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AC NO: 135-1B

DATE: 1/19/76



ADVISORY CIRCULAR

DEPARTMENT OF TRANSPORTATION FEDERAL AVIATION ADMINISTRATION

SUBJECT: AIR TAXI AIRCRAFT WEIGHT AND BALANCE CONTROL

1. **PURPOSE.** This advisory circular provides an updating of methods and procedures for developing an approved weight and balance control system for small aircraft operating in the air taxi fleet under Federal Aviation Regulation (FAR) Part 135.
 2. **CANCELLATION.** Advisory Circular No. 135-1A, dated September 26, 1969, is cancelled.
 3. **BACKGROUND.**
 - a. Refer to FAR Section 91.31, Civil aircraft operating limitations and marking requirements.
 - b. Under FAR Section 135.13, Application and issue of certificate and operations specifications, air taxi operators may be authorized to use an approved weight and balance control system based on average, assumed, or estimated passenger and baggage weights, to comply with applicable airworthiness requirements and aircraft operating limitations.
 - c. Amendment 135-12, issued on November 26, 1969, added a new FAR Section 135.167. Paragraph (a) of that Section prohibits the operations of a multiengine aircraft in Part 135 operations unless the current empty weight and center of gravity are calculated from values established by actual weighing of the aircraft within the preceding three years. The provision does not apply to either aircraft originally certificated for airworthiness within the preceding three years or aircraft under a weight and balance system approved in the operating specifications of the certificate holders.
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4. GENERAL. The operator may submit, for inclusion in the operations specifications, any method and procedure by which it can be shown that his aircraft will be properly loaded and will not exceed authorized weight and balance limitations during operation. The approval of such a weight and balance control system is based on an evaluation of the program presented for a particular aircraft, and of a particular operator's ability to implement that program. By whatever method used, account for all probable loading conditions which may be experienced in service, and show that the loading schedule developed will insure satisfactory aircraft loading, within the approved limits, throughout each flight.
5. CONTENTS. Weight and balance control systems encompass the following:
 - a. Methods for establishing, monitoring and adjusting empty weight and empty weight center of gravity, in conjunction with the initial and periodic reweighing of each aircraft.
 - b. A loading schedule composed of charts, wherein the various balance conditions of an aircraft have been computed, based on current data in the individual aircraft weight and balance report, for use in loading that particular aircraft in a rapid and satisfactory manner.
 - c. Procedures for using the loading schedule, to establish loaded condition of the aircraft for which the schedule was designed, thereby assuring that the aircraft is within safe operating limits.
 - d. A load manifest to document the findings of personnel responsible for weight and balance control, together with procedures for its preparation.
 - e. Procedures for crewmembers, cargo handlers, and other personnel concerned with aircraft loading, giving complete details regarding distribution of passengers and fuel, the distribution and security of cargo, and restrictions to passenger movement during flight.
6. ESTABLISHING INITIAL AIRCRAFT STATUS. Include provisions in the aircraft weight and balance control system for determining the aircraft empty weight and empty weight center of gravity location as follows:
 - a. Establishing empty weight before use in air taxi service. New production multiengine aircraft may be placed into service without reweighing, including those having a "computed" weight and balance report, if those reports have been adjusted for alterations or modifications to the aircraft. Used multiengine aircraft transferred from one operator to another need not be reweighed prior to utilization by the latter, unless 36-calendar months have elapsed since last weighing.

- b. Individual aircraft weight and balance changes. Utilize the individual empty weight of each aircraft in the loading schedules when computing gross weight and balance of each aircraft at specified reweighing periods. A new weight and balance should be reestablished whenever the accumulated weight change exceeds plus or minus one-half of one percent of the aircraft empty weight or the cumulative change in CG location exceeds one-half of one percent of the mean aerodynamic chord.
- c. Periodic reweighing. Aircraft operated under an approved weight and balance control system are normally reweighed in accordance with the provisions of the approved system as indicated in the operator's operations specifications.
- d. Weighing procedure. Use normal precautions, consistent with good practices in the weighing procedures, such as checking for the completeness of the aircraft and equipment, determining that fluids are properly accounted for, and that weighing is accomplished in an enclosed building to eliminate the possible effects of the slightest wind. Any acceptable scales may be used for weighing provided they are properly calibrated and used in accordance with the manufacturer's instructions. Use scales that have been calibrated by the manufacturer or other certifying agency within one year prior to weighing any aircraft, unless evidence is presented which indicates a longer period between calibrations is warranted.
- e. Fleet weights, establishment, and changes. For a fleet or group of aircraft of the same model and configuration, an average fleet empty weight may be utilized if the empty weights and CG positions are within the limits established herein. The fleet empty weight will be calculated on the following basis:
- (1) An operator's fleet empty weight is usually determined by weighing aircraft according to the following data: For a fleet of one to three, weigh all aircraft; for a fleet of four to nine, weigh three aircraft plus at least 50 percent of the number over three; for a fleet of nine or over, weigh six aircraft plus at least ten percent of the number over nine.
 - (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 have been determined for aircraft weighed and the basic fleet empty 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.

- (3) If the empty weight of any aircraft weighed, or the calculated empty weight of any of the remaining aircraft in the fleet, varies by an amount more than plus or minus one-half of one percent from the average fleet empty weight, or the CG position varies more than plus or minus one-half of one percent from the average fleet CG position, that aircraft should be omitted from that group and be operated using its actual or calculated empty weight and CG position. If it falls within the limits of another fleet or group, it may then become part of that group. In cases where the aircraft is within the fleet empty weight tolerance, but the CG position varies in excess of the tolerance allowed, the aircraft may still be operated under the applicable fleet empty weight, but with an individual CG position.
- (4) When an aircraft within a fleet or group has been altered (weight or CG changes), that aircraft's fleet empty weight or corresponding CG position may be reestablished by calculation based on the current average empty weight of aircraft weighed for fleet weight purposes.
- (5) Weighing for reestablishment of all fleet weights is normally conducted on a 36-calendar month basis, unless otherwise approved in the operator's operations specifications.

7. LOADING SCHEDULE. Design loading schedules are to be simple and orderly, based on sound principles, thus reducing the element of human error. A copy of the loading schedule is kept with the aircraft and, in some cases, forms a part of the airplane flight manual. It includes instructions on the proper load distribution, such as filling of fuel and oil tanks, passenger seating restrictions to passenger movement, distribution of cargo, etc. It must provide for a reduction of passengers, fuel and/or baggage, etc., as appropriate to remain within the aircraft weight and balance limitations.

- a. Other means of determining safe loading conditions, such as the use of graphic index, load adjuster, etc., are acceptable.
- b. Provide for computing a separate loading condition when the aircraft is to be loaded in other than as specified in the loading schedule.

8. COMPUTING AIRCRAFT LOAD.

- a. Passenger Weight. The operator may elect to use average passenger weight to compute passenger loads over any route, except in those cases where nonstandard weight passenger groups are carried. Either method 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. Incorporate provisions which clearly indicate to personnel the circumstances under which actual or average

passenger weights are to be used in computing the passenger load.

(1) Average passenger weight.

- (a) An average weight of 160 pounds (summer) may be used for adult passengers during the calendar period from May 1 through October 31.
- (b) An average weight of 165 pounds (winter) may be used for each adult passenger during the calendar period from November 1 through April 30.
- (c) An average 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 of age are considered "babes in arms."
- (d) The above passenger weight includes minor items normally carried by a passenger.

(2) Actual passenger weight. Do not use the average passenger weight method in the case of flights carrying passengers whose average weight obviously does not conform with the normal standard weight. Use actual weights when a passenger load consists partly of athletic squads or other groups which are smaller or larger than the U.S. average.

(3) Actual passenger weight may be determined by scale weighing of each passenger prior to boarding the aircraft, with such weight including minor articles carried on board by the passenger. If such articles are not weighed, account for the estimated weight. The actual passenger weight may also be determined by asking each passenger his weight and adding thereto a predetermined constant to provide for hand-carried 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 by the operator over the particular routes involved and during the extreme seasons when applicable.

b. Crew Weight. For crewmembers, the following average weights may be utilized:

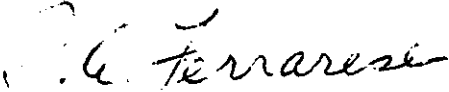
- (1) Male cabin attendants 150 pounds, female cabin attendants 130 pounds.
- (2) All other crewmembers, 170 pounds.

- c. Passenger and Crew Baggage. Provide procedures which properly account for all baggage, including that carried on board by the passengers. 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:
- (1) For each piece of checked baggage, an average of not less than 23.5 pounds; and
 - (2) For each passenger boarding the aircraft, add an average of not less than 5 pounds for hand baggage whether or not such baggage is carried by the passenger.
 - (3) Do not use average passenger baggage weights in computing the weight and balance of charter flights and other flights involving the carriage of special groups.
9. LOAD MANIFEST. Develop a form, to be prepared by personnel responsible for supervising the loading of aircraft, together with procedures for its completion. Include the following items on the load manifest:
- a. The weight of the aircraft, fuel, oil, cargo, passengers, mail, and baggage.
 - b. The maximum allowable takeoff weight for that flight.
 - c. The total weight as computed under the approved procedures.
 - d. Evidence that the aircraft is loaded according to an approved schedule, which insures that the center of gravity is within limits, and will remain so throughout the proposed flight.
10. SYSTEM DEVELOPMENT. Consider the following details when developing weight and balance control procedures:
- a. Insure that the terms and descriptions used are readily understandable to prevent possible confusion and error. Chapter 13 of Advisory Circular No. 43.13-1A provides a listing of recognized terminology.
 - b. Mark all seats, compartments, and other loading stations using identification corresponding to the procedures established for computing the weight and balance of each aircraft.
 - c. When the loading schedules require blocking-off seats or compartments in order to remain within center of gravity limits, provide effective means to assure that such seats or compartments are not occupied during operations specified.

- d. Include information relative to maximum capacities, and other pertinent limitations, affecting the weight or balance of the aircraft in these instructions.
- e. Prepare and issue special instructions to appropriate flight and ground personnel when it is possible to exceed approved aircraft CG limits by adverse distribution or displacement of passengers, baggage, or cargo.
- f. Center of gravity during flight. Fully account for extreme variations in center of gravity travel during flight caused by all or any combination of the following variables:
- (1) The movement of passengers and cabin attendants from their normal position in the aircraft cabin to such locations as a 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. Combine the various conditions in such a manner that the most adverse effect on the CG will be obtained and accounted for in the development of the loading schedule, to assure that the aircraft is loaded with the approved limits at all times during flight.
 - (2) Landing gear retraction. Investigate and account for a possible change in CG position due to landing gear retraction.
 - (3) Fuel. Account for the effect of CG travel during aircraft flight due to fuel consumed down to the required reserve quantity or to an acceptable minimum reserve quantity established for a particular route.
- g. Weight of fluids. Describe the procedure to be used for determining the quantity of fluids on board each aircraft operated. The total weights of all fluids may be established by calculation, using standard unit weights, such as:
- | | |
|-----------------------|----------------------------|
| Gasoline | 6 pounds per U.S. gallon |
| Turbine fuel | 6.7 pounds per U.S. gallon |
| Lubricating oil | 7.5 pounds per U.S. gallon |
11. RECORDS. Describe methods by which personnel will maintain a complete, current, and continuous record of the weight and center of gravity of each aircraft. Include the procedure for recording alterations and changes affecting either weight or balance of the aircraft, together with a procedure for maintaining a complete and current equipment list.

1/19/76

12. OPERATIONS SPECIFICATIONS. An approved weight and balance control system should be specified in the Operations Specifications shown on the examples of FAA Form 1014 (Operations Specifications) in Appendix 1, Pages 1, 2, and 3.



J. A. FERRARESE, Acting Director
Flight Standards Service

APPENDIX 1. FAA FORM 1014, OPERATIONS SPECIFICATIONS

UNITED STATES OF AMERICA
FEDERAL AVIATION AGENCY
WASHINGTONForm Approved
Budget Bureau No. 04-1073.

EXAMPLE

PART E

OPERATIONS SPECIFICATIONS

EXAMPLE OPERATIONS SPECIFICATIONS
AIRCRAFT WEIGHT AND BALANCE CONTROL

The following procedures have been established to maintain control of weight and balance of ABC Air Taxi Aircraft operated under the terms of these specifications (identified below) and to insure that these aircraft are loaded within the gross weight and center of gravity limitations.

Determination of Weight of Passengers and Crew. Procedures by which either actual or approved average passenger and crew weights may be used are provided in the operator's company manual. Section ____, Page ____.

Determination of Weight of Baggage.

(a) When computing the weight and balance of the aircraft, the average passenger baggage weights used are in accordance with the weight and balance section of ABC Air Taxi's company manual. Section ____, Page ____.

(b) The average passenger baggage weights authorized in paragraph (a) shall not be used in computing weight and balance involving carriage of non-standard groups.

Periodic Aircraft Weighing. All aircraft will be weighed in accordance with the procedures for establishing individual or fleet aircraft weights as outlined in weight and balance section of ABC Air Taxi company manual. Section ____, Page ____.

Loading Schedules and Identification of Aircraft. The following loading schedules are used for routine operation:

<u>Aircraft Type</u>		<u>Type Loading Schedule</u>
1.	Beech 99 Passenger and Cargo	Tabular
2.	Beech 18 Cargo	Index

Loading Instructions. Loading instructions relative to the above listed loading schedules are set forth in ABC Air Taxi weight and balance section of the company manual. Section ____, Page ____.

Effective date _____

UNITED STATES OF AMERICA
FEDERAL AVIATION AGENCY
WASHINGTON

Form Approved
Digest Bureau No. 01-1403

Example

Part E

OPERATIONS SPECIFICATIONS

AIRCRAFT WEIGHT AND BALANCE CONTROL

The operator is authorized to use average passenger weights to compute passenger loads over any route, except in those cases where nonstandard weight passenger groups are carried.

Either method 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.

1. Average Passenger Weight.

- a. An average weight of 160 pounds (summer) may be used for adult passengers during the calendar period of May 1 through October 31.
- b. An average weight of 165 pounds (winter) may be used for each adult passenger during the calendar period from November 1 through April 30.
- c. An average 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."
- d. The above passenger weight includes minor items normally carried by a passenger, such as handbags and attache cases.
- e. Use of average passenger weight is not authorized in the case of flights carrying passengers whose average weight obviously does not conform with the normal standard weight.

2. Actual Passenger Weight. Actual weight will be used when a passenger load consists partly or entirely of athletic squads or other groups which are larger or smaller than the average passenger weight as set forth in 1 above, or when the passengers' average weight obviously does not conform with the average passenger weight.

Actual passenger weight may be determined by scale weighing of each passenger prior to boarding the aircraft, with such weight including minor articles carried on board by the passenger. If such articles are not weighed, account for the estimated weight. 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.

3. Crew Weight. For crewmembers, the following average weights may be utilized:
- a. Male cabin attendants 150 pounds; female cabin attendants 130 pounds.
 - b. All other crewmembers 170 pounds.

Effective date _____

UNITED STATES OF AMERICA
FEDERAL AVIATION AGENCY
WASHINGTONForm Approved
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Example

Part E

OPERATIONS SPECIFICATIONS

AIRCRAFT WEIGHT AND BALANCE CONTROL

4. Passenger and Crew Baggage. The following average passenger baggage weights may be used in lieu of actual weights:
- a. For each piece of check baggage, an average of not less than 23.5 pounds; and
 - b. For each passenger boarding the aircraft, an average of not less than 5 pounds for hand baggage whether or not such baggage is carried by the passenger.
 - c. Do not use average passenger baggage weights in computing the weight and balance of charter flights and other flights involving the carriage of special groups.

LOAD MANIFEST.

A load manifest must be prepared by the flight crew prior to departure from the loading ramp and it shall include at least the following items:

- (1) The weight of the aircraft, fuel, oil, cargo, passengers, mail and baggage.
- (2) The maximum allowable weight for that flight.
- (3) The total weight as computed under the approved procedures.
- (4) Evidence that the aircraft is loaded according to an approved schedule which ensures that the center of gravity is within limits and will remain so throughout the proposed flight.

IN ANY EVENT, REGARDLESS OF WHICH METHOD IS USED, THE AIRCRAFT MUST NOT EXCEED ALLOWABLE WEIGHT AND CENTER OF GRAVITY LIMITS.

Effective date _____

DEPARTMENT OF TRANSPORTATION
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