



Advisory Circular

Subject: Use of Segmented Passenger Weights by Commercial Air Operators Under Subpart 703 of the Canadian Aviation Regulations

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1.0 Introduction

- (1) This Advisory Circular (AC) is provided for information and guidance purposes. It describes an example of an acceptable means, but not the only means, of demonstrating compliance with regulations and standards. This AC on its own does not change, create, amend or permit deviations from regulatory requirements, nor does it establish minimum standards.

1.1 Purpose

- (1) The purpose of this AC is to advise Transport Canada Civil Aviation (TCCA) and the aviation industry that segmented weight is one of the acceptable methods of determining passenger weights for weight and balance calculation of the aeroplane involved in operations under Subpart 703 of the *Canadian Aviation Regulations (CARs)*.

1.2 Applicability

- (1) Segmented weights are applicable:
- (a) To passengers (Male/Female/Gender X) aged 12 years and older; and
 - (b) To the weight and balance control of aeroplanes that are operated under Subpart 703 of the CARs.

1.3 Description of changes

- (1) Immigration, Refugees and Citizenship Canada (IRCC) have updated the Canadian Passport (amongst other documents) to now include Canadians who do not identify solely as male or female. The changes included in this AC will provide guidance to Canadian air operators, operating under Subpart 703 of the CARs on methods to include these changes within their weight and balance control programs.
- (2) The Segmented Weights depicted in Appendix A of this document have been updated to reflect the changes to the 2009 Canadian Community Health Survey.

2.0 References and requirements

2.1 Reference documents

- (1) It is intended that the following reference materials be used in conjunction with this document:
- (a) Part VII, Subpart 703 of the Canadian Aviation Regulations (CARs) — Air Taxi Operations;
 - (b) Transport Canada Aeronautical Information Manual (TC AIM) – Rules of the Air and Traffic Services (RAC) – 3.5 Weight and Balance Control;
 - (c) Transportation Safety Board (TSB) Recommendation Report Number A04-02 dated 2004-10-06; and
 - (d) Federal Aviation Administration (FAA) Advisory Circular (AC) 120-27E – Aircraft Weight and Balance Control.

2.2 Cancelled documents

- (1) Not applicable.
- (2) By default, it is understood that the publication of a new issue of a document automatically renders any earlier issues of the same document null and void.

2.3 Definitions and abbreviations

- (1) The following **definitions** are used in this document:

(a) **Actual Weight:** When reference to passenger weight, means the weight derived by actually weighing of each passenger just prior to boarding the flight, in the case of infants they shall be weighed along with their accompanying adult. This weight the allowances for personal clothing and carry-on baggage are required to be added and the resultant value shall be used as the passenger's weight. Where weighing scales are not available or serviceable, or a passenger refuses to be weighed the following may be used in lieu of actual weight:

- (i) **Volunteered Weight:** means weight obtained by asking the passenger for their weight, adding 4.5 kg (10lb) to the disclosed weight then adding the allowances for personal clothing and carry-on baggage and using the resultant value as the passenger's weight; or
- (ii) **Estimated Weight:** means where actual weight is not available and volunteered weight is either not provided or is deemed to be understated; the operator may make a reasonable estimate of the passenger's weight, then add the allowances of personal clothing and carry-on baggage and use the resultant value as the passenger's weight.

Note: Personnel boarding passengers on the basis of volunteered or estimated weights should be able to, with a reasonable degree of accuracy, assess the validity of the passenger's volunteered weight, or estimate them, and shall include allowances for personal clothing and carry-on baggage. Where necessary, the volunteered weight should be appropriately increased so as to avoid gross inaccuracies.

- (b) **Air Operator Segmented Weights:** means approved segmented weights derived by the air operator from statistically meaningful data using a methodology that is acceptable to the Minister. These weights may be used in lieu of the TCCA published segmented weights and are applicable only to that air operator and may only be used in circumstances consistent with those under which the survey was conducted.
- (c) **Carry-on Baggage:** means the baggage that a passenger may carry onboard. Based on the particular aircraft stowage limitations, the operator may limit the number, size, shape and weight of the carry-on baggage to enable it to be stowed under a passenger seat or in an approved stowage compartment. Should air operators not limit the weight of carry-on baggage, the standard allowance is 5.9kg (13lb) of carry-on-baggage per passenger, and remains constant throughout the year. Carry-on baggage weight shall be included in the weight of the passenger for the purpose of the weight and balance calculation.
- (d) **Empty Weight:** in respect of an aircraft, means the total weight of the following parts or contents that are part of, carried on board, the aircraft, namely;
 - (i) The airframe;
 - (ii) The power plant;
 - (iii) The fixed ballast;

- (iv) The unusable fuel;
 - (v) The maximum amount of normal operating fluids, including oil, power plant coolant, hydraulic fluid, de-icing fluid and anti-icing fluid but not including potable water, lavatory pre-charge fluid or fluid intended for injection into the engines; and
 - (vi) All of the installed equipment.
- (e) **Female/Male/Gender X Mixed Ratio:** the ratio of female, male and gender X passengers that are actually carried on board a flight, is expressed as a percentage ratio and is independent of the aircraft certificated seating capacity or configuration.
- (f) **Personal Clothing or Clothing Allowance:** A standard weight allowance for personal clothing that a passenger may carry on board the aircraft. It is 3.6 kg (8 lbs) for summer and 6.4 kg (14 lbs) for winter, that must be added to the passenger's weight for the purpose of a weight and balance calculation

3.0 Background

- (1) Accurate calculation of weight and balance for every phase of flight and ensuring that it is within an aeroplane's permissible limits is mandatory not only for compliance with the airworthiness certificate of the aeroplane but also for conformity with the regulations. Analysis of the accidents involving aeroplanes operated under Subpart 703 of the CARs revealed that five of those accidents were attributable to the over-weight condition of the aeroplane, four of them being fatal causing 24 fatalities.
- (2) TCCA also reviewed the standards for weight and balance control programs with a view to require the use of actual weights for all operations conducted under Subpart 703 of the CARs, and consequently issued a Notice of Proposed Amendment (NPA) for the introduction of Segmented Weights for the use in lieu of Standard Weights by air operators, operating under Subpart 703 of the CARs. This proposal has been progressed in accordance with the Canadian Aviation Regulation Advisory Council (CARAC) process.
- (3) Subsection 723.37(3) of the Commercial Air Service Standards (CASS) requires air operators to complete weight and balance calculations for aeroplanes operating under Subpart 703. Air operators, operating under Subpart 703 of the CARs cannot use the standard passenger weights published in Rules of the Air and Traffic Services (RAC) 3.5 – Weight and Balance Control in Transport Canada Publication (TP 14371) Aeronautical Information Manual (TC AIM) Table 3.1 - Standard Weights or Passengers Aged 12 years and older. Instead, air operators, operating under Subpart 703 of the CARs must calculate the weight of passengers, carry-on baggage and checked baggage, where the weight of the passengers and carry-on baggage is determined either by actual weight or by using segmented weight values either as published in RAC 3.5 – Weight and Balance Control in the TC AIM Table – 3.2 Segmented Weights of Passengers Aged 12 years and older (in pounds) or derived from statistically meaningful data using a methodology acceptable to the Minister.
- (4) In 2019 IRCC began providing Canadians with a third option on all Canadian Passports (and other documents) using the symbol X in place of the male (M) or female (F) gender markers. To ensure that air operators are accounting for Canadians who identify as gender X, the Segmented Weight chart used in RAC 3.5 of the TC AIM has been updated.

3.1 Cause Analysis

- (1) Cause analysis of the above-mentioned accidents led Transportation Safety Board (TSB) to suspect that the use of TCCA published standard weights, as it existed then, might have resulted in significant errors in the weight and balance calculations. This suspicion was strengthened by the results of studies undertaken by National Transportation Safety Board (NTSB) and the Federal Aviation Administration (FAA) that established that the FAA's published standard weights, as it existed then, under-estimated the average adult weight by 9.36 kg (20.63 lbs) and the average carry-on baggage weight by 2.59 kg (5.72 lbs).
- (2) Judging by the demographic similarity between the United States of America (USA) and Canada, TSB ascertained that the TCCA published standard weights were also under-estimates of the average adult weight of the Canadian society.

3.2 Impact of Standard Weights on Weight and Balance Calculations

- (1) In May 2005, TCCA conducted a Risk Assessment to determine the impact of the TCCA published standard weights on the weight and balance calculation of the aeroplanes.
- (2) The research determined that the use of published standard weights for calculating passenger weights for aeroplanes carrying small passenger loads under-estimated the actual passenger weight significantly causing a safety issue. Comparison of various aircraft types revealed that the impact of using standard passenger weights on weight balance control depended on the aeroplane's passenger carrying capacity and the ratio of the total passenger weight to its maximum certified take-off weight (MCTOW). For example, a Boeing 747 that carries over 400 passengers, the impact of passenger weight on weight and balance control is minimal because the total passenger weight represents only 9 percent of its maximum weight. However, for a Cessna Caravan model 208, configured to carry only 9 passengers (Subpart 703 of the CARs limitation), the impact is far greater because the total passenger weight represents about 22 percent of its maximum weight.

4.0 Implementation of Segmented Weights

4.1 Concept of Segmented Weights

- (1) TCCA has determined that for aeroplanes operating under Subpart 703 of the CARs, computation of weight and balance using actual passenger weights provides the greatest accuracy and recommends this as the standard practice for these operations.
- (2) An alternative method was required that could be used when the actual weight, volunteered weight or estimated weight of passengers were not available. Also, this alternative method provides a high degree of accuracy and reliability so as to ensure that the passenger weights calculated by using this method would not result in the aircraft operating outside its weight and balance envelope. Research into this subject matter resulted in the adoption of segmented weights. This is based on a similar system conceived by the FAA, but has been modified to suit the Canadian climate conditions. Segmented weights are designed to guarantee a 95 percent confidence level that the actual total weight of passengers will not exceed the total weight of passengers obtained by using segmented weights by more than one percent. This is the benchmark of segmented weights for accuracy and reliability.

4.2 Derivation of Transport Canada Civil Aviation Segmented Weights

- (1) The current TCCA published standard passenger weights are based on a nation-wide survey conducted by Statistics Canada in 2003. Statistically derived standard deviation of 16.78 kg (37

lbs) for male and 14.60 kg (32.2 lbs) for female passengers were added to their respective average weights. These additions were needed to ensure that the total passenger weight calculated by using these modified weight values would be an accurate representation of the actual weight of the passengers. These modified average weights are called segmented weights.

4.3 Application of Segmented Weights

- (1) TCCA published segmented weights are applicable to passengers aged 12 years or older and include the allowances for carry-on baggage and personal clothing. The segmented weight values are based on the certificated passenger seating capacity of the aeroplane (excluding pilot seats), and is not related to the actual number of passenger carried on board for that flight. For example, if an aeroplanes certificated seating capacity is 9 but only 5 passengers are carried on board for a flight, the row pertaining to the seating capacity for 9 – 11 passengers should be used.
- (2) Use Segmented Weight Tables as follows:
 - (a) Select summer or winter column - as appropriate, then pick the row that represents the certificated passenger seating capacity then:
 - (b) Number of males x weight of male + number of females x weight of female + Number of gender X weight of gender X = weight of adult, passenger load (in pounds).
 - (c) For example: It is summer season; aircraft has a certificated passenger seating capacity of 9; passengers are 4 males, 3 females and 1 gender X : To find the weight of adult passengers:
 - (d) Look under the summer section of the table and along the row for 9-11 passenger seating capacity, male, female and a gender X are listed as 233 lbs, 196 lbs and 233 lbs respectively. Therefore, the total weight of adult passengers is: $4 \times 233 + 3 \times 196 + 1 \times 233 = 1753$ lbs.

4.4 Publication of Segmented Weights

- (1) The Guidance Material – Subpart 703 of the CARs and RAC 3.5 of the TC AIM, will be suitably amended to include the revised Segmented Weight Tables.

5.0 Information management

- (1) Not applicable

6.0 Document history

- (1) Advisory Circular (AC) 703-004 Issue 03, RIDMS 8671345 (E), dated 2013-09-18 – Use of Segmented Passenger Weights by Commercial Air Operators under Subpart 703 of the Canadian Aviation Regulations.
- (2) Advisory Circular (AC) 703-004 Issue 02, RDIMS 7672779 (E), 7672801 (F), dated 2012-07-04 – Use of Segmented Passenger Weights by Commercial Air Operators under Subpart 703 of the Canadian Aviation Regulations.
- (3) Advisory Circular (AC) 703-004 Issue 01, RDIMS 4845867 (E), 6881265 (F), dated 2100-11-30 – Use of Segmented Passenger Weights by Commercial Air Operators under Subpart 703 of the Canadian Aviation Regulations.

7.0 Contact Us

For more information, please contact:
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We invite suggestions for amendment to this document

Submit your comments to:
Civil Aviation Communications Centre
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Document approved by

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**Appendix A — Segmented Weights for Passengers Aged 12 Years and Older
(In Pounds)**

Maximum Certificated Passenger Seating Capacity	Winter			Summer		
	Male	Female	Gender X	Male	Female	Gender X
1-4	Use actual weights, volunteered weights or estimated weights					
5	249	210	249	243	204	243
6-8	244	206	244	238	200	238
9-11	236	199	236	230	193	230
12-16	233	196	233	227	190	227
17-25	229	193	229	223	187	223