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AEROSPACE RECOMMENDED PRACTICE

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REQUIREMENTS FOR AIRCRAFT ON BOARD WEIGHT AND BALANCE SYSTEM

1. PURPOSE: This Aerospace Recommended Practice (ARP) establishes requirements for the function, characteristics and installation of an Aircraft On Board Weight and Balance System for use on civil transport aircraft. This ARP is not intended to specify design methods, mechanisms or material to accomplish the requirements set forth.

2. DESCRIPTION: The Aircraft On Board Weight and Balance System (OBWBS) shall provide a direct accurate measurement and display of the actual aircraft weight and center of gravity location under ground, preferably static, conditions. Optional functions, such as noted herein, may be included. The system shall function independent of any system external to the aircraft with the exception of ground electrical power when ship's power is not available.

   This Aerospace Recommended Practice (ARP) establishes requirements for three classes of Aircraft On Board Weight and Balance Systems:

   - Class I system shall be high accuracy/performance, very high level of confidence, systems capable of measuring and displaying both aircraft weight and aircraft balance condition.

   - Class II systems shall be high level of confidence systems that do not meet the accuracy requirements of Class I systems, while capable of measuring and displaying both aircraft weight and aircraft balance condition.

   - Class III systems shall be high level of confidence systems that do not meet the accuracy requirements of class I systems, capable of measuring and displaying only the aircraft balance condition.

   "Level of confidence", in the context of this ARP, is intended to mean the overall measurement validity resulting from the following factors:

2. DESCRIPTION (Cont'd.):

- measurement accuracy,
- statistical interval of confidence,
- probability of undetected system failure at dispatch (including the effect of any built-in redundancies/duplications).

3. WEIGHT AND BALANCE SYSTEM OBJECTIVES: The objective of Class I OBWBS shall be to provide at least as accurate weight and balance information as can be provided by established ground procedures and equipment for weight and balance control.

The objective of Class II or Class III OBWBS shall be to provide a reliable means of detecting major errors in the weight and balance condition determined by ground procedures and equipment, before aircraft take-off. Class II or Class III systems may not be used to meet the requirements of Class I systems.

The general objective for the overall level of confidence, as defined in paragraph 2 above, shall be:

- 99.7% minimum for Class I OBWBS (very high level of confidence).
- 95% minimum for Class II or Class III OBWBS (high level of confidence).

PART I: CLASS I ON BOARD WEIGHT AND BALANCE SYSTEM

4. CLASS I SYSTEM REQUIREMENTS: The system shall determine actual aircraft weight and center of gravity location as follows:

4.1 Range of Operation:

4.1.1 Weights: The system shall determine and display the aircraft weight at least throughout a range from 10% less than aircraft empty weight to 15% greater than maximum taxi gross weight. Overflow indication shall be provided if calculated weight exceeds maximum displayable value.

4.1.2 Center of Gravity: The system shall determine and display the aircraft center of gravity location throughout a system range determined as follows:

Determine aircraft maximum center of gravity range expressed in Percent of Reference Chord such as Mean Aerodynamic Chord (MAC) or equivalent by subtracting most forward limit from most aft limit. Extend most forward aircraft limit forward by an amount equal to 50% of the aircraft range or 20% MAC forward of the forward design limit, whichever is further forward. Extend most aft aircraft limit aft by an amount equal to 50% of the aircraft range, or 20% aft of the static aft tipping point, whichever is further aft.

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 a symmetric envelope 10% greater than the aircraft certified lateral center of gravity limits.

4.2 Mode of Operations: The system shall determine the aircraft weight and center of gravity location in both the ground static mode and the taxiing mode and shall automatically compensate for the following factors:

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

4.2.2 Aircraft brakes locked or released.

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

4.2.4 Continuous aircraft brakes temperature variations from 20°C above maximum temperature permitted for dispatch through cool down to ambient.

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

4.2.6 60 kt wind, or aircraft maximum ground operations limit, whichever is lower, through an azimuth of 360 deg. The system shall provide steady weight/center of gravity indications under wind gusts up to a minimum ± 10 kt differential. Manual input of average wind and azimuth is acceptable.

4.2.7 Any combination of operating engines from zero to ground taxiing/maneuvering thrust, over the aircraft's approved range of airport elevation.

4.2.8 Any effect of loading or unloading aircraft, or transfering load or fuel on board.

4.2.9 Landing gear tilt hydraulic system on or off.

4.3 Accuracy: The system shall be capable of determining and displaying actual aircraft weight and center of gravity within ±1.0% of actual aircraft weight and ±1.0% of Reference Chord (MAC or equivalent). Lateral center of gravity if required shall be determined and displayed within ±3.0% of the lateral center of gravity range.

As an objective, the above accuracy shall be guaranteed within ±3 standard deviations.

4.4 Response Time: The system shall respond to a command to continuously display weight and center of gravity location within 1 minute after initial self-test.

4.5 System Components: The system shall consist of the minimum components required to perform the functions defined by this ARP. A typical system may consist of four subsystems, eventually duplicated, 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 display a continuous digital readout of aircraft weight to nearest 100 lb or 100 kg in 4 lighted digits of 0.25 in. (6.4 mm) minimum size. It shall display a continuous digital readout of aircraft center of gravity location to nearest 0.1% of Reference Chord (MAC or equivalent) in 3 lighted digits of 0.25 in. (6.4 mm) minimum size. 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, unless individual controls are provided.

The 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 separate indication when preset weight and center of gravity location limits are exceeded, or the system is operating in degraded mode, if these options are exercised (see paragraph 5 below).

The display unit location, actuation and integration into flight deck controls shall comply with SAE ARP 268F (S-7 Committee) requirements.

4.5.1.2 Computer Unit: The computer unit shall perform the operations required by the system functions. The unit shall have provisions for signal outputs to additional remote display units and signal outputs when preset weight and center of gravity limits are exceeded. The computer shall provide at the display unit or through a centralized display system a malfunction warning indication whenever a system failure occurs or the error on either aircraft weight or center of gravity location exceeds preset limits. It shall include controls or provisions for malfunction trouble shooting. The unit shall have provisions for ARINC 429 outputs for use by external monitoring equipment such as AIDS.

It shall be possible to replace the computer unit without requiring system recalibration.

4.5.1.3 Sensors: The sensors 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 and system 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: All calibration data shall be stored in a calibration unit, which shall remain with the aircraft when other components are replaced, to prevent the need for recalibration. 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, Compatibility and Interface: The OBWBS components shall meet the dimensions, compatibility, interface and interchangeability criteria set forth in ARINC/AEEC 737 specification.

4.5.3 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, and shall continue to operate without interruption after normal system transients or power interruptions (e.g. changeover from ground power to aircraft power).

4.5.4 Weight: System weight shall be minimized consistent with function, maintenance and reliability requirements. Design objective of the system weight, less connecting lines or cables, shall not exceed 50 lb (22.7 kg).

4.6 Environmental and Functional Requirements: The system shall meet the requirements of Radio Technical Commission for Aeronautics (RTCA) Document N° DO-160A, "Environmental Conditions and Test Procedures for Airborne Electronic/Electrical and Instruments", dated 25 Jan. 1980 as follows:

4.6.1 All components within the pressurized fuselage shall meet DO-160A equipment class A-2 requirements for temperature and altitude.

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

4.6.3 All components shall meet the requirements for DO-160A category B "Severe Humidity" requirements.

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

4.6.5 The system shall withstand an aircraft weight range from zero weight to 150% greater than maximum taxi gross weight, without damage or loss of calibration. The sensors shall be capable of withstanding without damage the stresses resulting from the maximum hard landing specified for a particular aircraft type.

4.6.6 The system shall withstand center of gravity range 100% greater than aircraft ground operating cg range without damage or loss of calibration.

4.6.7 Cyclic Loading: The sensors shall withstand, without damage or fatigue, the stresses and deflections of the landing gear during take-off, landing, taxi, 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. The sensors shall be capable of withstanding at least 150% of aircraft maximum taxi gross weight.

4.7 Maintainability and Reliability:

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

4.7.2 Component Replacement: No special tools shall be required to remove and replace system components, except that special tools may be required for sensor mount installation. 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 one hour. Sensor and sensor mounting design shall minimize the possibility of sensor damage during removal or replacement.

4.7.3 Malfunction Troubleshooting: Self-test of the system shall be accomplished by one person at the display unit. The computer shall be equipped with a test connector or controls for malfunction troubleshooting of its 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.

4.7.4 Calibration: The system's components shall be designed so that calibration shall not be required at intervals of less than that equivalent to 10,000 aircraft flight hours.

4.7.5 Adjustment: The system shall be designed so that zero adjustments are automatically performed on each flight.

4.7.6 Operational Reliability: The system shall be designed to have a minimum dispatch reliability of 99% of operational flight departures, taking into account all detected system failures and degrade mode operation if provided.

4.7.7 Interchangeability: All components shall be so designed that they can be interchanged with any identical component without adjustment. Components tailored for a particular aircraft type shall be interchangeable with similar components for other aircraft types with minimum adjustment of the system. There shall be no requirement for calibration or recalibration in either case.

5. CLASS I SYSTEMS OPTIONAL FUNCTIONS: The following options have been identified as potentially desirable additional functions to be individually specified and mutually agreed upon between manufacturer and user as required. Optional functions shall have no adverse 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 Navigation System and calculate and display inflight weight and center of gravity based upon the last static reading.

5.2 In-Flight Fuel Usage Planning: The system shall forecast the effect on aircraft weight and balance due to a proposed fuel usage or transfer schedule.

5.3 Remote Displays: The system shall provide remote display(s) of aircraft weight and balance.

5.4 Tail Tip Audible Alarm: The system shall provide a signal for an audible alarm to indicate a potential aircraft tail tip condition. In cargo, convertible or Combi aircraft the same alarm signal shall provide a resettable output signal to interrupt power to aircraft cargo loading systems.

5.5 Flat Tire or Strut Indication: The system shall provide an indication or method of sensing aircraft flat strut or low tire pressure condition.

5.6 Hard Landing Indication: The system shall provide a resettable indication of any landing which experiences landing loads equal to or exceeding that specified as a hard landing for a particular aircraft.

5.7 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.

5.8 AIDS Output: The system shall provide signals to an Airborne Integrated Data System (AIDS) or flight recorder. Signal values shall be in accordance with the requirements of a particular AIDS system or flight recorder, but in any event compatible with ARINC 573 and 717 specifications.

5.9 Degrade Mode: Maintain degraded capability within accuracy limits of 2.0% of actual weight or MAC in the event of one or more sensors failure by providing complementary replacement sensors. Maintain equivalent degraded capability in the event of failure of one of any redundant/duplicated system component. Provide positive indication at the display unit that the system is operating in the degraded mode.

5.10 Printed Display: The system shall be capable of providing final weight and balance data to an on-board printer, or of transmitting this information to a remote printer through ACARS, AIRCOM or equivalent data transmission systems.

5.11 Lateral Center of Gravity (If not a basic requirement): The system shall determine the lateral center of gravity of the aircraft throughout a symmetrical envelope 10% greater than the aircraft certified lateral center of gravity limits and shall display lateral center of gravity within 3% of the aircraft lateral center of gravity range.

PART II: CLASS II ON BOARD WEIGHT AND BALANCE SYSTEM

6. CLASS II SYSTEMS REQUIREMENTS: The system shall determine actual aircraft weight and center of gravity location as follows:

6.1 Range of Operation:

6.1.1 Weights: The system shall determine and display the aircraft weight at least throughout a range from 10% less than aircraft empty weight to 15% greater than maximum taxi gross weight. Overflow indication shall be provided if calculated weight exceeds maximum displayable value.

6.1.2 Center of Gravity: The system shall determine and display the aircraft center of gravity location throughout a system range determined as follows:

Determine aircraft maximum center of gravity range expressed in Percent of Reference Chord such as Mean Aerodynamic Chord (MAC) or equivalent by subtracting most forward limit from most aft limit. Extend most forward aircraft limit forward by an amount equal to 50% of the aircraft range, or 20% MAC forward of the forward design limit, whichever is further forward. Extend most aft aircraft limit aft by an amount equal to 50% of the aircraft range, or 20% aft of the static aft tipping point, whichever is further aft.

6.2 Mode of Operation: The system shall determine the aircraft weight and center of gravity location on the ground in at least the taxiing mode or preferably both the taxiing and the static modes, and shall provide compensation means for the following factors.

6.2.1 Automatic Compensation:

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

6.2.1.2 The system shall provide steady weight/center of gravity location indications under wind gusts up to a minimum ±10 kt differential.

6.2.1.3 Any effect of loading or unloading aircraft, or transfering load or fuel on board.

6.2.1.4 Other compensation factors may be taken into account by providing correction charts or equivalent means, but may also be taken into account automatically if the system design allows it without additional cost or complexity.

6.2.2 Compensation by Correction Chart or Other Means:

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

6.2.2.2 Aircraft brakes locked or released.

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

6.2.2.4 Aircraft brakes temperature between ambient and 20°C above maximum temperature permitted for dispatch.

6.2.2.5 60 kt. wind, or aircraft maximum ground operations limit, whichever is lower, through an azimuth of 360 degrees.

6.2.2.6 Any combination of operating engines from zero to ground taxiing/maneuvering thrust, over the aircraft's approved range of airport elevation.

6.2.2.7 Landing gear tilt hydraulic system on or off.

6.3 Accuracy: The system shall be capable of determining and displaying actual aircraft weight and center of gravity within ±2.0% of aircraft maximum taxi gross weight and ±3.0% of Reference Chord (MAC or equivalent). As an objective, the above accuracy shall be guaranteed within ±2 standard deviations.

6.4 Response Time: The system shall respond to a command to continuously display weight and center of gravity location within 1 minute after initial self-test.

6.5 System Components: The system shall consist of the minimum components required to perform the functions defined by this ARP. A typical system may consist of four, normally unduplicated, 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.

6.5.1.1 Display Unit: The unit shall display a continuous digital readout of aircraft weight to nearest 100 lb or 100 kg for aircraft with maximum taxi gross weight below 100,000 lb or 100,000 kg, or to nearest 1,000 lb or 1,000 kg for aircraft with maximum taxi gross weight over 100,000 lb

6.5.1.1 Display Unit (Cont'd.):

or 100,000 kg, in 3 lighted digits of 0.25 in. (6.4 mm) minimum size. It shall display a continuous digital readout of aircraft center of gravity location to nearest 1% of Reference Chord (MAC or equivalent), in 2 lighted digits of 0.25 in. (6.4 mm) minimum size.

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, unless individual controls are provided.

The display unit shall contain all controls necessary to operate and self-test the system. The display unit shall provide separate indication when preset weight and center of gravity location limits are exceeded, if this option is exercised (see paragraph 7 below).

The display unit location actuation and integration into flight deck controls shall comply with SAE ARP 268F (S-7 Committee) requirements.

6.5.1.2 Computer Unit: The computer unit shall perform the operations required by the system functions. The unit shall have provisions for signal outputs to additional remote display units and signal outputs when preset weight and center of gravity limits are exceeded. The computer shall provide at the display unit or through a centralized display system a malfunction warning indication whenever a system failure occurs. It shall include controls or provisions for malfunction trouble shooting. The unit shall have provisions for ARINC 429 outputs for use by external monitoring equipment such as AIDS.

It shall be possible to replace the computer unit without requiring system recalibration.

6.5.1.3 Sensors: The sensors 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 and system design. Devices to overcome landing gear system friction if required and attitude sensors shall be considered a part of the sensor subsystem.

6.5.1.4 Calibration Unit: All calibration data shall be stored in a calibration unit, which shall remain with the aircraft when other components are replaced, to prevent the need for recalibration. 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.

6.5.2 Component Dimensions, Compatibility and Interface: The OBWBS components shall meet the dimensions, compatibility, interface and interchangeability criteria set forth in ARINC/AEEC 737 specification.

6.5.3 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, and shall continue to operate without interruption after normal system transients or power interruptions (e.g. changeover from ground power to aircraft power).

6.5.4 Weight: System weight shall be minimized consistent with function, maintenance and reliability requirements. Design objective of the system weight, less connecting lines or cables, shall not exceed 30 lb (13.6 kg).

6.6 Environmental and Functional Requirements: The system shall meet the requirements of Radio Technical Commission for Aeronautics (RTCA) Document N° DO-160A, "Environmental Conditions and Test Procedures for Airborne Electronic/Electrical and Instruments", dated 25 Jan. 1980 as follows:

6.6.1 All components within the pressurized fuselage shall meet DO-160A equipment class A-2 requirments for temperature and altitude.

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

6.6.3 All components shall meet the requirements for DO-160A category B "Severe Humidity" requirements.

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

6.6.5 The system shall withstand an aircraft weight range from zero weight to 150% greater than maximum taxi gross weight, without damage or loss of calibration. The sensors shall be capable of withstanding without damage the stresses resulting from the maximum hard landing specified for a particular aircraft type.

6.6.6 The system shall withstand center of gravity range 100% greater than aircraft ground operating cg range without damage or loss of calibration.

6.6.7 Cyclic Loading: The sensors shall withstand, without damage or fatigue, the stresses and deflections of the landing gear during take-off, landing, taxi, 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. The sensors shall be capable of withstanding at least 150% of aircraft maximum taxi gross weight.

6.7 Maintainability and Reliability:

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

6.7.2 Component Replacement: No special tools shall be required to remove and replace system components, except that special tools may be required for sensor mount installation. 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 one hour. Sensor and sensor mounting design shall minimize the possibility of sensor damage during removal or replacement.

6.7.3 Malfunction Troubleshooting: Self-test of the system shall be accomplished by one person at the display unit. The computer shall be equipped with a test connector or controls for malfunction troubleshooting of its 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.

6.7.4 Calibration: The system's components shall be designed so that calibration shall not be required at intervals of less than that equivalent to 10,000 aircraft flight hours.

6.7.5 Adjustment: The system shall be designed so that zero adjustments are automatically performed on each flight, or controls are available on the display unit for any required minor adjustment to the system basic zero reference. Adjustment procedure must be simple and brief and must be accomplished without use of tools.

6.7.6 Operational Reliability: The system shall be designed to have a minimum dispatch reliability of 95% of operational flight departures, taking into account all detected system failures.

6.7.7 Interchangeability: All components shall be so designed that they can be interchanged with any identical component without adjustment. Components tailored for a particular aircraft type shall be interchangeable with similar components for other aircraft types with minimum adjustment of the system. There shall be no requirement for calibration or recalibration in either case.

7. CLASS II SYSTEMS OPTIONAL FUNCTIONS: The following options have been identified as potentially desirable additional functions to be individually specified and mutually agreed upon between manufacturer and user as required. Optional functions shall have no adverse effect on basic system functions, characteristics or installation. Special consideration should be given to adding no unnecessary sophistication/complexity to a Class II OBWBS.

7.1 Remote Displays: The system shall provide remote display(s) of aircraft weight and balance.

7.2 Tail Tip Audible Alarm: The system shall provide a signal for an audible alarm to indicate a potential aircraft tail tip condition. In cargo, convertible or COMBI aircraft the same alarm signal shall provide a resettable output signal to interrupt power to aircraft cargo loading systems.

7.3 Flat Tire or Strut Indication: The system shall provide an indication or method of sensing aircraft flat strut or low tire pressure condition.

7.4 Hard Landing Indication: The system shall provide a resettable indication of any landing which experiences landing loads equal to or exceeding that specified as a hard landing for a particular aircraft.

7.5 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.

7.6 AIDS Output: The system shall provide signals to an Airborne Integrated Data System (AIDS) or flight recorder. Signal values shall be in accordance with the requirements of a particular AIDS system or flight recorder, but in any event compatible with ARINC 573 and 717 specifications.

PART III: CLASS III ON BOARD WEIGHT AND BALANCE SYSTEM

8. CLASS III SYSTEMS REQUIREMENTS: The system shall determine actual aircraft center of gravity location as follows:

8.1 Range of Operation: The system shall determine and display the aircraft center of gravity location throughout a system range determined as follows:

Determine aircraft maximum center of gravity range expressed in Percent of Reference Chord such as Mean Aerodynamic Chord (MAC) or equivalent by subtracting most forward limit from most aft limit. Extend most forward aircraft limit forward by an amount equal to 50% of the aircraft range, or 20% MAC forward of the forward design limit, whichever is further forward. Extend most aft aircraft limit aft by an amount equal to 50% of the aircraft range, or 20% aft of the static aft tipping point, whichever is further aft.

8.2 Mode of Operation: The system shall determine the aircraft center of gravity location on the ground, in at least the taxiing mode or preferably both the taxiing and the static modes, after the actual aircraft gross weight, as determined by standard weight and balance computation procedures (final loadsheet) is entered into the computer unit. Compensation means shall be provided for the following factors:

8.2.1 Automatic Compensation:

8.2.1.1 The system shall provide steady center of gravity location indications under wind gusts up to a minimum ±10 kt differential.

8.2.1.2 Any effect of loading or unloading aircraft, or transferring load or fuel on board.

8.2.1.3 Other compensation factors may be taken into account by providing correction charts or equivalent means, but may also be taken into account automatically if the system design allows it without additional cost or complexity.

8.2.2 Compensation by Correction Chart or Other Means:

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

8.2.2.2 Aircraft brakes locked or released.

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

8.2.2.4 60 kt. wind, or aircraft maximum ground operations limit, whichever is lower, through an azimuth of 360 degrees.

8.2.2.5 Any combination of operating engines from zero to ground taxiing/maneuvering thrust, over the aircraft's approved range of airport elevation.

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

8.3 Accuracy: The system shall be capable of determining and displaying actual aircraft center of gravity location within ±3.0% of Reference Chord (MAC or equivalent). As an objective, the above accuracy shall be guaranteed within ±2 standard deviations, under the assumption of an exact gross weight entered into the computer.

8.4 Response Time: The system shall respond to a command to continuously display center of gravity location within 1 minute after initial self-test.

8.5 System Components: The system shall consist of the minimum components required to perform the functions defined by this ARP. A typical system may consist of four unduplicated 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.

8.5.1 Component Description:

8.5.1.1 Display Unit: The unit shall display a continuous digital readout of aircraft center of gravity location to nearest 1% of Reference Chord (MAC or equivalent) in 2 lighted digits of 0.25 in. (6.4 mm) minimum size.

In addition, it shall provide a means of entering the actual aircraft gross weight, as determined by the final loadsheet, into the system, and provide digital readout of the entered aircraft weight to nearest 100 lb or 100 kg for aircraft with maximum taxi gross weight below 100,000 lb or 100,000 kg, or to nearest 1,000 lb or 1,000 kg for aircraft with maximum taxi gross weight over 100,000 lb or 100,000 kg, in 3 lighted digits of 0.25 in. (6.4 mm) minimum size.

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, unless individual controls are provided.

The display unit shall contain all controls necessary to operate and self-test the system. The display unit shall provide separate indication when preset center of gravity location limits are exceeded, if this option is exercised (see paragraph 9 below).

The display unit location, actuation and integration into flight deck controls shall comply with SAE ARP 268F (S-7 Committee) requirements.

8.5.1.2 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 center of gravity limits are exceeded. The computer shall provide at the display unit or through a centralized display system a malfunction warning indication whenever a system failure occurs. It shall include controls or provisions for malfunction troubleshooting.

It shall be possible to replace the computer unit without requiring system recalibration.

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