SAE Aerospace
An SAE International Group

AEROSPACE STANDARD

SAE AS5116 REV. C

Issued 1996-11
Revised 2003-06
Cancelled 2007-08

Superseded by AS5681

Minimum Operational Performance Specification for Ground Ice Detection Systems

RATIONALE

AS5116 is a Minimum Operational Performance Specification (MOPS) for Remote On-Ground Ice Detection Systems (ROGIDS), issued in February 2002. Since that time Human Factors tests, regulatory reviews and laboratory tests have emphasized the need for separate Standards for On-Ground Remote, On-Board Remote, and On-Board In Situ Sensors. Accordingly, a new upgraded document to cover Remote On-Ground Ice Detection Systems (ROGIDS) only, AS5681 is under development and scheduled for issue in 2007. At the present time work on an appropriate new Standards for On-Board sensors has not been initiated.

Based on a decision made by the G-12ID Committee, it was agreed to declare the subject specification CANCELLED.

CANCELLATION NOTICE

This document has been declared "CANCELLED" as of August 2008 and has been superseded by AS5681. By this action, this document will remain listed in the Numerical Section of the Aerospace Standards Index noting that it is superseded by AS5681.

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FOREWORD

The development of these guidelines was jointly accomplished by EUROCAE Working Group 54 and the Society of Automotive Engineers (SAE) G-12 Ice Detection Subcommittee through a consensus process. It was accepted by the Council of EUROCAE on November 2001 as ED 104 and SAE on February 2002 as AS5116A.

SAE and EUROCAE are, respectively, U.S. and international not-for-profit organizations, formed to advance the art and science of aviation and aviation electronic systems for the benefit of the public.

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1. SCOPE:

This SAE Aerospace Standard (AS)/Minimum Operational Performance Specification (MOPS) specifies the minimum performance requirements of Ground Ice Detection Systems (GIDS). These systems may be mounted onboard the airplane, or be ground-based. They may provide information for indication and/or control.

Chapter 1 provides information required to understand the need for the GIDS characteristics and tests defined in the remaining chapters. It describes typical GIDS applications and operational objectives and is the basis for the performance criteria stated in Chapter 3 through Chapter 5. Definitions essential to the proper understanding of this document are provided in Chapter 1.

Chapter 3 contains general design requirements for an ice detection system used during ground operations.

Chapter 4 contains the Minimum Operational Performance Requirements for the GIDS, defining performance under icing conditions likely to be encountered during ground operations.

Chapter 5 describes environmental test conditions providing laboratory means of testing the overall performance characteristics of the GIDS under conditions which may be encountered in actual operations.

Chapter 6 describes recommended test procedures for demonstrating compliance with Chapters 3 and 4.

Chapter 7 contains the Minimum Operational Performance Requirements for installed GIDS. Ground and flight tests are included when performance cannot be adequately determined through testing under standard test conditions.

1.1 Applications of This Document:

Compliance with this AS/MOPS ensures that the GIDS will satisfactorily perform its intended functions as given by 1.2 during airplane ground operations.

Compliance with this AS/MOPS does not necessarily constitute compliance with regulatory requirements. Any regulatory application of this document in whole or in part is the sole responsibility of the appropriate government agencies.

The measured values of the GIDS performance characteristics may be a function of the method of measurement. Therefore, standard test conditions and methods of testing are recommended in this document.

1.1 (Continued):

Mandating and Recommendation Phrases:

a. “Shall”

The use of the word “Shall” indicates a mandated criterion; i.e., compliance with the particular procedure or specification is mandatory and no alternative may be applied.

b. “Should”

The use of the word “Should” (and phrases such as “It is recommended that...”, etc.) indicates that although the procedure or criterion is regarded as the preferred option, alternative procedures, specifications or criteria may be applied, provided that the manufacturer, installer or tester can provide information or data to adequately support and justify the alternative.

1.2 Functional Description of System:

GIDS are intended to be used during airplane ground operations to inform the ground crew and/or the flight crew and/or a relevant system about the condition of monitored airplane surfaces.

The GIDS may provide a complementary or, when approved, a functional alternative to the visual and tactile checks required by regulatory agencies, including the European Joint Aviation Authorities (JAA), the United States Federal Aviation Administration (FAA) and Transport Canada Civil Aviation (TCCA), to determine the condition of airplane critical surfaces under operating conditions involving freezing contamination.

A PRIMARY GIDS can be used as the sole means of compliance with the operating rules applicable to airplane ground icing conditions, including pre-deicing check, post-deicing check and/or any applicable regulatory pre-take-off checks.

An ADVISORY GIDS, combined with other means, provides information for compliance with the operating rules applicable to airplane ground icing conditions.

The GIDS function is:

FROZEN CONTAMINATION DETECTION; which is to detect frozen contaminants (ice, frost, snow and/or slush) on airplane surfaces.

and/or

FLUID CONDITION MONITORING; which is to monitor and indicate de/anti-icing fluid conditions.

1.2.1 Onboard GIDS: Airplane mounted systems are designated as ONBOARD GIDS. and include the following two sub-categories:

IN SITU: GIDS that make a direct measurement on a monitored surface (flush mounted sensors).

REMOTE: GIDS that make a remote measurement of a monitored surface (e.g., optical camera methods).

Possible technologies include, but are not limited to, latent heat of fusion, vibrating elements, visual cues, ultrasonic sensors, visible or IR cameras, other optical methods, etc.

The ONBOARD GIDS may be:

Spot sensors (area of coverage per sensor <40 cm², [6.2 in^2])

Local area sensors. (40 cm² [6.2 in^2] < area of coverage per sensor <5m² [53.8 ft^2])

Wide area sensors. (area of coverage per sensor >5 m² [53.8 ft^2])

1.2.2 Ground-Based GIDS: Ground-based, hand held, pedestal or truck mounted systems are designated as GROUND-BASED GIDS and include only the following sub-category:

REMOTE: GIDS that make a remote measurement on a monitored surface (e.g., optical camera methods).

Possible technologies include, but are not limited to, visible or IR cameras, other optical methods, etc.

The GROUND-BASED GIDS may be:

Spot sensors (area of coverage per sensor <40 cm², [6.2 in^2])

Local area sensors. (40 cm² [6.2 in^2] < area of coverage per sensor <5 m² [53.8 ft^2])

Wide area sensors. (area of coverage per sensor >5 m² [53.8 ft^2])

1.3 Composition of a GIDS:

GIDS include:

At least one sensor which is directly or indirectly sensitive to the physical phenomena of icing and/or de/anti-icing fluid condition and which may be exposed to weather conditions as given in 3.8.6.

A processing unit to perform signal processing. The unit may either be integrated with or separate from the sensor(s).

A device to provide information to the flight and/or ground crew.

2. REFERENCES:

2.1 Applicable Documents:

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.

2.1.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

ARP582	Lighting, Integral, for Airplane Instruments: Criteria for Design of Red Lighted Instruments
ARP798	Design Criteria for White Incandescent Lighted Aerospace Instruments
ARP4102	Flight Deck Panels, Controls and Displays
ARP4102/7	Electronic Displays
ARP4102/8	Flight Deck, Head Up Displays
ARP4104/4	Flight Deck Alerting System (FAS)
ARP4256	Design Objectives for Liquid Crystal Displays for Part 25 (Transport)
AIR4367	Aircraft Ice Detectors and Icing Rate Measuring Instruments (In Flight Icing)

2.1.1 (Continued):

ARP4737	Airplane Deicing/Anti-icing Methods with Fluids for Large Transport Airplanes
ARP4761	Guidelines and Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment
AS8034	Minimum Performance Standard for Airborne Multipurpose Electronic Displays
SAE J1211	Recommended Environmental Practices for Electronic Equipment Design
AMS 1424	Deicing Anti-icing, Aircraft, Fluid, SAE Type I
AMS 1428	Deicing Anti-icing, Fluid, Aircraft, Non-newtonian (Pseudoplastic), SAE Types II, III, and IV

2.1.2 EUROCAE/RTCA or EUROCAE/SAE Publications: EUROCAE Documents (ED) available from EUROCAE, 17, rue Hamelin 75783 PARIS, Cedex 16, France.

RTCA documents (DO) available from RTCA, One McPherson Square, 1225 K Street N.W., Suite 500, Washington, DC 20005.

ED-14/RTCA DO-160	Environmental Conditions and Test Procedures for Airborne Equipment
ED-12/RTCA DO-178	Software Considerations for Airborne Systems and Equipment Certification
ED-79/SAE ARP4754	Certification Considerations for Highly-Integrated or Complex Aircraft Systems
ED-80/RTCA DO 254	Design Assurance Guidance for Airborne Electric Hardware
RTCA/DO-216	Minimum General Specification for Ground-Based Electronic Equipment

2.1.3 JAA/FAA Requirements, Regulations: JAA/JAR documents available from JAA, Saturnusstraat 8-10 PO Box 3000 2130 KA Hoofddorp The Netherlands.

FAA/FAR/AC documents available from, FAA Superintendent of Documents, US Governement Printing Office, Washington, DC 20402.

JAR-1	Definitions and Abbreviations
JAR-Part 21	Certification Procedures for Aircraft and Related Products and Parts
JAR/FAR Part 23	Airworthiness Standards: Normal, Utility, Acrobatic, and Commuter Category Airplanes
JAR/FAR Part 25	Airworthiness Standards: Transport Category Airplanes
JAR Part 26	Additional Airworthiness Requirements for Operations
JAR/FAR Part 27	Airworthiness Standards: Normal category Rotorcraft
FAR Part 29	Airworthiness Standards: Transport Category Rotorcraft
FAR Part 33	Airworthiness Standards: Aircraft Engines
FAR Part 39	Airworthiness Directives
FAR Part 43	Maintenance, Preventive Maintenance, Rebuilding and Alteration
FAR Part 91	General Operating and Flight Rules
FAR part 121	Certification and Operations: Domestic Flag, and Supplemental Air Carriers and Commercial Operators of Large Aircraft
FAR Part 125	Certification and Operations: Airplanes Having a Seating Capacity of 20 or More Passengers or a Maximum Payload Capacity of 6,000 Pounds or More
FAR Part 129	Operations: Foreign Air Carriers and Foreign Operators of U.S.- Registered Aircraft Engaged in Common Carriage
FAR part 135	Air Taxi Operators and Commercial Operators
JAR TSO	Joint Technical Standard Orders
JAR/OPS 1, [2]	Commercial Air Transportation (Aeroplanes)

2.1.3 (Continued):

JAA/Leaflet #4 to JAR/OPS1 Ice and Other Contaminants Procedures

JSSG-2010-5	Joint Service Specification Guide. 5 “Crew Systems, Aircraft Lighting Handbook”
JAR-E	Engines
JAR-P	Propellers
JAR-MMEL/MEL	Master Minimum Equipment List/Minimum Equipment List

FAA Aircraft Icing Handbook

AC 00-34A	Aircraft Ground Handling and Servicing
AC 20-73	Aircraft Ice Protection
AC 20-117	Hazards Following Ground Deicing and Ground Operations in Conditions Conducive to Aircraft Icing
AC 23-1419-2A	Certification of Part 23 Airplanes for Flight in Icing Conditions
AC 91-51A	Effect of Icing on Aircraft Control and Airplane Deice and Anti-Ice Systems
AC 120-58	Pilot Guide for Large Aircraft Ground Deicing
AC 120-60	Ground Deicing and Anti-Icing Program
AC 135-9	FAR Part 135 Icing Limitations
AC 135-16	Ground Deicing & Anti-Icing Training & Checking
AC 135-17	Pilot Guide - Small Aircraft Ground Deicing
AC 150/5300-14	Design of Aircraft Deicing Facilities

2.1.4 Transport Canada Regulations: TC documents available fom Transport Canada, Tower C, Place de Ville, 330 Sparks Street Ottawa, Ontario K1A 0N5.

TC-CASS 622.11	Commercial Air Service Standard - Ground Icing Operations Standard
TC CAR 602.11	Canadian Aviation Regulation - Aircraft Icing

2.1.5 CEN/IEC/ISO Publications: CEN/EN documents available from CEN, 36, rue de Stassart B-1050 Brussels.

IEC documents available from IEC, Central Office 3, rue de Varembé P.O. Box 131 CH - 1211 GENEVA 20 Switzerland.

ISO documents available from ISO, Central Secretariat: 1, rue de Varembé, Case postale 56 CH-1211 Geneva 20, Switzerland.

EN 50020	Electrical apparatus for potentially explosive atmospheres, intrinsic safety “i”
CEN 50082-2	Electromagnetic compatibility - Generic immunity standard - Part 2: Industrial environment
CEN 50081-2	Electromagnetic compatibility - Generic emission standard - Part 2: Industrial environment
CEN 12312 part 6	Deicing/Anti-icing equipment. A/C Ground support equipment requirements
IEC 0079 Part 11	Electrical apparatus for potentially explosive atmospheres, intrinsic safety
ISO 11077	Aerospace deicing/anti-icing vehicle requirements

2.1.6 ARINC Documents: ARINC documents available from ARINC, 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-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)

2.1.7 MIL Documents: MIL documents available from Standardization Documents Order desk, Bldg. 4D, 700 Robbins Ave., Philadelphia, PA 19111-5094.

MIL-STD-1472

2.1.8 Weather Related Documents: WMO documents available from World Meteorological Organization P.O. Box 2300 CH-1211 Geneva 2 Switzerland.

World Meteorological Organization Aerodrome Reports and Forecasts (Doc No. 782, revised 1 Jan 1996

Transport Canada Commercial and Business Aviation Advisory Circular (CBAAC), number 0165R, 00/10/23, Table 8
http://www.tc.gc.ca/aviation/commerce/advisory/english/ac0165r_table8_e.htm

2.2 Definitions and Abbreviations:

2.2.1 Definitions:

ANTI-ICING: A precautionary procedure that provides protection of an airplane against the formation of frost or ice and accumulation of snow or slush on treated surfaces of the airplane for a limited period of time.

DEICING: A procedure by which frost, ice, snow or slush is removed from the airplane in order to provide clean surfaces.

FALSE NEGATIVE: An indication of absence of frozen contamination when frozen contamination is present on the reference surface.

FALSE POSITIVE: An indication of the presence of frozen contamination when no frozen contamination is present on the reference surface.

FLUID FAILURE: Possibly indicated by the presence of frozen contamination in or on the fluid, surface freezing or snow accumulation, random snow accumulation and/or dulling of surface reflectivity caused by the gradual deterioration of the fluid.

FROZEN CONTAMINATION/CONTAMINANTS: For the purpose of this AS/MOPS: frost, ice, snow, slush.

IN SITU: GIDS that make a direct measurement on a monitored surface (flush mounted sensors).

MONITORED SURFACE: The surface of concern regarding ice hazard.

REFERENCE SURFACE: The surface where a GIDS sensor makes its measurement.

2.2.1 (Continued):

REMOTE: GIDS that make a remote measurement on a monitored surface (e.g., optical camera methods).

SYSTEM: A combination of components which are inter-connected to perform one or more functions.

VISUAL PATTERN OF FAILURE: Area and location of visible frozen contamination in or on or under the de/anti-icing fluid.

Descriptors of this frozen contamination may be any of the following, but not limited to:

a. Ice front,

b. Ice sheet,

c. Slush, in clusters or as a front,

d. Disseminated fine ice crystals,

e. Frost on surface,

f. Clear ice pieces partially or totally imbedded in fluid,

g. Snow bridges on top of the fluid.

WEATHER CONDITIONS: See 2.1.8.

2.2.2 Abbreviations:

AC	Advisory Circular (FAA)
AMJ	Advisory Material Joint (JAA)
ARINC	Aeronautical Radio, Inc.
ARP	Aerospace Recommended Practice
AS	Aerospace Standard
CEN	Comité Européen de Normalisation . European Committee for Standardisation. Europäisches Komitee für Normung.
EN	Norme Européenne. European Standard. Europäische Norm.
EUROCAE	The European Organisation for Civil Aviation Equipment

2.2.2 (Continued):

FAA	Federal Aviation Administration (USA)
FAR	Federal Aviation Regulations (USA)
FOD	Foreign Object Damage
FPD	Freezing Point Depressant; used to qualify the nature of fluids
GIDS	Ground Ice Detection System
IEC	International Electricity Committee
ISO	International Organization for Standardization
JAA	Joint Aviation Authorities (in Europe)
JAR	Joint Aviation Requirements (Europe)
LRU	Line Replaceable Unit
min	Minute
MOPS	Minimum Operational Performance Specification
MTBF	Mean Time Between Failure
OAT	Outside Air Temperature
RTCA	Radio Technical Commission for Aeronautics
SAE	Society of Automotive Engineers (USA originated)
T.C. -CAR	Transport Canada - Civil Aviation Requirements
T.C	Transport Canada (The Canadian Civil Aviation Authority)

3. GENERAL DESIGN REQUIREMENTS:

3.1 Introduction:

This chapter identifies general design considerations for systems comprising onboard and ground-based GIDS.

3.2 Airworthiness and Operational Requirements:

3.2.1 Onboard GIDS: An onboard GIDS installation used by the flight crew for airworthiness decisions shall comply with applicable requirements, and as further specified in 3.7. Regulatory bodies include the European Joint Aviation Authorities (JAA), Transport Canada (TC) and the United States Federal Aviation Administration (FAA). The JAA, TCCA and the FAA regulate the airworthiness of airplanes with the following standards :

JAR/AWM/FAR part 23 for normal, utility, acrobatic, and commuter category airplane.

JAR/AWM/FAR part 25 for transport category airplane.

Consideration shall also be given to JAA/TC/FAA operating regulations.

3.2.2 Ground-Based GIDS: The ground-based GIDS shall comply with JAA/TC/FAA operation regulations, and shall ensure detection of frozen contamination and/or fluid condition monitoring in compliance with the operator's approved deicing program.

The ground-based GIDS shall also be compatible with the airplane airworthiness requirements.

3.3 Complex Hardware and Software Design:

The design of complex hardware such as large scale integrated circuits shall follow the guidelines specified in document EUROCAE ED-80/RTCA DO-254 "Design Assurance Guidance for Airborne Electric Hardware".

3.3.1 Onboard GIDS: Software design shall follow the guidelines specified in document EUROCAE ED-12/RTCA DO-178 "Software Considerations in Airborne Systems and Equipment Certification". The software criticality level will depend on the particular GIDS function and application as defined by the airplane specification.

3.3.2 Ground-Based GIDS: Software design shall follow the guidelines specified in document EUROCAE ED-12/RTCA DO-178 “Software Considerations in Airborne Systems and Equipment Certification”. The software criticality level will depend on the particular GIDS function and application.

3.4 Technical Requirements:

3.4.1 Materials: Materials shall be of a quality which experience and/or tests have demonstrated to be suitable and dependable for use in the GIDS.

3.4.2 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 secured 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.

3.4.3 Electrical Bonding and Grounding: The GIDS 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 the airplane structure, which may be done by dedicated faying surface contacts, bonding jumper or by wiring through an interface connector. On non-conductive 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 GIDS. The maximum resistance across any bonding or grounding junction shall be 0.25 , as manufactured.

3.4.4 Interchangeability: All LRU’s having the same part number, shall be interchangeable with each other physically and functionally.

3.4.5 Marking: Information marked on the manufacturer's nameplate on the GIDS shall follow the guidelines of JAR 21.609 (e) and 21.807 (b) and/or FAR 21.607(d) unless otherwise specified. If the component includes software, the part number shall either include hardware and software identification, or use separate part numbers for hardware and software identification. The part number must uniquely identify the hardware and software design, including modification status.

3.5 Minimum Structural Requirements:

3.5.1 Exposure During Normal Operations: GIDS parts exposed to the external environment should be designed to withstand the temperature, pressure, chemical and/or radiation environment associated with deicing/anti-icing conditions. GIDS parts exposed to the external environment should be designed to withstand impact from ice particles shed from the airplane and remain functional.

3.5.2 Foreign Object Damage (FOD): The sensor should be constructed so that parts do not become loose in service. In the normal operating environment, it should withstand strains, impacts, vibrations, and damage from foreign objects. The GIDS is not required to remain functional in order to satisfy this requirement.

Ice formation on the protruding parts of the ONBOARD GIDS shall not represent a FOD risk for the airplane parts installed downstream.

3.6 Human Factors:

Design of any GIDS should include consideration of the applicable human factors as enumerated in MIL-STD-1472. As a minimum, each design shall consider the following factors:

3.6.1 Hazards: If the GIDS can produce a hazard to personnel or property then a warning label shall be prominently provided on or close to the unit. The GIDS shall not produce toxic fumes under any fault conditions. Except for small parts that would not significantly contribute to the propagation of fire, all materials used must be self-extinguishing.

3.6.2 Displays: The display design shall :

a. utilize natural and meaningful symbology that is readily understood.

b. provide information that is immediately discernible.

c. provide an indication when the GIDS is inoperative.

If a display is to operate in conjunction with a GIDS, then the requirements of the latest issues of SAE ARP4256, ARP582, ARP798, ARP4102, ARP4102/4, ARP4102/7, ARP4102/8, AS8034 and JAA/FAA/TCCA-AWM 23.1322 and 25.1322 regarding displays shall be considered. It may be useful to also consider the Joint Service Specification Guide JSSG-2010-5 “Crew Systems, Aircraft Lighting Handbook” paragraph 3.5.2.1.8.5 Visual Displays.

3.7 Safety Requirements:

3.7.1 Design for Safety: All aspects of the ice detection system design should be considered in terms of safety. The GIDS system should be designed so that, when installed:

1. Those features required for type certification or operational approval, or whose improper functioning would reduce safety, perform as intended under the airplane operating and environmental conditions.

2. The systems and associated components, considered separately and in relation to other systems, should be designed so that failure conditions classification and effects must be in compliance with JAR/FAR/AWM 523/23.1301, 523/23.1309, 525/25.1301, 525/25.1309, where applicable. Information concerning unsafe operating conditions must be provided to the crew.

3. GIDS must be designed, installed, operated, and maintained according to applicable safety standards defined by the authority having jurisdiction, including the requirements of RTCA/DO216 § 3.3.6.2.3 when applicable.

4. In order to assist designers, manufacturers, installers and certification authorities with the safety aspects associated with ONBOARD GIDS design, the following two SAE documents are referenced:

EUROCAE ED-79/SAE ARP4754 - Certification Considerations for Highly-Integrated or Complex Aircraft Systems.

SAE ARP4761 - Guidelines and Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment.

3.7.2 Failure Analysis: Undetected failure rate and MTBF of the GIDS shall be determined by failure analysis in accordance with AMJ 25.1309 or AC 25.1309.

The failure analysis shall include False Negatives.

3.7.3 Detection Reliability: The detection reliability is the capability to recognize frozen contamination when frozen contamination is present on the monitored surface. The detection reliability can be influenced by the physical measurement principle and the position of the sensor(s).

The detection reliability shall be included in the failure analysis.

NOTE: Chapters 6 and 7 define test procedures that demonstrate detection capability of the system.

3.8 GIDS Operation:

3.8.1 GIDS Controls: The operation of GIDS controls intended for use during normal operations, in all possible positions, combinations and sequences, shall not result in a condition the presence or continuation of which would be detrimental to the continued performance of the GIDS.

GIDS controls which are not intended to be adjusted in normal operation shall not be readily accessible to the ground and/or flight crew.

3.8.2 Data Processing: Following acquisition, the processing and interpretation of essential data by the GIDS shall be automatic.

The system shall be designed in such a manner as to preclude the display of output data unless all the input data required for proper computation are acquired and validated.

3.8.3 Onboard GIDS Activation: Onboard GIDS may need:

a. to have a means on the flight deck to activate and de-activate the display while the airplane is on ground,

b. to automatically inhibit the display during the take off roll,

c. to remain dormant in flight.

3.8.4 Built In Test Equipment (BITE): The GIDS shall include a confidence (BITE) test.

The test function shall be automatic during operation.

The GIDS shall indicate when the system is not operational.

Built-In Test Equipment (BITE) shall ensure the safety objectives and the reliability requirements as defined in 3.7. BITE shall annunciate detected GIDS failures to the appropriate crew.

3.8.5 Nuisance Alarms: Nuisance alarms should be minimized.

3.8.6 Operating Weather Conditions: The GIDS shall operate under the following conditions:

Outside Air Temperature from +20 °C and down to -40 °C,

Frost,

Visibility conditions down to 100 meters,

Snow (Wet or Dry),

Fog or Freezing Fog,

Freezing Drizzle,

Light Freezing Rain,

Rain.

3.9 Qualification Tests:

3.9.1 Responsibility for Testing: The manufacturer of the product shall be responsible for performing and documenting all required tests specified in Chapters 5, 6 and 7 to demonstrate compliance with this AS/MOPS.

If a manufacturer intends to seek regulatory approval for a limited application of a GIDS (e.g., sensors for cold-soak icing only, or fluid condition monitoring in the absence of frozen contamination) then the manufacturer is responsible for choosing the tests specified in Chapter 6 and 7 that are appropriate for demonstrating compliance with that subset of the MOPS. Such limitations shall be documented in accordance with 3.10.4. According to 6.1.1 and 7.1.1, a test plan and test procedures shall be prepared, and may be submitted to the appropriate authorities for review. Any deviation in the prepared test procedures with this standard shall be highlighted and justified.

3.9.2 Test Article: The tests shall be conducted with one or more GIDS that are in full conformity with production build. If the tested item incorporates features that are still experimental or in the development stage, any tests involving the non-production features shall be repeated later on a production item, or evidence presented to substantiate that the test results are valid for the production instrument.

3.9.3 Effects of Tests: Unless otherwise stated, the design of the system shall be such that during and after the application of the tests specified in Chapters 5, 6 and 7, no condition exists which would be detrimental to the subsequent performance of the GIDS.

As a minimum performance requirement, the test articles shall complete all tests without maintenance and without necessity to re-calibrate the test articles.

3.10 Reports and Declarations:

3.10.1 Summary Test Report: The GIDS manufacturer shall prepare a summary report declaring the following :

a. The part number and serial number, which identifies the GIDS as tested, and revision number if applicable.

b. A statement of all performance tests that have been successfully completed.

c. A specific statement for each performance test that was not performed or successfully completed.

d. A specific statement for each declared or identified operational GIDS limitation.

e. The summary report shall include the support data, see Appendix B paragraph B.4.5.5.

f. An environmental Qualification Form, in accordance with EUROCAE ED-14/RTCA DO-160, indicating which environmental tests were conducted and where applicable, the resulting environmental category of the GIDS.

g. Compliance with Requirements of EUROCAE ED-12/RTCA DO-178 and submission of supporting data.

3.10.2 Substantiating Test Data/Analysis: The GIDS manufacturer shall compile and make available for review all the following :

a. A description of the test facility and test procedures used.

b. The test results and technical data which substantiate the declarations of 3.10.1.

c. The processing cycle and/or refresh rate of the GIDS from data acquisition to final display.

d. Failure modes and effects analysis.

The foregoing information shall be available by referencing the appropriate sections of this AS/MOPS.

3.10.3 Operating Procedures: A set of operating procedures for each specific GIDS shall be developed.

3.10.4 Declarations: The GIDS manufacturer shall document and clearly identify all operational limitations which are applicable to the GIDS such as:

Lighting conditions,

Airplane surfaces compatibility,

Angle of viewing,

Range from sensor to the surface subject to inspection,

Visibility,

Vibrations during operations,

Movement between the GIDS and the target during acquisition cycle,

Any other limitations.

These limitations shall also be stated in the Summary report.

4. MINIMUM PERFORMANCE SPECIFICATION

This chapter defines the minimum performance criteria that shall be used for the design of GIDS described in 1.2 and 1.3. Chapter 7 defines the performance and validation methods for the GIDS when installed.

4.1 Frozen Contamination Detection:

Under the operating weather conditions given in 3.8.6, a GIDS shall be able to detect the presence of frost, ice, slush, or snow on the surface where the sensor makes its measurement.

4.1.1 Detection Threshold: As a minimum, the detection threshold shall ensure the detection of 0.5 mm thickness of ice and 0.5 mm maximum peak height of frost, or less, continuously distributed over an area of 315 cm² or less. For snow or slush the detection threshold determined in accordance with the tests of Chapter 6 shall be reported and documented.

The detection threshold of 0.5 mm has been chosen for the purpose of testing these devices and is not a statement of the acceptable level of frozen contamination on an airplane. The values of thickness sensitivity and area resolution are based on a consensus of EUROCAE WG54 and the SAE G-12 Ground Ice Detection Subcommittee as to the capability of commonly available technology at the time of the writing of this version of the AS/MOPS.

4.1.1 (Continued):

The GIDS shall provide an indication of this condition in the presence or absence of on-going precipitation in one or more of the following situations:

a. When the airplane surfaces have not been deiced.

b. When used for a post de/anti-icing check immediately following de/anti-icing.

c. When the airplane surfaces, have been de/anti-iced, and where the presence of contamination may be indicated by surface freezing or snow accumulation, random snow accumulation and/or dulling of surface reflectivity caused by the gradual deterioration of the fluid.

4.1.2 Frozen Contamination Above the Detection Threshold: If frozen contamination on the monitored surface is in excess of the detection threshold, the GIDS shall indicate its presence.

4.2 Fluid Condition Monitoring:

Under the operating weather conditions given in 3.8.6, a fluid monitoring sensor shall detect impending ice formation in, on or under the fluid, and shall not require ice build-up on the surface where the sensor makes its measurement.

A GIDS which monitors fluid conditions shall be able to provide an indication relative to the fluid condition.

The information shall include one or more of the following:

fluid dilution.

fluid failure, possibly but not necessarily indicated by surface freezing or snow accumulation, random snow accumulation, and/or dulling of surface reflectivity caused by the gradual deterioration of the fluid.

temperature difference between plate surface temperature and freezing point of the fluid.

estimated time to fluid failure.

4.3 Monitored Surface Finish and GIDS Performance:

A GIDS shall meet the performance criteria defined by 4.1 and 4.2.

The GIDS performance shall not be affected by the material, the surface finish and/or surface treatment of the monitored surface.

The performance of the Remote GIDS shall not be affected by the transition between two surface finishes.

5. MINIMUM PERFORMANCE SPECIFICATION UNDER ENVIRONMENTAL TEST CONDITIONS:

5.1 Introduction:

a. The environmental test conditions and performance criteria described in this section provide a laboratory means of determining the overall performance characteristics of the GIDS under conditions representative of those which may be encountered in actual operation.

b. Unless otherwise specified, the test procedures applicable to the determination of GIDS performance under environmental test conditions are contained in EUROCAE ED-14/RTCA DO-160 “Environmental Conditions and Test Procedures for Airborne Equipment”. For each test, the manufacturer must choose an appropriate category based on the expected application of the GIDS.

c. Some of the environmental tests contained in this section do not have to be performed unless the manufacturer wishes to qualify the GIDS for that particular environmental condition; these tests are identified by the phrase “If Required”. If the manufacturer wishes to qualify the GIDS to these additional environmental conditions, then the “If Required” tests shall be performed.

5.2 Testing:

The following tests determine whether the GIDS can withstand the effects of the following environmental test conditions and applicable test procedures described in document EUROCAE ED-14D/RTCA DO-160D.

The functional tests, defined in EUROCAE ED-14D/RTCA DO-160D, will be performed in relationship to the identified GIDS categories. Compliance will be also verified with the performance and accuracy of the GIDS design requirements defined in Chapter 4 after each environmental test as applicable. As it is not required (and not feasible) to conduct the tests under icing conditions, the acceptance criteria during the tests is limited to the absence of false positive and absence of system dysfunction. The GIDS manufacturer shall provide sufficient functional test data to show compliance of the equipment before, during and after the various tests detailed in the following tables.

5.3 Onboard GIDS:

TABLE 1

Test #	CONDITIONS	ED-14/ DO-160D SECTION	COMPLIANCE REQUIREMENTS	COMMENTS
1	Survival Low Temperature	4.5.1	§ 5.2	
2	Operating Low Temperature	4.5.1	§ 5.2	Limited to -40 °C for equipment parts exposed to external environment
3	Survival High Temperature	4.5.2	§ 5.2	Up to 85 °C for equipment parts exposed to external environment
4	Operating High Temperature	4.5.2	§ 5.2	Limited to +20 °C for equipment parts exposed to external environment
5	In Flight Loss of Cooling	4.5.4	(if required)	
6	Altitude	4.6.1	§ 5.2	
7	Decompression	4.6.2	(if required)	
8	Overpressure	4.6.3	(if required)	
9	Temperature Variation	5.0	§ 5.2	
10	Humidity	6.0	§ 5.2	
11	Operational Shock	7.2	§ 5.2	
12	Crash Safety	7.3	The GIDS shall remain in its mounting and no part of the equipment or its mounting shall have become detached.	This test shall be subject to Airworthiness Standards depending upon type approval basis of the airplane. The application of this test may result in damage to the GIDS. Paragraph 3.9.3 Effects of Tests does not apply.
13	Vibration	8.0	§ 5.2	
14	Explosion	9.0	(if required and if intrinsic safety is not demonstrated))	The application of this test may result in damage to the GIDS. Paragraph 3.9.3 Effects of Tests does not apply.

TABLE 1 (Continued)

Test #	CONDITIONS	ED-14/ DO-160D SECTION	COMPLIANCE REQUIREMENTS	COMMENTS
15	Waterproofness	10.0	§ 5.2	Applicable to equipment parts exposed to external environment only.
16	Fluids Susceptibility	11.0	§ 5.2	Applicable to equipment parts exposed to external environment only.
17	Sand and Dust	12.0	(if required)	
18	Fungus	13.0	(if required)	
19	Salt Spray	14.0	(if required)	
20	Magnetic effect	15.0	(if required)	
21	Power input	16.0	§ 5.2	
22	Voltage spike	17.0	§ 5.2	
23	Audio Frequency Susceptibility	18.0	§ 5.2	
24	Induced Signal Susceptibility	19.0	§ 5.2	
25	Radio Frequency Susceptibility	20.0	§ 5.2	
26	Radio Frequency Emission	21.0	§ 5.2	
27	Lightning Induced Transient Susceptibility	22.0	§ 5.2	
28	Lightning Direct Effects	23.0	§ 5.2	Extent of testing subject to system design and component location.
29	Icing	24.0	(if required)	
30	Electrostatic Discharge	25.0	(if required)	

5.4 Ground-Based GIDS:

TABLE 2

Test #	CONDITIONS	DOCUMENTS SECTION	COMPLIANCE REQUIREMENTS	COMMENTS
1	Survival Low Temperature	ED-14/ DO160D 4.5.1	§ 5.2	Category B2 (-55 °C)
2	Operating Low Temperature	ED-14/ DO160D 4.5.1	§ 5.2	Category B2 limited to -40 °C for GIDS parts exposed to external environment
3	Survival High Temperature	ED-14/ DO160D 4.5.2	§ 5.2	Category B2 (+70 °C)
4	Operating High Temperature	ED-14/ DO160D 4.5.2	§ 5.2	Category B2 limited to +20 °C for GIDS parts exposed to external environment
9	Temperature Variation	ED-14/ DO160D 5.0	§ 5.2	Category C
6	Altitude	ED-14/ DO160D 4.6.1	§ 5.2	If required. 13,000 ft max.
10	Humidity	ED-14/ DO160D 6.0	§ 5.2	Category A for equipment parts not exposed to external environment. Category B for GIDS parts exposed to external environment.
11	Operational Shock	SAE J1211 4.8	§ 5.2	Shipping, handling and installation
13	Vibration	SAE J1211 4.7	§ 5.2	
14	Explosion	ED-14/ DO160D 9.0	(Non applicable)	Category X

TABLE 2 (Continued)

Test #	CONDITIONS	DOCUMENTS SECTION	COMPLIANCE REQUIREMENTS	COMMENTS
15	Waterproofness	ED-14/ DO160D 10.3	§ 5.2	Category S for GIDS parts exposed to external environment.
16	Fluids Susceptibility	ED-14/ DO160D 11.4	Shall sustain De/anti-icing fluids (other fluids if required)	Applicable to GIDS exposed to fluid projections.
17	Sand and Dust	SAE J1211 4.5	(if required)	Dust, sand and gravel bombardment
18	Fungus	ED-14/ DO160D 13.0	(if required)	Conduct test on components only
19	Salt Spray	ED-14/ DO160D 14.0	(if required)	
20	Magnetic effect	ED-14/ DO160D 15.0	(Non applicable)	Category X
21	Power input	DO 216 § 3.2.1.2.5	§ 5.2	If applicable
22	Voltage spike	DO 216 § 3.2.1.5	§ 5.2	If applicable
23	Audio Frequency Susceptibility	ED-14/ DO160D 18.0	§ 5.2	
24	Induced Signal Susceptibility	EN 50082-2	§ 5.2	
25	Radio Frequency Susceptibility	EN 50082-2	§ 5.2	
26	Radio Frequency Emission	EN 50081-2	§ 5.2	
29	Icing	ED-14/ DO160D 24.0	Ensure that all mechanical devices operate satisfactorily.	Category A
30	Electrostatic Discharge	ED-14/ DO160D 25.0	(if required)	

6. TEST PROCEDURES:

6.1 General:

6.1.1 Test Plan, Procedures and Reports: A test plan and test procedures shall be prepared, and may be submitted to the appropriate authorities for review. Any deviation in the prepared test procedures with this standard shall be highlighted and justified.

A report of test results shall be prepared in accordance with 3.10.

Except where tests are GO/NO GO in character (e.g., the determination of whether or not mechanical devices function correctly) the test conditions and actual numerical values obtained for each of the parameters tested shall be recorded.

6.1.2 Power Input Voltage: Unless otherwise specified, all tests shall be conducted at the designed power input voltage. The input voltage shall be measured at the equipment input terminals.

6.1.3 Power Input Frequency: In the case of equipment designed for operation from an AC power source of essentially constant frequency, tests shall be conducted at the designed input frequency.

In the case of equipment designed for operation from an AC power source of variable frequency, unless otherwise specified, tests shall be conducted at the designed input frequency range.

6.1.4 Ambient Conditions: Unless otherwise specified, all tests shall be conducted under conditions of ambient room temperature, pressure, and humidity, as defined in document EUROCAE ED-14/RTCA DO-160, paragraph 3.5.

6.1.5 Warm-up Period: All tests shall be conducted after the warm-up period specified by the manufacturer.

6.1.6 Test Procedures:

a. The following test procedures are considered to be a satisfactory means of establishing compliance with the performance specifications of Chapter 3 and 4.

b. Alternative procedures which provide equivalent information may be used. In such cases, the procedures described in this chapter shall be used as reference criteria for evaluation of such alternative procedures.

c. All test procedures shall be documented.

6.2 Detection Indication:

False Positive and/or False Negative indication shall be reported and the conditions giving rise to the false alarm shall be documented.

In case of False Negative indication, the test is failed.

6.3 Detailed Test Procedures:

The tests given in this section, summarized in Appendix A, and detailed in Appendix B are required to demonstrate the capability of the GIDS to perform the functions as described by 4.1 and 4.2 under the operating weather conditions as given in 3.8.6.

The operating weather conditions of 3.8.6 include environmental factors which affect visibility. Therefore additional tests described by 6.3.3 are required to demonstrate the capability of the Remote GIDS to detect contamination through active precipitation.

The test equipment of 6.3.1.2 including different material surfaces and different surface finishes to comply with 4.3 are included to ensure demonstration of GIDS performance under representative operational conditions. For test purposes, the following surfaces have been selected: Aluminum, polished, unpolished and painted white and red; Fiber re-inforced painted white and red.

To demonstrate the capability to identify frozen contamination, the selected laboratory precipitation conditions specified in 6.3.1.2.1 are considered to be consistent with natural FROST, ICE, SLUSH formation and SNOW.

Test conditions, including methods to generate, control and validate precipitation conditions, are given in Appendix B.

These test conditions have been adapted from and use the same principles as laboratory test procedures under development for airplane deicing/anti-icing fluids (SAE Type I, II, III, and IV) to establish deicing/anti-icing Endurance Time Tables.

Particular tests are specified for detection of laboratory-generated frost:

Remote GIDS tests are based on 'frost' growth on the test surface of a box cooled below ambient temperature in a humid environment.

In-Situ GIDS tests are based on freezing fog accumulation on an otherwise clean plate.

6.3.1 Frozen Contamination Detection (4.1.1):

6.3.1.1 Purpose of the Tests: The purpose of the tests is to demonstrate that the GIDS complies with the minimum performance specifications for the detection of frozen contamination with and/or without FPD fluids.

The tests for In Situ GIDS and Remote GIDS specified by 6.3.1.3 address three applications:

a. Untreated surfaces subject to precipitation: Demonstrate compliance with the performance specification of 4.1.1 under the conditions defined by 4.1.1 a.

b. Contaminated surfaces treated with fluid: Demonstrate compliance with the performance specification of 4.1.1 under the conditions defined by 4.1.1 b.

c. Treated surfaces subject to precipitations: Demonstrate compliance with the performance specification of 4.1.1 under the conditions defined by 4.1.1 c.

6.3.1.2 Test Equipment Required: For more details on equipment requirements refer to Appendix B.

Conduct tests using flat test plates representative of airplane surface materials and finishes, subject to the specified SAE approved deicing and anti-icing fluids, and exposed to artificial precipitation in a temperature-controlled climatic chamber. Alternative procedures, including tests conducted under natural conditions, which provide equivalent information but which require different test equipment may be used (see 6.1.6 b).

Where physical facility limitations exist which influence the set-up and conduct of the tests, these limitations shall be noted.

6.3.1.2.1 Precipitation Conditions:

For laboratory tests:

The test plates are to be exposed to precipitation in accordance with Table B3, see Appendix B (B.5). For tests requiring fluid treatment, exposure to precipitation shall start within 30 seconds after the application of the de/anti-icing fluid.

For tests under natural conditions:

The test plates are to be exposed to natural precipitation for conditions given in Table B3. Tests shall be conducted when the mean precipitation rate is equal to, or greater than the required rate, and the temperature shall be lower or equal to the required value. Actual test conditions shall be reported, as experienced.

6.3.1.3 Test Procedure for Detection of Frozen Contamination: For more details on procedure requirements refer to Appendix B.

Appendix A provides a summary of tests:

- Test set #1 is the list of tests required for In SITU GIDS.

- Test set #2 is the list of tests required for Remote GIDS.

The testing agent shall ensure that all plates are clean at the beginning of each test.

a. Untreated Surface Subject to Precipitation - Paragraph 4.1.1 a

A set of tests shall be conducted to demonstrate the capability of GIDS to identify Frost (test FROST/F0), Ice (test FZDZ-C/F0 and FZRA-C/F0) and Snow (test SN-B/F0) under simulated operating weather conditions in accordance with conditions given in the test matrix of the Appendix B - Table B3.

Conduct tests FROST/F0, FZDZ-C/F0, FZRA-C/F0 and SN-B/F0.

Each time contamination is first detected by a GIDS sensor, measure and record the thickness of frost at the time of detection (test FROST/F0), ice (tests FZDZ-C/F0 and FZRA-C/F0) or snow (test SN-B/F0).

End of test occurs when the GIDS first detects the contamination or when the monitored surface is covered with a contaminated area greater than 315 cm² and with a thickness greater than 0.5 mm.

6.3.1.3 (Continued):

Acceptance Criteria

For tests FROST/F0, FZRA-C/F0 and FZDZ-C/F0, the contamination thickness measured shall not exceed the threshold criteria as defined in 4.1.

For test SN-B/F0 and in accordance with 4.1, there are no threshold thickness criteria for snow. However, the detection threshold thickness shall be measured and reported.

Test Reporting

Document the test procedures, thickness measurement methods and results for each test conducted.

b. Contaminated Surface Treated With Fluid - Paragraph 4.1.1 b

A set of tests shall be conducted at -10 °C +1/-2 to demonstrate the capability of GIDS to identify residual ice under a fluid layer in accordance with the criteria defined in 4.1.1 b. For these tests Ethylene glycol, Diethylene glycol and Propylene glycol based fluids shall be used.

Develop a layer of ice on each plate, within or over the sensing area of the sensor subject to test in order to ensure a maximum thickness of 0.5 mm and a maximum area of 315 cm² of ice after the fluid application. Only for this test, and in order to ensure a significant fluid thickness over the contamination, the plates shall be horizontal.

The sensor, or all sensors of the GIDS involved in the test shall indicate the presence of ice.

Pour a Type I fluid as described in Appendix B on each test plate.

Repeat the test with a Type II and a Type IV neat and Type I followed by Type II or Type IV fluid layer of 3 mm 0.5 mm thickness over the ice patch at the start of the GIDS observation. (As a minimum, Type I followed by Type II and IV shall be limited to only one compatible glycol base.)

For Type I tests, ensure that the test start is conducted within a maximum of 15 seconds from the time of pouring the fluid.

For Type II or Type IV tests, a retainer placed on the plate may be used to ensure that 3 mm ± 0.5 is achieved.

6.3.1.3 (Continued):

For Type I followed by Type II/IV, the following procedure may be used: Pour Type I, allow to drain for a maximum of 15 seconds after fluid application. Place the retainer, and pour Type II or Type IV. Ensure that 3 mm ± 0.5 mm above the ice patch is achieved. An alternative method may be used provided 3 mm ± 0.5 mm is achieved.

The fluid selection process is described in Appendix B.

Acceptance Criteria for IN SITU GIDS

The sensor, or all sensors of the GIDS involved in the test shall indicate the presence of ice after the fluid(s) application.

Acceptance Criteria for REMOTE GIDS

Verify that the remote GIDS indicates the presence of ice after the fluid(s) application. Verify that the displayed contamination formation(s) displayed is (are) consistent with the visual observation of ice present (if required).

Test Reporting

Document the test procedures, fluids used, thickness measurement methods and results for each test conducted.

c. Treated Surface Subject to Precipitation - Paragraph 4.1.1 c

A set of tests shall be conducted to demonstrate the capability of GIDS to identify fluid contamination resulting from exposure to simulated operating weather conditions in accordance with the conditions given in the test matrix of Appendix B - Table B3 and summarized here after:

Type I Fluid:FZDZ-C/F1, SN-E/F1,

Type II Fluid: FZDZ-C/F2, FZRA-C/F2, FZRA-B/F2, SN-B/F2, SN-D/F2,

Type IV Fluid: FZDZ-C/F4, FZRA-C/F4, FZRA-B/F4, SN-B/F4, SN-D/F4.

The fluid selection process is described in Appendix B.

6.3.1.3 (Continued):

For these tests Ethylene glycol, Diethylene glycol, and Propylene glycol based fluids shall be used, with the fluid for each test selected randomly.

Within 30 seconds of the start of the test (Start time = T0) all plates are to be treated with FPD fluid.

Before the start of precipitation, verify the absence of False Positives that could be induced by the presence of fluid on the test plate(s).

Start Precipitation at T0 and conduct tests FZDZ-C/F1, SN-E/F1, FZDZ-C/F2, FZRA-C/F2, FZRA-B/F2, SN-B/F2, SN-D/F2, FZDZ-C/F4, FZRA-C/F4, FZRA-B/F4, SN-B/F4 and SN-D/F4.

Each time contamination is first detected by a GIDS sensor, record the visual pattern of failure on the plate and evaluate the contamination thickness over the failure area and more specifically over the surface where the sensor makes its measurement at the time of detection.

End of test occurs when the GIDS first detects the contamination or when the monitored surface is covered with a contaminated area greater than 315 cm² and with a thickness greater than 0.5 mm.

Test reporting

Document the test procedures, fluids used, thickness evaluation methods, the visual fluid pattern of failure and results for each test conducted.

6.3.1.4 Frozen Contamination Above the Detection Threshold: Validate by analysis or by tests that frozen contamination on the monitored surface in excess of the detection threshold will be detected by the GIDS when validated by tests the following method shall be used:

Develop a layer of ice on each plate (plates 1-6). The sensor manufacturer shall declare the thickness above the detection threshold and the tolerance for testing.

The sensor, or all sensors of the GIDS, involved in the test shall indicate the presence of ice.

6.3.2 Fluid Condition Monitoring (4.2):

6.3.2.1 Purpose of the Tests: The purpose of these tests is to demonstrate that the fluid condition monitoring GIDS complies with the minimum performance specifications of 4.2 for monitoring deicing or/and anti-icing fluid condition, and to verify the ability of the GIDS to provide indications relative to the fluid conditions defined in 4.2.

6.3.2.2 Test Equipment Required: Test setup is identical to 6.3.1.2.

6.3.2.3 Test Procedure for Fluid Condition Monitoring: Appendix A provides a summary of all the tests that shall be performed. Test set #3 is the list of tests required for fluid conditions monitoring GIDS.

A set of tests shall be conducted in accordance with conditions given in the test matrix of the Appendix B - Table B3 and summarized here after:

Type I Fluid:FZDZ-C/F1, SN-E/F1,

Type II Fluid: FZDZ-C/F2, FZRA-C/F2, FZRA-B/F2, SN-B/F2, SN-D/F2,

Type IV Fluid: FZDZ-C/F4, FZRA-C/F4, FZRA-B/F4, SN-B/F4, SN-D/F4.

The fluid selection process is described in Appendix B.

The testing agent shall ensure that all plates are clean at the beginning of each test.

Within 30 seconds of the start of the test (Start time = T0) all plates are to be treated with FPD fluid.

Before the start of precipitation, verify the absence of a False Positive that could be induced by the presence of fluid on the test plate(s).

Start Precipitation at T0 and conduct tests FZDZ-C/F1, SN-E/F1, FZDZ-C/F2, FZRA-C/F2, FZRA-B/F2, SN-B/F2, SN-D/F2, FZDZ-C/F4, FZRA-C/F4, FZRA-B/F4, SN-B/F4 and SN-D/F4.

The GIDS indications, the plate visual aspect, and the temperature of the plate (applicable if the GIDS uses the temperature buffer to provide an indication on the fluid condition) shall be recorded continuously or by time increment by any standard means.

During the test, fluid samples and plate temperature shall be taken at appropriate time increments and each time an unsafe fluid condition is first detected by a GIDS sensor.

6.3.2.3 (Continued):

Fluid sampling locations shall be selected such as to be representative of the conditions over the sensing area without influencing the sensor measurements.

Stagger the collection of samples, identify each sample and measure its refractive index to determine fluid dilution level during or after the tests.

Each time an unsafe fluid condition is first detected by a GIDS sensor, sample the fluid, record the visual pattern of failure on the plate, and evaluate the contamination thickness over the failure area, and more specifically, over the surface where the sensor makes its measurement at the time of detection.

End of test occurs when the GIDS first detects the contamination or when the monitored surface is covered with a contaminated area greater than 315 cm² and with a thickness greater than 0.5 mm.

Acceptance Criteria

During the test and at the end of the test, verify that GIDS indications are consistent with the true fluid conditions measured.

The GIDS shall indicate unsafe fluid conditions consistent with a fluid failure.

Test Reporting

Document the test procedures, fluids used, fluid sampling method, thickness evaluation methods, and the visual fluid pattern of failure. Report measurement values and results for each test conducted.

6.3.3 Area Detection and Visibility Tests for Remote GIDS:

6.3.3.1 Purpose of the Tests: The purpose of the tests is to demonstrate that the remote GIDS complies with the minimum performance specifications of 4.1 under visibility conditions as specified by 3.8.6.

6.3.3.2 Test Equipment Required: The test setup is identical to 6.3.1.2.

6.3.3.3 Test Procedure for Area Detection and Visibility Test: Appendix A, provides a summary of all the tests that shall be performed. Test set #4 is the list of tests required for Remote GIDS visibility tests.

Conduct tests to demonstrate the ability of the remote GIDS sensor to detect an area of 315 cm² of ice on a test plate at the maximum distance of use in accordance with the conditions specified in 3.8.6.

Develop 0.5 mm of ice on each plate over one circular area of 315 cm².

The GIDS, when inspecting the plates without precipitation, shall indicate the presence of contamination.

Conduct tests with the following precipitation conditions:

- FZFG-V with visual interference equivalent to a field visibility of 100 m.
- SN-V between the plates and the sensor(s), and encompassing the sensor field of view..
- FZDZ-V between the plates and the sensor(s), and encompassing the sensor field of view.
- FZRA-V between the plates and the sensor(s), and encompassing the sensor field of view.

Acceptance Criteria

The sensor(s), when inspecting the plates through active precipitation, shall continue to indicate the presence of contamination.

Test reporting

Document the test procedures, precipitation rates, measurement methods and results.

Include the following:

- Distance between the GIDS and the plate.
- Visibility conditions and precipitation characteristics.

7. INSTALLED EQUIPMENT PERFORMANCE:

7.1 Introduction:

This chapter specifies the minimum acceptable level of performance and test procedures for verifying the performance of the GIDS when installed. This chapter does not specify means to show compliance with regulatory requirements. Installed performance criteria are generally the same as those contained in Chapter 4, which were verified through laboratory and environmental tests. However, certain performance parameters may be affected by the physical installation and can only be verified after installation. The installed performance limits specified below take these situations into consideration.

7.1.1 Test Plan, Procedures and Reports: A test plan and test procedures shall be prepared, and may be submitted to the appropriate authorities for review. Any deviation in the prepared test procedures with this standard shall be highlighted and justified.

A report of test results shall be prepared in accordance with 3.10.

Except where tests are obviously GO/NO GO in character (e.g., the determination of whether or not mechanical devices function correctly) the actual numerical values obtained for each of the parameters tested shall be recorded.

7.2 Installed Equipment Requirements:

7.2.1 General:

7.2.1.1 Installation: The GIDS shall be compatible with the physical and environmental conditions present in the installed location. Installation of the equipment should permit ease of access for maintenance and testing. It shall be physically impossible to install the GIDS improperly.

7.2.1.2 Display Visibility: The user(s) shall have an unobstructed view of the displayed data when in the normal operating position. Display intensity shall be adequate for data interpretation under all relevant operating conditions.

7.2.1.3 Controls Accessibility: Controls shall be readily accessible from the user's normal operating position.

7.2.1.4 Failure Protection: Any probable failure of the GIDS shall not degrade the normal operation of any other equipment or systems.

Failure of interfaced equipment or systems shall not degrade the safe operation of the GIDS. The validity of signals from interfaced equipment or systems shall be considered in the BITE as defined in 3.8.4.

7.2.1.5 Interference Effects: The GIDS shall not be the source of harmful interference and shall not be adversely affected by interference from other equipment or systems.

7.2.1.6 Documentation: Documentation provided with installed systems shall incorporate the operating procedures defined in accordance with 3.10.3.

If any operational limitations (see 3.10.4) are applicable to the GIDS, these limitations shall clearly be stated in the documentation provided with the system.

7.2.2 Technical:

7.2.2.1 Power Source: The GIDS shall meet its performance criteria when supplied with the specified electrical power.

Protection against inadvertent turnoff should be provided.

7.2.2.2 Aerodynamic Compatibility: The onboard GIDS shall not adversely affect the airplane flying qualities.

7.2.2.3 Thermal Compatibility: The thermal characteristics of the GIDS shall not affect its ability to accurately perform its intended function.

7.2.2.4 Self Heating: If onboard surface mounted sensors incorporate any electrical devices or components, the power dissipation shall be such that, the resulting temperature rise at the sensing surface level is always less than 0.25 °C when the sensor is mounted on the airplane surfaces, unless heating is part of the contamination detection principle.

7.2.2.5 Intrinsic Safety: The requirements of EN 50020 or IEC 0079 part 11 or any local requirements apply to GIDS where installation locations could be made hazardous by the presence of explosive gas or vapor.

7.2.2.6 External Light: The GIDS performance shall not be affected by natural and artificial visible and non-visible light conditions.

7.2.2.7 Operation During Reduced Visibility Conditions: The GIDS performance shall not be affected by reduced visibility conditions resulting from operations under environmental conditions defined in 3.8.6.

7.2.2.8 Compatibility With the Monitored Surface: The GIDS performance shall not be affected by the material, the surface finish and/or surface treatment of the airplane monitored surface.

7.2.2.9 Non-Frozen Contaminants on the Monitored Surface: GIDS performance should not be affected by non-frozen contaminants on the monitored surface. Any non-frozen contaminants identified by the manufacturer and/or end users to affect the performance of the GIDS shall be documented in the summary test report.

7.2.2.10 Dynamic Response: The GIDS performance shall not be affected by the dynamic operating conditions of installation (user, vehicle, and airplane movement encountered during ground operations).

7.2.2.11 Electromagnetic Interference Effects: The GIDS shall not be the source of harmful electromagnetic interference and shall not be adversely affected by electromagnetic interference from other equipment or systems.

7.2.2.12 Fluid Foaming Effects: The GIDS should not be affected by foaming in applied de/anti-icing fluids.

7.3 Installed Equipment Performance:

Installed GIDS shall comply with the requirements of 3.2 and the operator's approved deicing program.

The GIDS shall achieve, when installed, the performance specified in Chapter 4, taking into account the following:

If the surface where a GIDS sensor makes its measurement is smaller than the monitored surface, the capacity of the GIDS to assess the condition of the monitored surface shall be demonstrated.

7.3.1 Onboard GIDS: Sensing unit(s) shall be located on the airplane, either by analysis or by experiment, so as to ensure detection of frozen contamination or monitoring of fluid condition in compliance with the operator's deicing program and regulatory requirements.

7.3.2 Ground-Based GIDS: The installation, sensor resolution and/or operation of the sensing unit(s) shall be determined, either by analysis or by experiment, so as to ensure detection of frozen contamination or monitoring of fluid condition in compliance with the operator's deicing program and regulatory requirements.

7.4 Conditions of Test:

7.4.1 Safety Precautions: Any unusual characteristics or hazards to personel or property (e.g., laser radiation, etc.) resulting from operation of the GIDS shall be analyzed and documented before the test.

While the materials, methods, applications, and processes described or referenced in this procedure may involve the use of hazardous materials, this procedure does not address the hazards that may be involved in such use. It is the sole responsibility of the user to ensure familiarity with the safe and proper use of any hazardous materials and processes, and to take the necessary precautionary measures to ensure the health and safety of all personnel involved.

7.4.2 Power Input: The test(s) shall be conducted with the GIDS powered by the installed equipment electrical power generating system.

7.4.3 Associated Equipment and Systems: All other electrical or mechanical equipment likely to be operated simultaneously on ground shall be activated for the test(s).

7.4.4 Environment: During the test, the environmental conditions shall not exceed those specified by the airplane manufacturer or ground support equipment manufacturer, as applicable, and accepted by the GIDS manufacturer.

7.4.5 Warm-up Period: All tests shall be conducted after a warm-up period as specified by the manufacturer.

7.5 Test Procedures for Installed Equipment Performance:

7.5.1 General: These test procedures are aimed at demonstrating proper operation (qualitative) of the installed GIDS, since simulation of all icing conditions listed in 3.8.6 is usually not feasible, they also address additional conditions that are not covered by Chapter 6 tests.

7.5.2 Ground Test Procedure: Testing will consist of compatibility and operational tests. A simulated detector output may be used to demonstrate proper operation of the display and other parts of the system operation.

7.5.2.1 Conformity Inspection: The installed GIDS shall be inspected to determine conformity with acceptable workmanship and engineering practices, that proper mechanical and electrical connections have been made, and that the equipment is installed in accordance with the manufacturer's recommendations.

7.5.2.2 Maintainability: Verify access and removal of the equipment in accordance with the best maintenance practices.

Verify that it is not possible to incorrectly install or connect any Line Replaceable Unit (LRU).

7.5.2.3 System Operations: The installed system shall be operated according to the documented system operating procedures. Proper function shall be verified.

Validate that the Remote GIDS display correctly identifies the inspected surface.

7.5.2.4 Interference Effects:

General: The effects of some possible interference which may affect the GIDS performance are not always easy to identify through dedicated tests. Therefore, when reliable tests cannot be defined to validate the effect of some possible interference, the GIDS behavior may need to be monitored for an appropriate period of time to demonstrate its functionality under actual operating conditions.

Thermal compatibility: Validate that the thermal characteristics of the GIDS do not affect its ability to accurately perform its intended function.

Sensor self-heating: Validate that IN SITU sensor self-heating will not increase the temperature of the sensor surface by more than that specified in 7.2.2.4, unless heating is part of the contamination detection principle.

External light: Validate that GIDS performance is not affected by artificial or natural external light (visible and/or non-visible).

Operation under reduced visibility conditions: Validate that Remote GIDS performance is not affected by reduced visibility conditions.

Compatibility with the monitored surface: Validate that GIDS performance is not affected by the material, the surface finish and/or surface treatment of the airplane monitored surface.

Non-frozen contaminants on the monitored surface: Validate that GIDS performance is not affected by non-frozen contaminants (e.g., grease, dirt, fuel) commonly occurring in airplane operation and maintenance. If tests show that non-frozen contaminants affect the frozen contamination detection or fluid monitoring abilities of the GIDS, this limitation shall be noted in the GIDS documentation supplied to the operator.

Dynamic Response: Validate that GIDS performance is not affected by dynamic operating conditions of installation (user, vehicle, and airplane movement encountered during ground operations).

Electromagnetic Interference and Electromagnetic Compatibility: Validate that the GIDS is not the source of harmful interference and is not adversely affected by interference from other equipment or systems.

Fluid Foaming Effects: De/anti-icing fluids shall be applied according to the standard de/anti-icing methods as defined by the operator's approved program. If tests show that foaming of applied de/anti-icing fluids affects the frozen contamination detection or fluid monitoring abilities of the GIDS, this limitation shall be noted in the GIDS documentation supplied to the operator.

7.5.2.5 Power Supply: Under installed conditions, verify the proper operation of the equipment.

7.5.2.6 Displays and Controls Accessibility: Demonstrate that all equipment controls and displayed data are readily accessible, intuitive and easily interpreted.

7.5.2.7 Frozen Contamination Detection and Fluid Monitoring: The GIDS shall be monitored to demonstrate its functionality under actual operating conditions and tested as follows:

a. When the airplane surfaces have not been deiced.

   Determine the presence of frozen contamination consistent with the GIDS performance criteria defined in 4.1.1.

b. When used for a post de/anti-icing check immediately following de/anti-icing.

   Determine the presence of frozen contamination consistent with the GIDS performance criteria defined in 4.1.1.

c. When airplane surfaces have been de/anti-iced.

   Tests shall be conducted on a stationary airplane under conditions of winter precipitation to demonstrate that the GIDS or an array of GIDS indicates the onset of an unsafe condition.

NOTE: The Operator may define additional GIDS acceptance tests prior to receipt of the GIDS for service use.

7.5.3 Flight Test Procedure:

Aerodynamic compatibility: The onboard GIDS shall not adversely affect the flying qualities of the airplane.

PREPARED UNDER THE JURISDICTION OF
SAE SUBCOMMITTEE G-12ID, ICE DETECTION OF
COMMITTEE G-12, AIRCRAFT GROUND DEICING

APPENDIX A

Test Set 1: **Minimum Tests Required to Demonstrate Frozen Contamination Detection, Applicable to In-Situ GIDS**

Test Set: #1-1 Test Plate 1

Test #	Precip. Type	Precip. Rate ($g/dm^2/h$)	Temperature (Deg. C)	Fluid	Precip. ID / fluid.
FROZEN CONTAMINATION DETECTION: Paragraph 4.1.1 a) – BEFORE DEICING					
1	Freezing Fog	2,0	-10	None	FROST / F0
2	Freezing Drizzle	5,0	-10	None	FZDZ-C / F0
3	Light Fr. Rain	13,0	-10	None	FZRA-C / F0
4	Snow	25,0	-3	None	SN-B / F0
FROZEN CONTAMINATION DETECTION Paragraph 4.1.1 b) – FOLLOWING DEICING					
5	None	-	-10	Ice under Type I (D base)	-
6	None	-	-10	Ice under Type I (E base)	-
7	None	-	-10	Ice under Type I (P base)	-
8	None	-	-10	Ice under Type II (E base)	-
9	None	-	-10	Ice under Type II (P base)	-
10	None	-	-10	Ice under Type IV (E base)	-
11	None	-	-10	Ice under Type IV (P base)	-
12	None	-	-10	Ice under Type I+II (E or P base)	-
13	None	-	-10	Ice under Type I+IV (E or P base)	-
FROZEN CONTAMINATION DETECTION: Paragraph 4.1.1 c) – PRIOR TO TAKEOFF					
14	Freezing Drizzle	5,0	-10	Type I (D, E or P base)	FZDZ-C / F1
15	Freezing Drizzle	5,0	-10	Type II (E or P base)	FZDZ-C / F2
16	Freezing Drizzle	5,0	-10	Type IV (E or P base)	FZDZ-C / F4
17	Light Fr. Rain	13,0	-10	Type II (E or P base)	FZRA-C / F2
18	Light Fr. Rain	13,0	-10	Type IV (E or P base)	FZRA-C / F4
19	Light Fr. Rain	25,0	-3	Type II (E or P base)	FZRA-B / F2
20	Light Fr. Rain	25,0	-3	Type IV (E or P base)	FZRA-B / F4
21	Snow	10,0	-10	Type I (D, E or P base)	SN-E / F1
22	Snow	25,0	-3	Type II (E or P base)	SN-B / F2
23	Snow	25,0	-3	Type IV (E or P base)	SN-B / F4
24	Snow	25,0	-10	Type II (E or P base)	SN-D / F2
25	Snow	25,0	-10	Type IV (E or P base)	SN-D / F4

Sub-Total, Test set #1 = 25 tests

Test Set: #1-2 Test Plate 2

Sub-Total, Test set #2 = 25 tests

Test Set: #1-3* Test Plate 3 *Only required if GIDS is to be installed in a composite surface

Sub-Total, Test set #3 = 25 tests

Total Tests: In-Situ Sensors (Sets 1-1,1-2): 50, plus 25 additional tests (Set #1-3), if required.

Test Set 2: **Minimum Tests Required to Demonstrate Frozen Contamination Detection, Applicable to Remote GIDS**

Test Set: #2-1 Test Plate 1 at minimum sight angle and maximum distance.

Test #	Precip. Type	Precip. Rate (g/dm2/h)	Temperature (Deg. C)	Fluid	Precip. ID / fluid.
FROZEN CONTAMINATION DETECTION: Paragraph 4.1.1 a) – BEFORE DEICING					
1	Frost	-	< 0	None	FROST / F0
2	Freezing Drizzle	5,0	-10	None	FZDZ-C / F0
3	Light Fr. Rain	13,0	-10	None	FZRA-C / F0
4	Snow	25,0	-3	None	SN-B / F0
FROZEN CONTAMINATION DETECTION Paragraph 4.1.1 b) – FOLLOWING DEICING					
5	None	-	-10	Ice under Type I (D base)	-
6	None	-	-10	Ice under Type I (E base)	-
7	None	-	-10	Ice under Type I (P base)	-
8	None	-	-10	Ice under Type II (E base)	-
9	None	-	-10	Ice under Type II (P base)	-
10	None	-	-10	Ice under Type IV (E base)	-
11	None	-	-10	Ice under Type IV (P base)	-
12	None	-	-10	Ice under Type I+II (E or P base)	-
13	None	-	-10	Ice under Type I+IV (E or P base)	-
FROZEN CONTAMINATION DETECTION: Paragraph 4.1.1 c) – PRIOR TO TAKEOFF					
14	Freezing Drizzle	5,0	-10	Type I (D, E or P-base)	FZDZ-C / F1
15	Freezing Drizzle	5,0	-10	Type II (E or P base)	FZDZ-C / F2
16	Freezing Drizzle	5,0	-10	Type IV (E or P base)	FZDZ-C / F4
17	Light Fr. Rain	13,0	-10	Type II (E or P base)	FZRA-C / F2
18	Light Fr. Rain	13,0	-10	Type IV (E or P base)	FZRA-C / F4
19	Light Fr. Rain	25,0	-3	Type II (E or P base)	FZRA-B / F2
20	Light Fr. Rain	25,0	-3	Type IV (E or P base)	FZRA-B / F4
21	Snow	10,0	-10	Type I (E or P-base)	SN-E / F1
22	Snow	25,0	-3	Type II (E or P base)	SN-B / F2
23	Snow	25,0	-3	Type IV (E or P base)	SN-B / F4
24	Snow	25,0	-10	Type II (E or P base)	SN-D / F2
25	Snow	25,0	-10	Type IV (E or P base)	SN-D / F4

Sub-Total, Test set #1 = 25 tests

Test Set: #2-2 Test Plate 2 at minimum sight angle and maximum distance

Sub-Total, Test set #2 = 25 tests

Test Set: #2-3 Test Plate 3 at minimum sight angle and maximum distance

Sub-Total, Test set #3 = 25 tests

Test Set: #2-4 Test Plate 4 at minimum sight angle and maximum distance

Sub-Total, Test set #4 = 25 tests

Test Set: #2-5 Test Plate 5 at minimum sight angle and maximum distance

Sub-Total, Test set #5 = 25 tests

Test Set: #2-6 Test Plate 6 at minimum sight angle and maximum distance

Sub-Total, Test set #6 = 25 tests

Total number of tests at minimum sight angle and maximum distance : 150 Tests

Repeat test set 2-1 to 2-6 at maximum sight angle and minimum distance: 150 Tests

Total number of tests for Remote GIDS (All tests) 300 Tests

Test Set 3: **Minimum Tests Required for Fluid Conditions Monitoring GIDS. Applicable to Fluid Conditions Monitoring GIDS**

Test Set: #3-1 Test Plate 1

Test #	Precip. Type	Precip. Rate (g/dm2/h)	Temperature (Deg. C)	Fluid	Precip. ID / fluid.	
FLUID CONDITION MONITORING: Paragraph 4.2						
1	Freezing Drizzle	5,0	-10	Type I (D, E or P-base)	FZDZ-C /	F1
2	Freezing Drizzle	5,0	-10	Type II (E or P base)	FZDZ-C /	F2
3	Freezing Drizzle	5,0	-10	Type IV (E or P base)	FZDZ-C /	F4
4	Light Fr. Rain	13,0	-10	Type II (E or P base)	FZRA-C /	F2
5	Light Fr. Rain	13,0	-10	Type IV (E or P base)	FZRA-C /	F4
6	Light Fr. Rain	25,0	-3	Type II (E or P base)	FZRA-B /	F2
7	Light Fr. Rain	25,0	-3	Type IV (E or P base)	FZRA-B /	F4
8	Snow	10,0	-10	Type I (D, E or P-base)	SN-E /	F1
9	Snow	25,0	-3	Type II (E or P base)	SN-B /	F2
10	Snow	25,0	-3	Type IV (E or P base)	SN-B /	F4
11	Snow	25,0	-10	Type II (E or P base)	SN-D /	F2
12	Snow	25,0	-10	Type IV (E or P base)	SN-D /	F4

Sub-Total, Test set #1 = 12 tests

Test Set: #3-2 Test Plate 2

Sub-Total, Test set #2 = 12 tests

Test Set: #3-3* Test Plate 3 *Only required if GIDS is to be installed in a composite surface

Sub-Total, Test set #3 = 12 tests

Total Tests: In-Situ Sensors (Sets 3-1,3-2): 24, plus 12 additional tests (Set #3-3), if required