . .

(Authorized Personnel)

MASS CONTROL CALCULATION

Empty mass lever arms

Aircraft type . . . . . .

Registration . . . . . .

Reaction (wheel, jack, point, etc.)	Average scale reading (kg)	ARM (cm)	Moment (cm-kg)
Left main gear			
Right main gear			
Sub-total			
Nose/tail gear			
Total (as measured)			

Items included in empty mass:

1.
2.
3.
4.
5.

Remarks:

MASS CONTROL CALCULATION

Aircraft Mass and CG determination

COLUMN I			
Items included but not part of empty mass	Mass (kg)	ARM (cm)	Moment (cm-kg)
TOTAL			

COLUMN II			
Basic items not included when determining mass	Mass (kg)	ARM (cm)	Moment (cm-kg)
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: