



The European Organisation for Civil Aviation Equipment
L'Organisation Européenne pour l'Équipement de l'Aviation Civile

MINIMUM OPERATIONAL PERFORMANCE SPECIFICATION FOR GROUND ICE DETECTION SYSTEMS

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June 2003

Supersedes Document ED-104

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FOREWORD

- 1 The development of document ED-104 "Minimum Operational Performance Specification for Ground Ice Detection Systems" was jointly accomplished by EUROCAE Working Group 54 and the Society of Automotive Engineers (SAE) G12 Ice Detection Subcommittee through a consensus process. It was published by EUROCAE on November 2001, and by SAE on February 2002 as AS 5116A.
- 2 This joint document was updated and approved by Eurocae Council on June 2003, as well as by SAE. The revised version is presently published as ED-104A. The main modifications which it comprises are in the following areas:
 - Air temperature and fluid thickness
 - Detection and contamination
 - Freezing Fog visibility tests
 - Natural Snow visibility tests
 - Temperature and Precipitation visibility testsIt also includes some minor corrections.
- 3 EUROCAE and SAE, Inc. are, respectively, international and US not-for-profit organisations, formed to advance the art and science of aviation and aviation electronic systems for the benefit of the public.
- 4 Since EUROCAE or SAE are not official agencies of any US or European government, their recommendations may not be regarded as statements of official government policy unless so enunciated by the appropriate government organization, conference of governments, or agency having statutory jurisdiction over any matters to which the recommendations relate.
- 5 Details of any amendments and updates of this document may be found on the Eurocae web site: www.eurocae.net
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TABLE OF CONTENTS

FOREWORD	I
CHAPTER 1 SCOPE	1
1.1 Application of this Document	1
1.2 Functional Description of System	2
1.2.1 Onboard GIDS	2
1.2.2 Ground-Based GIDS	2
1.3 COMPOSITION OF A GIDS	3
1.4 DEFINITIONS AND ABBREVIATIONS	3
1.4.1 Definitions	3
1.4.2 Abbreviations	4
1.5 References	5
CHAPTER 2 GENERAL DESIGN REQUIREMENTS	8
2.1 INTRODUCTION	8
2.2 AIRWORTHINESS AND OPERATIONAL REQUIREMENTS	8
2.2.1 Onboard GIDS	8
2.2.2 Ground-Based GIDS	8
2.3 COMPLEX HARDWARE AND SOFTWARE DESIGN	8
2.3.1 Onboard GIDS	8
2.3.2 Ground-Based GIDS	8
2.4 TECHNICAL REQUIREMENTS	8
2.4.1 Materials	8
2.4.2 Workmanship	9
2.4.3 Electrical Bonding and Grounding	9
2.4.4 Interchangeability	9
2.4.5 Marking	9
2.5 MINIMUM STRUCTURAL REQUIREMENTS	9
2.5.1 Exposure During Normal Operations	9
2.5.2 Foreign Object Damage (FOD)	9
2.6 HUMAN FACTORS	9
2.6.1 Hazards	10
2.6.2 Displays	10
2.7 SAFETY REQUIREMENTS	10
2.7.1 Design for Safety	10
2.7.2 Failure Analysis	10
2.7.3 Detection Reliability	11

2.8	GIDS OPERATION	11
2.8.1	GIDS Controls	11
2.8.2	Data Processing	11
2.8.3	Onboard GIDS Activation	11
2.8.4	Built in Test Equipment (BITE)	11
2.8.5	Nuisance Alarms	11
2.8.6	Operating Weather Conditions	12
2.9	QUALIFICATION TESTS	12
2.9.1	Responsibility for Testing	12
2.9.2	Test Article	12
2.9.3	Effects of Tests	12
2.10	REPORTS AND DECLARATIONS	12
2.10.1	Summary Test Report	12
2.10.2	Substantiating Test Data/Analysis	13
2.10.3	Operating Procedures	13
2.10.4	Declarations	13
CHAPTER 3	MINIMUM PERFORMANCE SPECIFICATION	14
3.1	FROZEN CONTAMINATION DETECTION	14
3.1.1	Detection Threshold	14
3.1.2	Frozen Contamination Above the Detection Threshold	14
3.2	FLUID CONDITION MONITORING	14
3.3	MONITORED SURFACE FINISH AND GIDS PERFORMANCE	15
CHAPTER 4	MINIMUM PERFORMANCE SPECIFICATION UNDER ENVIRONMENTAL TEST CONDITIONS	16
4.1	INTRODUCTION	16
4.2	TESTING	16
4.3	ONBOARD GIDS	17
4.4	GROUND-BASED GIDS	19
CHAPTER 5	TEST PROCEDURES	21
5.1	GENERAL	21
5.1.1	Test Plan, Procedures and Reports	21
5.1.2	Power Input Voltage	21
5.1.3	Power Input Frequency	21
5.1.4	Ambient Conditions	21
5.1.5	Warm-Up Period	21
5.1.6	Test Procedures	21
5.2	DETECTION INDICATION	21

5.3	DETAILED TEST PROCEDURES	22
5.3.1	Frozen Contamination Detection (Paragraph 3.1.1)	22
5.3.2	Fluid Condition Monitoring (Paragraph 3.2)	25
5.3.3	Area detection and Visibility Tests for Remote GIDS	27
CHAPTER 6	INSTALLED EQUIPMENT PERFORMANCE.....	28
6.1	INTRODUCTION	28
6.1.1	Test Plan, Procedures and Reports	28
6.2	INSTALLED EQUIPMENT REQUIREMENTS.....	28
6.2.1	General.....	28
6.2.2	Technical	29
6.3	INSTALLED EQUIPMENT PERFORMANCE.....	30
6.3.1	Onboard GIDS.....	30
6.3.2	Ground-Based GIDS	30
6.4	CONDITIONS OF TEST	30
6.4.1	Safety Precautions	30
6.4.2	Power Input	31
6.4.3	Associated Equipment and Systems.....	31
6.4.4	Environment	31
6.4.5	Warm-Up Period.....	31
6.5	TEST PROCEDURES FOR INSTALLED EQUIPMENT PERFORMANCE	31
6.5.1	General.....	31
6.5.2	Ground Test Procedure.....	31
6.5.3	Flight Test Procedure	33
APPENDIX A		34
APPENDIX B		38
B.1	Scope.....	38
B.1.1	Safety	38
B.2	FLUID Sample Selection Procedure for Type I Fluids.....	38
B.2.1	Requirements.....	38
B.2.2	Condition of the Sample to be used for Test	38
B.3	FLUID Sample Selection Procedure for Type II, and IV Fluids	38
B.3.1	Requirements.....	38
B.3.2	Condition of the Sample to be used for Test	39
B.4	Test Procedure - General	39
B.4.1	Purpose.....	39
B.4.2	General Versus Specific Requirements.....	39
B.4.3	GIDS Sensor and Plate Test Set-Up	39
B.4.4	Calibration and Measurement Methods.....	42

B.4.5	General Test Procedures	42
B.5	Precipitation Conditions	43
B.5.1	"Frost" Test Equipment and Test Parameters	44
B.5.2	Freezing Fog Test Equipment and Test Parameters.....	44
B.5.3	Freezing Drizzle Test Equipment and Test Parameters	45
B.5.4	Light Freezing Rain Test Equipment and Test Parameters.....	46
B.5.5	Snow Test Equipment and Test Parameters	46
	LIST OF WORKING GROUP 54 MEMBERS	48
	LIST OF WORKING GROUP 54 GROUND SUBGROUP MEMBERS	50
	CHANGE ED-104 TO ED-104A- JUNE 2003.....	51
	ED-104A IMPROVEMENT SUGGESTION FORM	52

CHAPTER 1

SCOPE

This EUROCAE 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 2 through Chapter 4. Definitions essential to the proper understanding of this document are provided in Chapter 1.
- Chapter 2 contains general design requirements for an ice detection system used during ground operations.
- Chapter 3 contains the Minimum Operational Performance Requirements for the GIDS, defining performance under icing conditions likely to be encountered during ground operations.
- Chapter 4 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 5 describes recommended test procedures for demonstrating compliance with Chapters 2 and 3.
- Chapter 6 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

APPLICATION OF THIS DOCUMENT

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

Compliance with this 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.

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 " On-Board 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 sq.ins.])
- Local area sensors. (40 cm² [6.2 sq.ins.]< area of coverage per sensor < 5m² [53.8 sq.ft.])
- Wide area sensors. (area of coverage per sensor > 5 m² [53.8 sq.ft.])

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 sq.ins.])
- Local area sensors. (40 cm² [6.2 sq.ins.]< area of coverage per sensor < 5m² [53.8 sq.ft.])
- Wide area sensors. (area of coverage per sensor > 5 m² [53.8 sq.ft.])

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 paragraph 2.8.6.
- 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.

1.4

DEFINITIONS AND ABBREVIATIONS

1.4.1

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 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.
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: - Ice front, - Ice sheet, - Slush, in clusters or as a front, - Disseminated fine ice crystals, - Frost on surface, - Clear ice pieces partially or totally imbedded in fluid, - Snow bridges on top of the fluid.
Weather conditions	See References section 1.5 Weather related documents.

1.4.2 Abbreviations

A.C	Advisory Circular.
AC	Advisory Circular (FAA)
AMJ	Advisory Material Joint.(JAA)
ARINC	Aeronautical Radio, Inc.
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.
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.
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.
SAE	Society of Automotive Engineers (USA originated).
T.C. -CAR	Transport Canada -Civil Aviation Requirements.
T.C	Transport Canada (The Canadian Civil Aviation Authority).

1.5

REFERENCES

The following documents are incorporated by reference. The latest issue in effect shall be the one which will apply.

EUROCAE / RTCA or EUROCAE/SAE Publications

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 ARP 4754	Certification Considerations for Highly-Integrated or Complex Aircraft Systems.
ED-80/RTCA DO 254	Design Assurance Guidance for Airborne Electric Hardware.
DO-216	Minimum General Specification for Ground-Based Electronic Equipment.

SAE Publications

AIR4367	Aircraft ice detectors and icing rate measuring instruments. (In Flight Icing).
AS 5116	Performance standard for airplane ground ice detection system, airplane/ground-based.
AS 8034	Minimum performance standard for airborne multipurpose electronic displays.
ARP 582	Lighting, integral, for airplane instruments: Criteria for design of red lighted instruments.
ARP 4104/4	Flight Deck Alerting System [FAS]).
ARP 798	Design criteria for white incandescent lighted aerospace instruments.
ARP 4102	Flight Deck Panels, Controls and Displays.
ARP 4102/7	Electronic Displays.
ARP 4102/8	Flight Deck, Head Up Displays.
ARP 4256	Design Objectives for Liquid Crystal Displays for Part 25 (Transport).
ARP 4737	Airplane Deicing/Anti-icing Methods with Fluids for Large Transport Airplanes.
ARP 4761	Guidelines and Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment.
SAE J1211	Recommended Environmental Practices for Electronic Equipment Design.
SAE AMS 1424	Deicing anti-icing, aircraft, fluid, SAE TYPE I.
SAE AMS 1428	Deicing anti-icing, fluid, aircraft, non-newtonian (pseudoplastic), SAE TYPES II, III, and IV.

JAA / FAA Requirements, Regulations

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)
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.

Transport Canada Regulations

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

CEN / IEC / ISO Publications

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.

ARINC Documents

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).

MIL Documents

MIL-STD-1472

Weather related documents

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

CHAPTER 2

GENERAL DESIGN REQUIREMENTS

2.1 INTRODUCTION

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

2.2 AIRWORTHINESS AND OPERATIONAL REQUIREMENTS

2.2.1 Onboard GIDS

An onboard GIDS installation used by the flight crew for airworthiness decisions shall comply with applicable requirements, and as further specified in 2.7. 'Safety Requirements'. 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.

2.2.2 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.

2.3 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".

2.3.1 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.

2.3.2 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.

2.4 TECHNICAL REQUIREMENTS

2.4.1 Materials

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

2.4.2 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.

2.4.3 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 Ω , as manufactured.

2.4.4 Interchangeability

All LRU's having the same part number, shall be interchangeable with each other physically and functionally.

2.4.5 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.

2.5 MINIMUM STRUCTURAL REQUIREMENTS

2.5.1 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.

2.5.2 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.

2.6 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:

2.6.1 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.

2.6.2 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 ARP 4256, ARP 582, ARP 798, ARP 4102, ARP 4102/4, ARP 4102/7, ARP 4102/8, AS 8034 and JAR/FAR/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.

2.7 SAFETY REQUIREMENTS

2.7.1 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 ARP 4754 - Certification Considerations for Highly-Integrated or Complex Aircraft Systems.

SAE ARP 4761 - Guidelines and Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment.

2.7.2 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.

2.7.3 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 5 and 6 define test procedures that demonstrate detection capability of the system.*

2.8 GIDS OPERATION

2.8.1 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.

2.8.2 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.

2.8.3 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.

2.8.4 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 paragraph 2.7. BITE shall annunciate detected GIDS failures to the appropriate crew.

2.8.5 Nuisance Alarms

Nuisance alarms should be minimized.