Cancelled See 120-27

Federal Aviation Agency

ADVISORY CIRCULAR

AC NO: AC 121-5	AIR CARRIER AND COMMERCIAL OPERATIONS
EFFECTIVE:	1/8/65

SUBJECT: AIRCRAFT WEIGHT AND BALANCE CONTROL

1. PURPOSE. This Advisory Circular provides a method and procedures for weight and balance control.

2. REFERENCES. This document is appropriate for the guidance of that segment of the public which operates or plans to operate aircraft in accordance with Federal Aviation Regulations, Part 121.

3. GENERAL. The operator may submit for inclusion in the operations specifications any method and procedure by which it can be shown that the aircraft is properly loaded and will not exceed authorized weight and balance limitations during operation.

   By whatever method used, the operator should account for all probable loading conditions which may be experienced in service and show that the loading schedule will provide satisfactory loading. Loading schedules may be applied to individual aircraft or to a complete fleet. When an operator utilizes several types or models of aircraft, the loading schedule, which may be index type, tabular type or a mechanical computer, should be identified with the type or model of aircraft for which it is designed.

4. LOADING PROVISIONS. All seats, compartments, and other loading stations will be properly marked and the identification used should correspond with the instructions established for computing the weight and balance of the aircraft. When the loading schedule provides blocking off of seats or compartments in order to remain within the center of gravity limits, effective means will be provided to assure that such seats or compartments are not occupied during operations specified. Instructions should be prepared for crewmembers, cargo handlers, and other personnel concerned, giving complete information necessary regarding distribution of passengers, cargo, fuel, and other items.

Information relative to maximum capacities and other pertinent limitations affecting the weight or balance of the aircraft are to be included in these instructions. When it is possible by adverse distribution of passengers to exceed the approved CG limits of the aircraft, special instructions should be issued to the appropriate crewmembers so that the load distribution can be maintained within the approved limitation.

5. TERMS, DESCRIPTIONS, AND GENERAL STANDARDS.

a. Empty weight. The empty weight of an aircraft is the maximum gross weight less the following:

(1) All fuel and oil, except system fuel and oil. System fuel and oil is that amount 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) Crew and baggage.

(3) Drainable antidetonant injector and deicing fluids.

(4) Passengers and cargo (revenue and nonrevenue).

(5) Removable passenger service equipment, food, magazines, etc., including drainable washing and drinking water.

(6) Emergency equipment (overwater, tropical, frigid).

(7) Other equipment, variable for flights.

(8) Flight spares (spark plugs, wheel, cylinder, etc.).

b. Operating weight. The basic weight established by the operator for a particular model aircraft should include the following standard items of the operator in addition to the empty weight of the aircraft unless otherwise specified by the operator:

(1) Normal oil quantity.

(2) Antidetonant injector and deicing (winter fluids).

(3) Crew and baggage.

(4) Passenger service equipment including washing and drinking water, magazines, etc.

(5) All other items of equipment considered standard by the operator concerned.

(6) Emergency equipment, if required for all flights.

c. Aircraft, zero fuel weight. The zero fuel weight of an aircraft is the maximum weight authorized for such aircraft without fuel. The weight of fuel carried in the fuselage, or equivalent locations, will be deducted from such maximum. When zero fuel weight limitations or equivalent restrictions are specified, proper provision for loading will be made by the operator so that such structural limitations are not exceeded.

6. AIRCRAFT WEIGHTS. Aircraft weight and balance control systems normally contain provisions for determining aircraft weight in accordance with the following procedures:

a. Individual aircraft weight and changes. The loading schedule may utilize the individual weight of the aircraft in computing pertinent gross weight and balance. The individual weight and balance of each aircraft should be reestablished at the specified reweighing periods. It normally is reestablished whenever the accumulated changes to the operating weight exceeds plus or minus one-half of 1 percent of the maximum landing weight or the cumulative change in CG position exceeds one-half of 1 percent of the MAC.

b. Fleet weights, establishment and changes. For a fleet or group of aircraft of the same model and configuration, an average operating fleet weight may be utilized if the operating weights and CG position are within the limits established herein. The fleet weight will be calculated on the following basis:

(1) An operator's empty fleet weight is usually determined by weighing aircraft according to the following table: for fleet of 1 to 3, weigh all aircraft; for fleet of 4 to 9, weigh 3 aircraft plus at least 50 percent of the number over 3; for fleet of over 9, weigh 6 aircraft plus at least 10 percent of the number over 9.

(2) In choosing the aircraft to be weighed, the aircraft in the fleet having the highest time since last weighing should be selected. When the average empty weight and CG position has been determined for aircraft weighed and the basic operating fleet weight (winter and summer, if applicable) established, necessary data should be computed for aircraft not weighed but which are considered eligible under such fleet weight.

If the basic operating weight of any aircraft weight or the calculated basic operating weight of any of the remaining aircraft in the fleet varies by an amount more than plus or minus one-half of 1 percent of the maximum landing weight from the established basic operating fleet weight or the CG position varies more than plus or minus one-half of 1 percent of the MAC from the fleet weight CG, that aircraft should be omitted from that group and operated on its actual or calculated operating weight and CG position. If it falls within the limits of another fleet or group, it may then become part of that operating fleet weight. In cases where the aircraft is within the operating fleet weight tolerance, but the CG position varies in excess of the tolerance allowed, the aircraft may still be utilized under the applicable operating fleet weight but with an individual CG position.

(3) Reestablishment of the operator's empty fleet weight or the operating fleet weight and corresponding CG positions may be accomplished between weighing periods by calculation based on the current empty weight of the aircraft previously weighed for fleet weight purposes. Weighing for reestablishment of all fleet weights is normally conducted on a 2-year basis unless shorter periods are desired by the operator.

c. Establishing initial weight before use in air carrier service. Prior to being placed into service, each aircraft should be weighed and the empty weight and center of gravity location established. New production transport category aircraft delivered to operators normally are weighed at the factory and are eligible to be placed into operations without reweighing if the weight and balance records have been adjusted for alterations or modifications to the aircraft. Aircraft transferred from one operator to another need not be weighed prior to utilization by the latter unless more than 24 calendar months have elapsed since last weighing.

d. Periodic weighing - aircraft using individual weights. Aircraft operated under a loading schedule utilizing individual aircraft weights in computing the gross weight are normally weighed at intervals of 24 calendar months. An operator may, however, extend this weighing period for a particular model aircraft, when pertinent records and actual routine weighing during the preceeding 24 months of operation show that weight and balance records maintained are sufficiently accurate to indicate aircraft weights and CG positions are within the established limitations. Such applications should be limited to increases in increments of 12 months and should be substantiated in each instance with at least two aircraft weighings. Increases should not be granted which would permit any aircraft to exceed 48 calendar months since last weighing.

e. Periodic weighing, aircraft using "fleet weights." Aircraft operating under fleet weights should be weighed in accordance with procedures outlined for the establishment of fleet weights. Since each fleet weight is normally reestablished every 2 years and a specified number of aircraft weighed at such periods, no additional weighing is considered necessary. A rotation program should, however, be incorporated so all aircraft in the fleet will be weighed periodically.

f. Weighing procedure. Normal precautions, consistent with good practices in the weighing procedures, such as checking for completeness of the aircraft and equipment, determining that fluids are properly accounted for, and that weighing is accomplished in an enclosed building preventing the effect of the wind, should prevail. Any acceptable scales may be used for weighing provided they are properly calibrated, zeroed and used in accordance with the manufacturer's instructions. Each scale should have been calibrated, either by the manufacturer or by a civil Department of Weights and Measures, within 1 year prior to weighing any aircraft for this purpose unless the operator has evidence which warrants a longer period between calibrations.

7. PASSENGER WEIGHTS. The operator may elect to use the average passenger weight to compute passenger loads over any route, except in those cases where nonstandard weight passenger groups are carried. Both methods may be used interchangeably provided only one method is used for any flight from beginning to terminating point of the particular trip or flight involved, except as indicated in subparagraph (b). Provisions should be incorporated in the load manifest to clearly indicate to personnel concerned whether actual or average passenger weights are to be used in computing the passenger load:

a. Average passenger weight. An average weight of 160 pounds (summer) may be used for adult passengers during the calendar period of May 1 through October 31.

An average weight of 165 pounds (winter) may be used for each adult passenger during the callendar period from November 1 through April 30.

An average weight of 80 pounds may be used for children between the ages of 2 and 12. Children above 12 years of age are classified as adults for the purpose of weight and balance computations. Children less than 2 years old are considered "babes in arms."

The above passenger weight includes minor items normally carried by a passenger.

b. Nonstandard weight group of passengers. The average passenger weight method will not be used in the case of flights carrying large groups of passengers whose average weight obviously does not conform with the normal standard weight. Actual weights will be used when a passenger load consists to a large extent of athletic squads or other groups which are smaller or larger than the U.S. average. Where such a group forms only a part of the total passenger load, the actual weights may be used for such groups and average weights used for the balance of the passenger load. In such instances, a notation should be made on the load manifest, indicating number of persons in the special group and identifying the group i.e., football squad, Blank Nationals, etc.

Actual passenger weight may be determined by scale weighing of each passenger prior to boarding the aircraft, and such weight is to include minor articles carried on board by the passenger. If such articles are not weighed, the estimated weight is to be accounted for. The actual passenger weight may also be determined by asking each passenger his weight and adding thereto a predetermined constant to provide for handcarried articles and also to cover possible seasonal effect upon passenger weight due to variance in clothing weight. This constant may be approved for an operator on the basis of a detailed study conducted by the operator over the particular routes involved and during the extreme seasons when applicable.

8. CREW WEIGHT. For crewmembers, the following approved average weights may be utilized:

a. Male cabin attendants 150 pounds; female cabin attendants 130 pounds.

b. All other crewmembers 170 pounds.

9. PASSENGER AND CREW BAGGAGE. Procedures should be provided so that all baggage, including that carried on board by the passengers, is properly accounted for. If desired by the operator, a standard crew baggage weight may be used. The following average passenger baggage weights may be used in lieu of actual weights:

a. For domestic operations.

(1) For each piece of checked baggage, an average of not less than 23.5 pounds; and

(2) For each passenger boarding the aircraft, an average of not less than 5 pounds shall be added for hand baggage whether or not such baggage is carried by the passenger.

b. For Trans-Atlantic flights between U.S. and Europe or Trans-Pacific flights via Manila, Tokyo, Hong Kong or Australia.

(1) For each piece of checked baggage, an average of not less than 26.5 pounds; and

(2) For each passenger boarding the aircraft not less than 5 pounds shall be added for hand baggage whether or not such baggage is carried by the passenger.

c. For Trans-Pacific flights originating and terminating at U.S., Honolulu, or Alaska.

(1) For each piece of checked baggage, an average of not less than 23.5 pounds; and

(2) For each passenger boarding the aircraft not less than 5 pounds shall be added for hand baggage whether or not such baggage is carried by the passenger.

Average passenger baggage weights shall not be used in computing the weight and balance of charter flights and other special services involving the carriage of special groups.

10. CENTER OF GRAVITY TRAVEL DURING FLIGHT. The operator will show that the procedures fully account for the extreme variations in center of gravity travel during flight caused by all or any combination of the following variables:

a. The movement of a number of passengers and cabin attendants equal to the placarded capacity of the lounges and lavatories from their normal position in the aircraft cabin to such lounge or lavatory. If the capacity of such compartment is one, the movement of either one passenger or one cabin attendant, whichever most adversely affects the CG condition will be considered. When the capacity of the lavatory or lounge is two or more, the movement of that number of passengers or cabin attendants from positions evenly distributed throughout the aircraft may be used. Where seats are blocked off, the movement of passengers and/or cabin attendants evenly distributed throughout, only the actual loaded section of the aircraft will be used. The extreme movements of the cabin attendants carrying out their assigned duties within the cabin will be considered. The various conditions will be combined in such a manner that the most adverse effect on the CG will be obtained and so accounted for in the development of the loading schedule to assure the aircraft being loaded within the approved limits at all times during flight.

b. Landing gear retraction. Possible change in CG position due to landing gear retraction will be investigated and results accounted for.

c. Fuel. The effect of the CG travel of the aircraft during flight due to fuel used down to the required reserve fuel or to an acceptable minimum reserve fuel established by the operator will be accounted for.

11. RECORDS. The weight and balance system should include methods by which the operator will maintain a complete, current, and continuous record of the weight and center of gravity of each aircraft. Such records should reflect all alterations and changes affecting either the weight or balance of the aircraft, and will include a complete and current equipment list. When fleet weights are used, pertinent computations should also be available in individual aircraft files.

12. WEIGHT OF FLUIDS. The weight of all fluids used in aircraft may be established on the basis of actual weight, a standard volume conversion, or a volume conversion utilizing appropriate temperature correction factors to accurately determine the weight by computation of the quantity of fluid on board.

13. CONTENT OF OPERATIONS SPECIFICATIONS PROCEDURES FOR AIRCRAFT WEIGHT AND BALANCE CONTROL. The Operations Specifications, as submitted by an air carrier, will contain the procedures used to maintain control of weight and balance of all aircraft operated under the terms of the operating certificate which assures that the aircraft, under all operating conditions, is loaded within the gross weight and center of gravity limitations. This description should include a reference to the procedures used for determining weight of passengers/crew, weight of baggage, periodic aircraft weighing, type of loading devices, and identification of the aircraft concerned.

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