International Standard 6702

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Aircraft — Requirements for on board weight and balance control systems

Aéronefs — Caractéristiques des systèmes de contrôle de la masse et du centrage à bord

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Foreword

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Aircraft — Requirements for on board weight and balance control systems

1 Scope and field of application

This International Standard establishes requirements for the function, characteristics and installation of an On Board Weight and Balance Control System for use on civil transport aircraft. This International Standard is not intended to specify design methods, mechanisms or material to fulfil the requirements specified.

The basic On Board Weight and Balance Control System (OBWBCS) shall provide a direct, accurate measurement and display of the actual aircraft weight and centre of gravity under ground static conditions. Optional functions, such as those given in clause 5, may be included. The system shall function independently of any system external to the aircraft, with the exception of ground electrical power when aircraft power is not available.

2 References

Specification 404A, *Air Transport Equipment Cases and Racking*, Aeronautical Radio Inc. (U.S.), 1974.[1]

ISO 7137, *Aircraft — Environmental conditions and test procedures for airborne equipment.*

3 Weight and balance control

The purpose of the OBWBCS shall be to serve as a primary means of weight and balance determination and to meet administrative authority regulations pertaining to weight and balance control of the aircraft at dispatch.

4 Requirements

The system shall determine actual aircraft weight and centre of gravity as follows.

4.1 Range of operation

4.1.1 Weights

The system shall determine and display the aircraft weight throughout a range from 10 % less than the aircraft empty weight to 10 % greater than the maximum taxi gross weight.

4.1.2 Centre of gravity

The system shall determine and display the aircraft centre of gravity throughout a system range determined as follows :

Determine the aircraft maximum centre of gravity range, expressed as a percentage of a reference chord, such as Mean Aerodynamic Chord (MAC) or equivalent, by subtracting the most forward limit from the most aft limit. Extend the most forward aircraft limit forward by an amount equal to 50 % of the aircraft range, but not exceeding the forward point equivalent to zero MAC. Extend the most aft aircraft limit aft by an amount equal to 50 % of the aircraft range, or to the static aft tipping point, whichever is further aft.

4.1.2.1 Lateral centre of gravity

Where required for a specific aircraft usage, the system shall be capable of determining the lateral centre of gravity of the aircraft throughout a symmetrical envelope 10 % greater than the aircraft certified lateral centre of gravity limits.

4.2 Mode of operation

The system shall determine the aircraft weight and centre of gravity in the ground static mode and shall compensate for the following factors.

4.2.1 Automatic compensation

4.2.1.1 Any combination of ramp slopes up to 3 %, aircraft pitch and/or roll attitude changes up to 3° in excess of the established range of aircraft ground attitude excursion.

4.2.1.2 Aircraft brakes locked or released.

4.2.1.3 Landing gear steering set for zero to minimum turning radius.

4.2.1.4 Aircraft brakes at ambient or at maximum temperature permitted for dispatch.

1) Or similar, until such time as an International Standard is made available.

4.2.1.5 Plus or minus 50 % variations of normal landing gear oleostrut pressure for any permissible degree of strut extension.

4.2.2 Compensation by correction chart or other means

4.2.2.1 74 km/h (40 kt) wind through an azimuth of 360°.

4.2.2.2 Any combination of operating engines from zero to ground idle thrust, over the aircraft approved range of airport elevation.

4.3 Accuracy

The system shall be capable of determining and displaying aircraft weight and centre of gravity within ± 0,5 % of the actual aircraft weight and ± 0,5 % of the Mean Aerodynamic Chord. Lateral centre of gravity, if required, shall be determined and displayed within 1,0 % of the lateral centre of gravity range.

4.4 Response time

The system shall respond to a command to display the weight and centre of gravity within one minute, including warm-up time.

4.5 System components

The system shall consist of the minimum components required to perform the functions defined in this International Standard. A typical system may consist of four subsystems, plus connecting lines or cabling : the display unit, the computer unit, the calibration unit and the sensors. No external equipment, ramps, stabilizer or temporary aircraft-to-ground supports shall be required.

4.5.1 Component description

4.5.1.1 Display unit

The unit shall provide a digital readout of the aircraft weight in 50 kg increments and the aircraft centre of gravity in increments of 0,10 % of the reference chord (MAC or equivalent), in illuminated digits of 6,4 mm minimum size. The readout shall be visible in conditions ranging from full sunlight to total darkness. Display unit lighting intensity shall be controlled by normal cockpit instrument lighting controls. The display unit shall contain all controls necessary to operate and self-test the system. If controls are required for in-flight adjustment, they shall be located on the display unit. The display unit shall provide separate indication, when preset weight and centre of gravity limits are exceeded, or the system is operating in degraded mode, if that option (see 5.13) is exercised.

4.5.1.2 Computer unit

The computer unit shall perform the operations required by the system functions. The unit may have provisions for signal outputs to additional remote display units and signal outputs when preset weight and centre of gravity limits are exceeded. The computer shall provide the controls or provisions for malfunction troubleshooting.

4.5.1.3 Sensors

The sensor shall detect changes in aircraft weight and attitude and transmit them to the computer unit. Number, mounting and location of sensors shall be determined by the specific aircraft design. Devices to overcome landing gear system friction, if required, and attitude sensors shall be considered a part of the sensor subsystem.

4.5.1.4 Calibration unit

The calibration unit shall contain the controls necessary to adjust the system to read within the specified accuracy limits on a particular aircraft. These controls shall be protected from unauthorized or inadvertent use.

4.5.2 Component dimensions and interface

Component dimensions shall be a minimum, consistent with function, maintenance and reliability requirements.

The display unit shall be compatible with front-mounted installation requirements for a specific aircraft. The computer unit shall be compatible with ARINC Specification 404A electronic rack interface requirements. Sensor units shall be compatible with landing gear or structure attachment requirements for a specific aircraft and shall take into account the environmental, maintenance and reliability requirements of this International Standard.

4.5.3 Power requirements

4.5.3.1 Power supply

The system shall operate from aircraft electrical power, 115 V a.c. 400 Hz; 28 V d.c. or 5 V a.c. for lighting purposes. The system shall also operate when the aircraft is powered from a ground power source, and shall continue to operate after normal system transients or power interruptions (for example, changeover from ground power to aircraft power).

4.5.3.2 Power consumption

The system shall consume no more than 500 W peak power. The power factor shall not be less than 0,86.

4.5.4 Mass

The system mass shall be minimized, consistent with function, maintenance and reliability requirements. The design objective of the system mass, excluding connecting lines or cables, shall not exceed 22 kg.

4.6 Compatibility

There shall be no structural, electrical, functioning or servicing interference between the OBWBCS and any other aircraft system or component, whether the OBWBCS is operating, not operating or has experienced any failure mode to be expected in service. The system design shall provide protective devices

to ensure the system offers no mechanical, electrical or explosive hazard with the system operating, not operating or in any normal failure mode. The OBWBCS shall be electromagnetically compatible with other aircraft systems when operating, not operating or in any normal failure mode.

4.7 Environmental and functional requirements

The system shall meet the requirements of ISO 7137.

4.7.1 All components within the pressurized fuselage shall meet requirements for temperatures and altitude specified for class A-2 equipment in ISO 7137.

4.7.2 All other components shall meet requirements for temperature and altitude specified for class D-2 and E-2 equipment in ISO 7137.

4.7.3 All components shall meet the requirements for category B "Severe Humidity" specified in ISO 7137.

4.7.4 All components shall meet all other requirements specified in ISO 7137, except that components within the pressurized fuselage are exempt from requirements specified in clause 10, "Water Proofness", and clause 11, "Hydraulic Fluid" of ISO 7137.

4.7.5 The system shall withstand an aircraft weight range from zero weight to 100 % greater than the maximum taxi gross weight, without damage or loss of calibration.

4.7.6 The system shall withstand a centre of gravity range 100 % greater than the aircraft ground operating centre of gravity range without damage or loss of calibration.

4.7.7 Cyclic loading

The sensors shall withstand, without damage or fatigue, the stresses and deflections of the landing gear during landing, taxiing, braking and loading operations for a period equal to 15 000 landing cycles or a predicted number of cycles compatible with 10 000 flight hours, whichever is the larger. Maximum loading shall be 300 % of the aircraft maximum taxi gross weight.

4.8 Maintainability and reliability

4.8.1 Construction

Standard parts, fittings and fasteners shall be used wherever possible.

4.8.2 Component replacement

A strict minimum of special tools shall be required to remove and replace system components. System component replacement shall require a minimum displacement of other aircraft systems or components. It shall be a design objective to be able to replace any system component, adjust as required, and test the system within 1 h. Sensor and sensor mounting design shall minimize the possibility of sensor damage during removal or replacement.

4.8.3 Malfunction troubleshooting

Self-testing of the system shall be carried out by one person at the display unit. The computer shall be equipped with a test connector for malfunction troubleshooting of its own functions. The system design shall permit isolation and testing of individual sensors. The equipment shall be designed so that failure of the self-test feature cannot cause the system to malfunction.

4.8.4 Calibration

The system components shall be designed so that calibration shall not be required at intervals of less than that equivalent to 10 000 flight hours.

4.8.5 Adjustment

The system shall be designed so that controls are available on the display unit for any required minor adjustment to the system basic zero reference. Adjustment may be carried out on the ground or in flight. Adjustment procedure shall be simple and brief and shall be carried out without the use of tools.

4.8.6 Reliability

The system shall be designed to have a mean-time between failure not less than that equivalent to 10 000 flight hours.

4.8.7 Interchangeability

All components shall be designed so that they can be interchanged with any identical component for a particular aircraft type with minimum adjustment of the system and with no requirement for calibration.

5 Optional functions

The following options have been identified as potentially desirable additional functions to be individually specified and mutually agreed between manufacturer and user as required. Optional functions shall have no effect on basic system functions, characteristics or installation.

5.1 In-flight weight and balance

The system shall accept inputs such as fuel flow, fuel quantity and fuel transfer monitors and angle of attack or pitch attitude from the navigation system, and shall calculate and display in-flight weight centre of gravity based upon the last static reading.

5.2 In-flight fuel usage planning

The system shall forecast the effect, due to a proposed fuel usage or transfer schedule, on aircraft weight and balance.

5.3 Ground load planning

The system shall forecast the effect, due to a single selected load or processed loading schedule, on aircraft weight and balance.

5.4 Permanent record

The system shall keep a permanent record of instantaneous and/or continuous weight and balance readouts throughout the ground and flight modes.

5.5 Remote displays

The system shall provide remote displays of aircraft weight and balance.

5.6 Tail tip audible alarm

The system shall provide an audible alarm to indicate a potential aircraft tail tip condition. In cargo aircraft, the same alarm signal shall provide a resettable output signal to interrupt power to aircraft cargo loading systems.

5.7 Flat tyre or strut indication

The system shall provide an indication or method of sensing aricraft flat strut or low tyre pressure.

5.8 Hard landing indication

The system shall provide a resettable indication of any landing during which deceleration forces equal or exceed that specified as hard landing for a particular aircraft.

5.9 AIDS output

The system shall provide signals to an Airborn Integrated Data System (AIDS) or flight recorder. Signal values shall be in accordance with the requirements of a particular AIDS system or flight recorder.

5.10 Repetitive readings

The system shall be capable of repetitively displaying correct weight and centre of gravity at time intervals not to exceed 15 s.

5.11 Lateral centre of gravity (if not a basic requirement)

The system shall determine the lateral centre of gravity of the aircraft throughout a symmetrical envelope 10 % greater than the aircraft certified lateral centre of gravity limits, and shall display the lateral centre of gravity within 1 % of the aircraft lateral centre of gravity range.

5.12 Preset weight and balance limits, remote display

The system shall indicate when preset weight and balance limits are met, or exceeded, on remote display units.

5.13 Degrade mode

The system shall maintain degraded capability, within accuracy limits of 1 % of the actual weight or MAC, in the event of one or more sensor failure(s), by providing complementary replacement sensors within the circuitry. The system shall independently display a warning of the degraded operation.

5.14 Print or visual display

The system shall either transmit or print final weight and balance data, so that appropriate legal and/or required paperwork is completed prior to dispatch.