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AEROSPACE STANDARD

Submitted for recognition as an American National Standard



AS5116

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PERFORMANCE STANDARD FOR AIRPLANE GROUND ICE DETECTION SYSTEM, AIRPLANE/GROUND BASED

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1. SCOPE:

This SAE Aerospace Standard (AS) establishes minimum performance standards for Airplane Ground Ice Detection (AGID) Systems. This standard also defines functional capabilities, design requirements and test procedures. An AGID system detects frost, ice, slush, or snow on the upper surface of the wings, control surfaces, and/or other critical surfaces of airplanes. The AGID system can include ground-based and/or airplane mounted devices.

The AGID system will provide an indication within its area of coverage whenever frost, ice, slush or snow will affect safety of flight.

1.1 Product Classification:

An AGID system covered by this standard shall be identified by category and class as defined in 1.1.1 and 1.1.2. Each category and class may also incorporate additional features not addressed in this standard (such as facility to provide automatic temperature display in the event that the wing temperature is below ambient temperature). The incorporation of such additional features, not considered essential for detection system functioning, shall not compromise the detection system's intended purpose.

1.1.1 Categories:

Category I: Airplane mounted detection systems.

Category II: Ground-based detection systems.

1.1.2 Classes: Detection systems are also classified as:

- a. Class A: A primary system that eliminates the need for a pretakeoff check or pretakeoff contamination check and can solely determine compliance with the operating rules applicable to airplane ground icing conditions.
- b. Class B: An advisory system that provides information to the flight crew that aids them in complying with the operating rules applicable to airplane ground icing conditions.

1.2 Field of Application:

1.2.1 Applicable Airplanes: The AGID system is applicable to civil airplanes. No attempt has been made to meet military specifications.

1.2.2 Applicable Airports: Ground-based AGID systems should be compatible with airport operations.

1.2.3 Applicable Operations: The AGID system is capable for use during all ground operations.

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2. NORMATIVE REFERENCES:

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1 Applicable Documents:

2.1.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096.

- ARP450 Flight Deck Visual Audible, and Tactile Signals (to be superseded by ARP4104/4, Flight Deck Alerting System [FAS])
- ARP582 Lighting, Integral, for Airplane Instruments: Criteria for Design of Red Lighted Instruments
- ARP798 Design Criteria for White Incandescent Lighted Aerospace Instruments
- ARP1068 Flight Deck Instrumentation, Display Criteria and Associated Controls for Transport Airplane (to be superseded by ARP4/02, Flight Deck Panels, Controls and Displays; ARP4102/7, Electronic Displays; and ARP410218, Flight Deck, Head Up Displays).
- ARP4737 Airplane Deicing/Anti-icing methods with fluids for large transport airplane
- AS425 Nomenclature and Abbreviations for Use on the Flight Deck (to be superseded by ARP4103)
- AS264 Instrument and Cockpit Lighting for Commercial Transport Airplane (to be superseded by ARP4101/3, Instrument and Flight Deck Lighting)
- AS8034 Minimum Performance Standard for Airborne Multipurpose Electronic Displays

2.1.2 ARINC Publications: Available from Aeronautical Radio, Inc., 2551 Riva Road, Annapolis, MD 21401.

- ARINC-403 Guidance for Designers of Airborne Electronics Equipment
- ARINC-408A Air Transport Indicator Cases and Mounting
- ARINC-409A Selection and Application of Semiconductor Devices
- ARINC-413 Airplane Electrical Power Utilization and Transient Protection
- ARINC-415 Operational and Technical Guidelines on Failure Warning and Functional Test
- ARINC-429-9 Mark 33 Digital Information Transfer Systems (DITS)
- ARINC-600 Equipment Cases and Racking - Air Transport
- ARINC-602-1 Test Equipment Guidance
- ARINC-604 Guidance for Design and Use of Built-in Test Equipment (BITE)

2.1.3 RTCA Publications: Available from Radio Technical Commission for Aeronautics, One McPherson Square, 1425 K Street N.W., Suite 500, Washington, DC 20005.

- RTCA DO-160C Environmental Conditions and Test Procedures for Airborne Equipment
- RTCA DO-178B Software Considerations in Airborne Systems and Equipment

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2.1.4 ATA Publications: Available from Air Transport Association of America, 1709 New York Avenue N.W., Washington, DC 20006.

ATA No. 100 Specifications for Manufacturers Technical Data

ATA No. 300 Specifications for Packaging of Airline Supplies

2.1.5 Federal Aviation Regulations: Available from Federal Aviation Administration, 800 Independence Avenue, SW, Washington, DC 20591.

The applicable parts of the following documents should be adhered to:

AC120-60 Ground Deicing and Anti-Icing Program

14 CFR PART 23 Airworthiness Standards: Normal, Utility, Acrobatic, and Commuter Category Airplanes

14 CFR PART 25 Airworthiness Standards: Transport Category Airplanes

14 CFR PART 91 General Operating and Flight Rules

14 CFR PART 121 Certification and Operations: Domestic Flag, and Supplemental Air Carriers and Commercial Operators of Large Airplane

14 CFR PART 135 Air Taxi Operators and Commercial Operators

2.1.6 Special Documents: It can be expected that other special documents may be made applicable to the manufacturer of the AGID system by a particular airplane for the type of airplane for which the system is intended to be installed. It is not within the scope of this document to define these special documents.

2.2 Definitions:

The following definitions and glossary terms are applicable to this document. Terms for which standard dictionary definitions apply are not included herein.

ADVISORY SYSTEM: AGID system that enunciates the sensor indication described in 3.3.6 (a) or (b). The flight crew remains responsible for monitoring the ground icing conditions and meeting the requirements of FAR 121.629(b) or equivalent.

GROUND ICING CONDITIONS: Weather conditions, on the ground, that are conducive to formation of frost or ice or the accumulation of snow or slush on airplane surfaces and components.

HOLDOVER TIME: The estimated time anti-icing fluid will prevent the formation of frozen accumulations on the protected surfaces of an airplane.

PRETAKEOFF CHECK: A check of the airplane's wings or representative surfaces for frost, ice, snow or slush within the airplane's holdover time.

PRETAKEOFF CONTAMINATION CHECK: A check of the airplane's wings or representative surfaces for frost, ice, snow or slush after exceeding any maximum holdover time in the certificate holder's timetable.

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2.2 (Continued):

PRIMARY SYSTEM: AGID system that enunciates the sensor indication described in 3.3.6(a) or (b). The flight crew is not responsible for monitoring the ground icing conditions and meeting the requirements of FAR 121.629(b) or equivalent. The primary AGID system automatically provides this information to them.

2.3 Symbols and Abbreviations:

AGID	Airplane Ground Ice Detection
ARINC	Aeronautical Radio Incorporated
ARP	SAE Aerospace Recommended Practice
AS	SAE Aerospace Standard
BITE	Built-In Test Equipment
FAA	Federal Aviation Administration
RTCA	Radio Technical Commission for Aeronautics
SAE	Society of Automotive Engineers
TSO	FAA Technical Standard Order

3. TECHNICAL REQUIREMENTS:

3.1 General:

3.1.1 Materials and Workmanship:

3.1.1.1 Materials: Materials shall be of a quality which experience and/or tests have demonstrated to be suitable and dependable for use in Category I and Category II equipment.

3.1.1.2 Workmanship: Workmanship shall be such as to minimize degradation of service performance and reliability. All components shall be fitted properly and firmly in their appropriate positions. All electrical connections shall be mechanically secure and electrically sound. Care shall be given to neatness and thoroughness of soldering, wiring, welding, brazing, surface treatments, painting, screwed and bolted assemblies, marking of parts and assemblies, and elimination of burrs and sharp edges.

3.1.2 Identification: The following information shall be legibly and permanently marked on the manufacturer's nameplate as applicable:

- Manufacturer's part number
- Manufacturer's serial number or date of manufacture
- Manufacturer's name and/or trade mark
- ISO number
- Modification status number or code (including software revision number)

3.1.3 Interchangeability: All parts having the same part number shall be directly and completely interchangeable with each other physically and functionally. It shall only be possible to correctly assemble components and subassemblies.

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3.1.4 Electrical Bonding and Grounding: The equipment grounding system shall provide for separation of AC power, DC power, chassis ground and signal ground(s). Optionally, signal ground(s) may be "referenced" to chassis ground. Wire shields shall not be used as a signal return. Conductive equipment enclosures must be capable of being bonded to aircraft structure, which may be done by dedicated faying surface contacts, bonding jumper or by wiring through an interface connector. On nonconductive enclosures, controls or metal parts which may be touched shall be bonded to ground. Case ground shall not be used for electrical power returns. Materials, surface preparation and finishes for electric bonding surfaces shall be compatible with preservation of adequate electrical conductivity over the life of the equipment. The maximum resistance across any bonding or grounding junction shall be 10 mW, as manufactured.

3.2 Physical Requirements:

An AGID system shall not degrade the airplane's takeoff performance.

3.2.1 Aerodynamic Compatibility: Category I surface mounted sensors shall comply with airplane manufacturers' smoothness and waviness requirements.

3.2.2 Thermal Compatibility: Category I equipment mounted on an exterior surface shall be thermally compatible with the airplane skin, and shall not distort the thermal characteristics of the previously un-instrumented surfaces if required.

3.3 AGID System Operation:

The combination of parts, tangible or intangible, that work together to perform the AGID function shall operate essentially as follows:

3.3.1 Input Data: The acquisition by the AGID system of essential data shall, if appropriate, be automatic.

3.3.2 Data Processing: The system shall be designed in such a manner as to preclude the display of output data unless all input data required for proper computation are provided.

3.3.3 Data Output:

3.3.3.1 Display Design Simplicity: The display design shall:

- a. Utilize natural and meaningful symbology that is readily understood.
- b. Provide information that is immediately discernible such that there is no need to watch the display for a period of time to observe rates of change.

3.3.3.2 Other Criteria: For other criteria affecting the AGID display (colors, titles, lighting, etc.) refer to ARP450, ARP582, ARP798, ARP1068, and AS8034.

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3.3.4 Confidence (BITE) Test - Indication: The AGID system shall include a confidence (BITE) test, which will indicate that the system is functioning and that valid signals are available. This test function shall be automatic. A failure of the confidence test shall be clearly indicated.

3.3.5 AGID System Activation: Category I AGID systems shall:

- a. Have a means on the flight deck to activate and de-activate the system while the airplane is on the ground.
- b. Automatically inhibit the display during the takeoff roll.
- c. Remain dormant in flight.

The update period of the system shall not exceed 10 s, regardless of the number of sensors.

3.3.6 Indication: The AGID system shall provide an indication when:

- a. The detector senses the presence of frost, ice, slush, or snow on the airplane that would produce degradation in aerodynamic performance, stability, maneuverability or controllability from FAR 25 Subpart B (or equivalent) requirements¹, or
- b. The airplanes surfaces have been treated with a deicing/anti-icing fluid; and the detector senses the failure of that fluid as indicated by "surface freezing or snow accumulation, random snow accumulation and dulling of surface reflectivity (loss of gloss) caused by the gradual deterioration of the fluid to slush." (FAA Advisory Circular 120-60)

3.3.7 AGID System Operating Procedures: A set of procedures pertinent to each specific AGID system shall be developed.

3.4 Electrical Requirements:

3.4.1 Power Supply: Category I AGID systems shall be designed to accept, and operate with, the electrical power characteristics defined either by the airframe manufacturer, or as required for a specified installation, including maintaining operation and indication during and after voltage transients such as will normally occur during electrical bus switching.

3.4.2 Protection: The system shall provide short circuit protection for all subsystem line replaceable units. There shall be no circuit breakers or fuses. Transient suppression devices shall be provided on each power lead to minimize the effect of voltage transients.

3.5 Maintainability:

It shall be physically impossible to install components improperly. Component assemblies shall be interchangeable when they are functionally inter-changeable. There shall be no requirement for on-airplane adjustment or calibration. The system and components shall require replacement only upon functional failure. Special purpose tools shall not be required.

¹ The AGID system manufacturer shall obtain this information from the appropriate airframe manufacturer(s).

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3.6 AGID System Reliability Requirements:

- 3.6.1 Reliability Requirements: Class A AGID systems shall be designed such that a combination of system failure to detect contamination and a failure to enunciate a failed condition to the flight crew must be extremely improbable (i.e., probability on the order of 10^{-9}). Reference FAR 25.1309.
- 3.6.2 Hazard Analysis: It shall be shown that hazards resulting from system failures, including human errors, reasonably anticipated as possible, have been considered and preventive actions taken accordingly.

3.7 Parts Selection:

Off the shelf components shall be selected on the basis of proven airline or military service reliability.

3.8 Environmental Requirements:

The various system components of Category I AGID systems may be installed in significantly different environments.

Unless specifically called out in this document, the equipment categories (as defined in RTCA DO-160C) to which the AGID components are designed and tested may be selected by the equipment supplier, based on either preference or knowledge of a specific application. The selected categories for each component shall be listed in the Installation Instructions and optionally, on the component, or component nameplate, as specified in 3.1.2.

- 3.8.1 Aircraft Attitude: The aircraft attitude shall have no effect on system performance when the AGID System components are in their normal installed positions.
- 3.8.2 Temperature and Altitude: The AGID System components shall be designed to meet the requirements of this document over the temperature and altitude ranges defined in Section 4.0, Table 4-1 of RTCA DO-160C.
- 3.8.3 Temperature Variation: The AGID System components shall be designed to meet the requirements of this Aerospace Standard during and after exposure to the temperature variations defined in Section 5.0 of RTCA DO-160C.
- 3.8.4 Humidity: The AGID System components shall be designed to meet the requirements of this document during and after exposure to the humidity environment defined in Section 6.0 of RTCA DO-160C.

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3.8.5 Operational Shocks and Crash Safety: The AGID System components shall be designed to meet the requirements of this document after being exposed to shocks experienced during normal aircraft operation per the conditions defined in Section 7.0 of RTCA DO-160C.

The AGID System components shall also be designed to not detach from their mountings or separate in a manner that presents a hazard during an emergency landing.

If the AGID System components are designed to a known mounting orientation in the aircraft, the minimum crash safety load factors specified in FAR Part 25 shall be met.

If the AGID System components are designed for an unknown orientation in the aircraft, the minimum crash safety load factors shall be 9.0 g for all directions of load.

3.8.6 Vibration: The AGID System components shall be designed to meet the requirements of this document during and after exposure to the vibration environments defined in Section 8.0 of RTCA DO-160C as applicable to the aircraft type and installation location.

3.8.7 Explosion Proofness: The AGID System shall be designated as Category X equipment as defined in RTCA DO-160C, Section 9.0 and have no special requirements.

3.8.8 Waterproofness: The AGID System shall be designated as Category X equipment as defined in RTCA DO-160C, Section 10.0 and have no special requirements.

3.8.9 Susceptibility to Fluids: The AGID System shall be designated as Category X equipment as defined in RTCA DO-160C, Section 11.0 and have no special requirements.

3.8.10 Sand and Dust: AGID System components installed inside the fuselage, shall be designated as Category X equipment as defined in RTCA DO-160C, Section 12.0 and have no special requirements.

The requirements for components located elsewhere shall be provided by the installer.

3.8.11 Fungus Resistance: The AGID System components shall be designed and tested to meet the requirements of Category F equipment as defined in RTCA DO-160C, Section 13.0.

3.8.12 Salt Spray: The AGID System shall be designated as Category X equipment as defined in RTCA DO-160C, Section 14.0 and have no special requirements.

3.8.13 Electromagnetic Compatibility (EMC): Electromagnetic compatibility requires that:

- a. The AGID System perform its intended functions in the airplane electromagnetic environment.
- b. The presence or operation of the subject system shall not degrade the performance of other airplane systems.

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- 3.8.13.1 Magnetic Effect: Any AGID System component installed in, or near, the flight deck shall be designed and tested to meet the requirements of equipment Class A as defined in RTCA DO-160C, Section 15.0.
- 3.8.13.2 Audio Frequency: Conducted Susceptibility - Power Inputs: Unless otherwise specified, the AGID System components shall be designated as Category E equipment as defined in RTCA DO-160C, Section 18.0. The AGID System components shall be designed to not be adversely affected by conducted frequency components harmonically related to the power source fundamental frequency and shall function with no false warnings, malfunctions and/or damage allowed.
- 3.8.13.3 Induced Signal Susceptibility: Unless otherwise specified, the AGID System components shall be designated as Category Z equipment as defined in RTCA DO-160C, Section 19.0. The AGID System shall be designed to not be adversely affected by induced audio frequency signals and transients generated by other on-board equipment and shall function with no false warnings, malfunctions and/or damage allowed.
- 3.8.13.4 Radio Frequency Susceptibility (Radiated and Conducted): Unless otherwise specified by the installer, the AGID System supplier shall select the category to which the equipment is designed and qualified from the categories defined in RTCA DO-160C, Section 20.0.
- 3.8.13.5 Emission of Radio Frequency Energy: The AGID System components shall be designated as Category Z equipment as defined in RTCA DO-160C, Section 21.0.

The AGID System components shall not be a source of any objectionable interference under operating conditions at any frequencies used by the airplane, either by radiation, conduction or feedback in any electronic equipment installed in the same airplane, in accordance with RTCA DO-160C.

- 3.8.14 Susceptibility to Lightning Induced Effects: Unless otherwise specified by the installer, the AGID System supplier shall select the category to which the equipment is designed and qualified from the categories defined in RTCA DO-160C, Section 22.0. The AGID System, as installed in the airplane, shall withstand lightning-induced voltage transients, resulting from the lightning environment defined in AC 20-136, with no false warnings, malfunctions and/or damage and shall automatically recover to normal operation within 4 s of cessation of the transient.