INTERNATIONAL

SOCIETY OF ALLIED WEIGHTS ENGINEERS, INC.

Serving the Aerospace - Shipbuilding - Land Vehicle and Allied Industries

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REQUIREMENTS FOR AIRCRAFT ON BOARD WEIGHT AND BALANCE SYSTEM

Revision Letter _____

Prepared by
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SAWE RECOMMENDED PRACTICE

Introduction

In the immediate future, the On Board Weight and Balance System (OBWBS) application will probably only function as a check of the conventional weight and balance manifest. However, the intent of this specification is to provide a primary system of weight and balance control which is supported by a manifest system. Eventually, an OBWBS may be totally automatic providing a computerized check of all the mass property limitations involved; however, that kind of OBWBS hardware is currently beyond the scope of this document. The actual application of this specification is, of course, up to the user.

Acknowledgment

This specification is in major part of revision to Aerospace Recommended Practice (ARP) 1409 published by the Society of Automotive Engineers, Inc. (SAE) in January 1978.

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1. Purpose

Provide criteria for aircraft on board weight and balance systems.

2. Description

The system will provide weight and balance information independent of any system external to the aircraft with the exception of ground electrical power.

3. Objective

The system shall be capable of serving as the primary means of providing weight and balance information required by regulations.

4. Requirements

The system shall determine actual aircraft weight and center 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 aircraft empty weight to 10% greater than maximum taxi gross weight.

4.1.2 Center of Gravity

The system shall determine the center of gravity throughout a range from a fully compressed nose gear strut to a fully extended nose gear strut.

4.1.2.1 Lateral Center of Gravity

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

4.2 Mode of Operation

The system shall determine the aircraft weight and center of gravity in the ground static mode and shall compensate for the following factors, as required, either by self contained automatic program(s) or by external means (e.g., correction charts):

4.2.1

Any combination of ramp slopes and aircraft attitude up to 3% pitch and/or roll ramp slope, and attitude changes up to 3 degrees in excess of the normal aircraft ground handling attitude.

4.2.2

Aircraft brakes locked or released.

4.2.3

Landing gear configured for straight ahead taxi or minimum turning radius and tire pressures within normal operating pressure.

4.2.4

Aircraft brakes at ambient or at maximum temperatures permitted for dispatch.

4.2.5

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

4.2.6

30KT. Wind through an azimuth of 360 degrees.

4.2.7

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

4.2.8

Surface condition normal to the particular aircraft.

4.3 Accuracy

The system shall be capable of determining aircraft weight within +/- 1.0% and center of gravity within +/- 1.0% of Mean Aerodynamic Chord (MAC). Lateral center of gravity, if required, shall be determined with +/- 1.0% of the lateral distance between outboard main landing gears. These accuracy criteria shall apply throughout the calibration period.

4.4 Response Time

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

4.5 System Components

4.5.1 Data Display

Digital readout of aircraft weight shall be provided to one hundred pounds (or kilos) and aircraft center of gravity to 0.10% of MAC in lighted digits of 0.25 inch (0.64 cm) minimum size (if required, lateral center of gravity to 0.10 inch from centerline). The readout shall be visible in conditions of full sunlight to total darkness. Display unit lighting intensity shall be controlled by normal cockpit instrument lighting controls. This display unit shall contain all controls necessary to operate and self-test the system. If controls are required for inflight adjustment, they shall be located on the display unit. The display unit shall provide indication(s) when preset weight and center of gravity limits are exceeded.

4.5.2 Additional Outputs

The unit may have provisions for signal outputs to additional units.

4.5.3 Calibration Unit

Controls necessary to adjust the system to read within the specified accuracy limits shall be provided if required. These controls shall be protected from unauthorized or inadvertent manipulation.

4.5.4 Component, Dimensions, 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 shall be compatible with ARINC characteristic 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 requirement of this specification.

4.5.5 Power Supply Requirements

The system shall operate from aircraft electrical power. The system shall also operate when the aircraft is powered from a ground power source.

4.6 Compatibility

There shall be no structural, electrical, functioning or servicing interference between the OBWBS and any other aircraft system or component, whether the OBWBS is operating, not operating or has experienced any failure mode to be expected in service. The system design shall provide protective devices to insure the system offers no mechanical, electrical, or explosive hazard with the systems operating, non-operating, or in any failure mode. The OBWBS shall be protected from any electromagnetic interference.

4.7 Failure Indications

The system shall provide an indication readily understandable to the crew that a malfunction has occurred which may invalidate all weight and balance system display data.

4.8 Environmental and Functional Requirements

The system shall meet the requirements of Radio Technical Commission for Aeronautics document No. DO-160, "Environmental Conditions and Test Procedures for Airborne Electric/Electrical Equipment and Instrument," dated 28 Feb 75, as follows:

4.8.1

All components within a pressurized fuselage shall meet DO-160, equipment Class A-2 requirements for temperature and altitude.

4.8.2

All other components shall meet DO-160 equipment Class D-2 and E-2 requirements for temperature and altitude.

4.8.3

All components shall meet the requirements for DO-160 Category B "Severe Humidity" requirements.

4.8.4

All components shall meet all other DO-160 requirements except that components within the pressurized fuselage are exempt from DO-160 Chapter 10, "Water Proofness" and DO-160 Chapter 11, "Hydraulic Fluid" requirements.

4.8.5

The system shall withstand any load within the aircraft design envelope without damage or loss of calibration.

4.8.6

The system shall withstand the center of gravity range as specified in 4.1.2 without damage or loss of calibration.

4.8.7

The sensors shall withstand, without damage or fatigue failure, the stresses, deflections and thermodynamic effects of the landing gear during takeoff, landing, taxi, braking and loading operations for a period of not less than 5000 normal aircraft takeoff/landing cycles.

4.9 Maintainability and Interchangeability

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

4.10 Reliability

The system shall be designed to have a mean-time-between-failure not less than 5,000 flight hours.

5.0 Optional Functions

Optional functions shall have no adverse effect on basic system functions, characteristics or installation.

6.0 Quality Assurance

Test plans and reports fulfilling the criteria of this paragraph shall be subject to approval as required by the procuring agency.

6.1 Environmental Tests

Tests in accordance with RTCA DO-160 shall be accomplished as required to meet the requirements in paragraph 4.8 of this specification.

6.2 Systemic Tests

Demonstration of system accuracy and repeatability shall be accomplished by comparison of installed system (systemic) displayed values to actual weight and center of gravity determined by weighing of the aircraft on certified scales external to the aircraft.

6.2.1 Test Points

Various gross weights and center of gravity shall be tested representing the normal maximum and minimum of the gross weight and center of gravity range of operation. Tests shall be performed for each mode of operation (reference 4.2 through 4.2.8), as required by the procuring agency.

6.2.2 Accuracy

Demonstrated systemic accuracy shall be as required in 4.3.

6.2.3 Stability

The above systemic accuracy demonstration shall be repeated after the recalibration period with no recalibration and no degradation of system accuracy below the weight and center of gravity criteria of 4.3.

7.0 Manuals

The manufacturer will provide manuals to ATA (Air Transport Association) requirements which describe the operation and use of the system, and give sufficient information for all calibration and adjustment which may be expected of personnel utilizing the equipment. The manufacturer shall also provide all manuals necessary for maintenance personnel to trouble shoot and correct any systemic malfunction.