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AEROSPACE STANDARD

SAE AS5681 | REV. A

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Superseding AS5681

Minimum Operational Performance Specification for Remote On-Ground Ice Detection Systems

RATIONALE

Corrections have been made to spelling, grammar, references, definitions, and document consistency.

FOREWORD

Exposure to weather conditions on the ground that are conducive to clear ice formation can cause aircraft surfaces and components to adversely affect aircraft performance, stability, and control.

Specific rules for aircraft operations in ground icing conditions are set forth in United States Federal Aviation Regulations (FARs), (European) Joint Aviation Regulations (JARs), Canadian Aviation Regulations (CARs), and others. The intent of the applicable regulations is to ensure that no one attempts to dispatch an aircraft with frozen contamination adhering to any aircraft component critical to safe flight.

The Human Factors tests reported in FAA reports DOT/FAA/TC-06/20 and DOT/FAA/TC-06/21 have shown that, based on the particular conditions of the tests, remote on-ground sensors that meet the requirements of this standard perform more consistently and are more reliable than human visual, and/or tactile detection of clear ice on an aircraft critical surface in winter conditions.

Human Factors tests have demonstrated that in certain circumstances respect for the regulations may be most reliably achieved by use of remote on-ground sensors. These circumstances do not include the specific case of frost. Frost is generally readily detected visually, and may affect the takeoff performance of an aircraft at roughness levels below the reliable detection threshold of sensors available at the time of publication of this document.

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TABLE OF CONTENTS

1. SCOPE

This SAE Aerospace Standard (AS)/Minimum Operational Performance Specification (MOPS) specifies the minimum performance requirements of Remote On-Ground Ice Detection Systems (ROGIDS). These systems are ground-based. They provide information that indicates whether frozen contamination is present on aircraft surfaces.

Section 1 provides information required to understand the need for the ROGIDS, ROGIDS characteristics, and tests that are defined in subsequent sections. It describes typical ROGIDS applications and operational objectives and is the basis for the performance criteria stated in Section 3 through Section 5.

Section 2 provides reference information, including related documents, abbreviations and definitions.

Section 3 contains general design requirements for the ROGIDS.

Section 4 contains the Minimum Operational Performance Requirements for the ROGIDS, which define performance in icing conditions likely to be encountered during ground operations.

Section 5 describes environmental test conditions that provide laboratory means of testing the overall performance characteristics of the ROGIDS in conditions that may be encountered in actual operations.

Section 6 describes recommended test procedures for demonstrating compliance with Sections 3 and 4.

Section 7 contains the operational evaluation requirements for verifying the performance of the ROGIDS when installed for in-service use.

1.1 Applications of This Document

Compliance with this AS/MOPS ensures that the ROGIDS will satisfactorily perform its intended functions.

Compliance with this AS/MOPS does not necessarily constitute compliance with regulatory requirements. Any application of this document in whole or in part is the sole responsibility of the appropriate regulatory agencies. It is recommended to seek guidance from the regulatory agencies before developing any test plans or test procedures. The manufacturer should confer with the regulatory agencies to determine those tests that need to be witnessed or performed by the regulatory agencies or other acceptable entity(s) and any associated reporting requirements.

The measured values of the ROGIDS performance characteristics may be a function of the method of measurement. Therefore, controlled 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 Safety

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 necessary precautionary measures to ensure the health and safety of all personnel involved.

1.3 Functional Description of System

The function of ROGIDS is to detect clear ice on aircraft surfaces.

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

ROGIDS make a remote measurement of a monitored surface, and may be hand held, pedestal or vehicle mounted.

The ROGIDS may provide an alternative to the visual and tactile post-deicing checks required by aviation regulatory agencies, including the European Aviation Safety Agency (EASA), the United States Federal Aviation Administration (FAA) and Transport Canada Civil Aviation (TCCA), to determine the condition of aircraft critical surfaces in operating conditions involving freezing contamination. Approval for the use of ROGIDS as a means of performing post-deicing checks rests with the appropriate regulatory agency.

In addition, the ROGIDS may also supplement visual and tactile pre-deicing checks for clear ice. Approval for the use of ROGIDS as a means of performing pre-deicing checks rests with the appropriate regulatory agency.

1.4 The ROGIDS should typically include:

a. At least one sensor that is directly or indirectly sensitive to the physical phenomena of aircraft icing during weather conditions consistent with ground icing operations.

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

c. 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 International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

ARP926 Fault/Failure Analysis Procedure

ARP1971 Aircraft Deicing Vehicle - Self-Propelled

ARP4256 Design Objectives for Liquid Crystal Displays for Part 25 (Transport) Aircraft

ARP4737 Aircraft Deicing/Anti-icing Methods

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

ARP5485 Endurance Time Tests for Aircraft Deicing/Anti-icing Fluids, SAE Type II, III, and IV

ARP5945 Endurance Time Tests for Aircraft Deicing/Anti-icing Fluids, SAE Type I

AMS1424 Deicing/Anti-icing Fluid, Aircraft, SAE Type I

AMS1428 Fluid, Aircraft Deicing/Anti-icing, Non-Newtonian (Pseudoplastic), SAE Types II, III, and IV

SAE J1211 Handbook for Robustness Validation of Automotive Electrical/Electronic Modules

2.1.2 RTCA/EUROCAE or SAE/EUROCAE Publications

RTCA documents (DO) available from Radio Technical Commission for Aeronautics Inc., 1828 L Street, NW, Suite 805, Washington, DC 20036, Tel: 202-833-9339, www.rtca.org.

EUROCAE Documents (ED) available from EUROCAE, 4th Floor, 102 rue Etienne Dolet, 92240 - Malakoff, France, Tel: +33 1 45 05 71 88, eurocae@compuserve.com.

RTCA DO-160/ED-14 Environmental Conditions and Test Procedures for Airborne Equipment

RTCA DO-178/ED-12 Software Considerations in Airborne Systems and Equipment Certification

RTCA DO-216 Minimum General Specification for Ground-Based Electronic Equipment

RTCA DO-254/ED-80 Design Assurance Guidance for Airborne Electric Hardware

2.1.3 U.S. Government Publications

FAA/FAR/AC documents available from Federal Aviation Administration, 800 Independence Avenue, SW, Washington, DC 20591, Tel: 1-866-TELL-FAA (1-866-835-5322), www.faa.gov/regulations_policies/faa_regulations.

AC 00-34A	Aircraft Ground Handling and Servicing
AC 20-117	Hazards Following Ground Deicing and Ground Operations in Conditions Conducive to Aircraft Icing
AC 120-58	Pilot Guide for Large Aircraft Ground Deicing
AC 120-60	Ground Deicing and Anti-Icing Program
AC 120-107	Use of Remote On-Ground Ice Detection System - http://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.information/documentID/813451
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
DOT/FAA/TC-06/20	Comparison of Human Ice Detection Capabilities and Ground Ice Detection System Performance Under Post-deicing Conditions http://www.tc.faa.gov/acb300/Techreports/TC06_20_GIDS.pdf
DOT/FAA/TC-06/21	Human Visual and Tactile Ice Detection Capabilities under Aircraft Post Deicing Conditions http://www.tc.faa.gov/acb300/Techreports/TC06_21_GIDS_new.pdf
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
HF-STD-001	FAA Human Factors Design Standard http://acb220.tc.faa.gov/hfds/default.htm
Code of Federal Regulations, Title 47	Federal Communications Commission Part 15 – Radio Frequency Devices Section 15.109 Radiated Emission Limits

2.1.4 JAA Publications

JAA/JAR documents are available from JAA, Saturnusstraat 8-10 PO Box 3000 2130 KA Hoofddorp The Netherlands, Tel: +31 23 5679 764, publications@jaa.nl, www.jaa.nl.

JAA/Leaflet #4 to JAR/OPS1	Ice and Other Contaminants Procedures
JAR-1	Definitions and Abbreviations
JAR TSO	Joint Technical Standard Orders
JAR/OPS 1, [2]	Commercial Air Transportation (Aeroplanes)

2.1.5 Transport Canada Publications

Transport Canada documents are available from Transport Canada, Tower C, Place de Ville, 330 Sparks Street Ottawa, Ontario K1A 0N5, Tel: 1-800-305-2059, www.tc.gc.ca.

TP14052	Guidelines for Aircraft Ground Deicing Operations
TP 14449	Development of Ice Samples for Visual and Tactile Ice Detection Capability Tests
TP 14450	Development of Ice Samples for Comparison Study of Human and Sensor Capability to Detect Ice on Aircraft
TP 14452	Feasibility of ROGIDS Test Conditions Stipulated in SAE Draft Standard AS5681 (not yet published)
TC-CASS 622.11	Commercial Air Service Standard - Ground Icing Operations Standard
TC CAR 602.11	Canadian Aviation Regulation - Aircraft Icing
AC No. 602-001	Operational Use of Remote On-Ground Ice Detection Systems (ROGIDS) for Post De-icing Applications http://www.tc.gc.ca/eng/civilaviation/opssvs/managementservices-referencecentre-acs-600-602-001-492.htm#s5-0

2.1.6 CEN/IEC/ISO Publications

CEN/EN documents available from CEN, 36, rue de Stassart B-1050 Brussels, Tel: +32 2 550 0811, infodesk@cenorm.be.

CEN 50081-2	Electromagnetic compatibility - Generic emission standard - Part 2: Industrial environment
CEN 50082-2	Electromagnetic compatibility - Generic immunity standard - Part 2: Industrial environment

2.1.7 ARINC Publications

Available from ARINC, 2551 Riva Road, Annapolis, MD 21401, www.arinc.com.

ARINC-415	Operational and Technical Guidelines on Failure Warning and Functional Test
ARINC-604	Guidance for Design and Use of Built-in Test Equipment (BITE)

2.1.8 Weather Related Publications

WMO documents are available from World Meteorological Organization, P.O. Box 2300, CH-1211, Geneva 2, Switzerland, Tel: 617 227 2425, wmopubs@ametsoc.org.

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

2.2 Definitions and Abbreviations

2.2.1 Definitions

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

CLEAR ICE: Clear ice forms at temperatures at or below 0 °C, often associated with a high concentration of large supercooled water droplets. It can also be a residual product of an incomplete deicing process. Clear ice is hard, and appears as a smooth and glassy coating that can be very difficult to detect without a tactile inspection. Clear ice may not be seen during a walkaround, particularly if the wing is wet or during night-time operations. Clear ice can occur inflight or on the ground. Clear ice adheres firmly to surfaces, is difficult to remove, and requires special care during deicing/anti-icing.

DEICING: A procedure by which frost, ice, snow or slush is removed from the aircraft in order to provide aerodynamically clean surfaces. This is typically performed using heated (at least 60 °C) deicing fluid.

DEICING EVENT: A deicing event is the series of action required to deice and inspect one aircraft, culminating with the release of that aircraft in what is considered to be a state compliant with the ground icing regulatory requirements.

DEICING (and ANTI-ICING) FLUIDS: The fluids used for conduct of the deicing (and anti-icing) procedures. These are typically ethylene or propylene glycol based.

FALSE NEGATIVE: An indication of the 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.

DEICING/ANTI-ICING FLUID FAILURE: When the deicing/anti-icing fluid can no longer absorb incoming precipitation and provide protection from the adherence of frozen contamination on treated surfaces. Characteristics of fluid failure can be surface freezing or snow accumulation, random snow accumulation and/or dulling of surface reflectivity caused by the gradual deterioration of the deicing/anti-icing fluid, possibly indicated by the presence of frozen contamination in or on the de/anti-icing fluid.

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

ILLUMINANCE: The amount of visible light power incident per unit area of a surface; measured in lux (lumens/meter^2) or foot-candles (Lumens/foot^2).

LATENT FAILURE: A latent failure is one that is inherently undetected when it occurs.

Lx: Lux

MAXIMUM DETECTION ANGLE: The maximum angle with respect to the surface being monitored that the ROGIDS sensor can be aimed and still be expected to achieve the performance specified in this MOPS.

MAXIMUM DETECTION DISTANCE: The furthest the ROGIDS sensor can be from the surface being monitored that the ROGIDS sensor can be aimed and still be expected to achieve the performance specified in this MOPS.

MINIMUM DETECTION ANGLE: The minimum angle with respect to the surface being monitored that the ROGIDS sensor can be aimed and still be expected to achieve the performance specified in this MOPS.

MINIMUM DETECTION DISTANCE: The closest the ROGIDS sensor can be to the surface being monitored that the ROGIDS sensor can be aimed and still be expected to achieve the performance specified in this MOPS.

MONITORED SURFACE: The surface of concern regarding ice hazard.

PRE-DEICING CHECK: An examination of an aircraft's wings and/or other critical surfaces to check for the presence of frozen contamination. Usually performed to determine the need for deicing.

POST-DEICING CHECK: An examination of an aircraft's wings and/or other critical surfaces after a deicing has been performed to determine the presence of any remaining frozen contamination.

Ra: Average surface roughness.

ROGIDS: A system or device that makes a remote measurement of a monitored surface to determine whether frozen contamination is present. For the purpose of this Aerospace Standard, the intended function of the ROGIDS is the detection of clear ice.

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

2.3 Abbreviations

AC	Advisory Circular (FAA)
AMJ	Advisory Material Joint (JAA)
ARINC	Aeronautical Radio, Inc.
ARP	Aerospace Recommended Practice
AS	Aerospace Standard
BIT	Built In Test
BITE	Built In Test Equipment
CEN	Comité Européen de Normalisation. European Committee for Standardisation. Europäisches Komitee für Normung.
EASA	European Aviation Safety Agency
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 deicing/anti-icing fluids
FTA	Fault Tree Analysis

GIDS	Ground Ice Detection System
IEC	International Electricity Committee
ISO	International Organization for Standardization
JAA	Joint Aviation Authorities (Europe)
JAR	Joint Aviation Requirements (Europe)
min	Minute
MOPS	Minimum Operational Performance Specification
MTBF	Mean Time Between Failure
OAT	Outside Air Temperature
ROGIDS	Remote On-Ground Ice Detection System(s)
RTCA	Radio Technical Commission for Aeronautics
TC - CAR	Transport Canada - Civil Aviation Requirements
TC	Transport Canada (Canadian Civil Aviation Authority)

3. GENERAL DESIGN REQUIREMENTS

3.1 Introduction

This section identifies general design considerations for ROGIDS.

3.2 Complex Hardware and Software Design

3.2.1 Hardware Design

The design of complex hardware such as large scale integrated circuits shall follow the guidelines specified in document RTCA DO-254/EUROCAE ED-80. The hardware criticality level will depend on the particular ROGIDS architecture.

3.2.2 Software Design

Software design shall follow the guidelines specified in document RTCA DO-178/EUROCAE ED-12. The software criticality level will depend on the particular ROGIDS architecture.

3.3 Technical Requirements

3.3.1 Materials

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

3.3.2 Workmanship

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.

3.3.3 Mean Time Between Failure (MTBF)

The manufacturer shall report the MTBF.

3.3.4 Electrical Bonding and Grounding

The ROGIDS grounding system should 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.

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 ROGIDS. The maximum resistance across any bonding or grounding junction shall be 0.25 Ω, as manufactured.

3.3.5 Interchangeability

All major components having the same part number shall be interchangeable with each other physically and functionally.

3.3.6 Marking

Permanently and legibly mark each major component with the following information:

1. Name and address of the manufacturer.

2. The name, type, part number or model designation of the component.

3. The serial number and the date of manufacture of the component.

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 shall uniquely identify the hardware and software design, including modification status.

3.4 Exposure During Normal Operations

ROGIDS 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. ROGIDS parts exposed to the external environment should be designed to withstand impact from ice particles shed from the aircraft and remain functional.

3.5 Foreign Object Damage (FOD)

The ROGIDS should be constructed so that in the normal operating environment parts do not become loose in service and create a FOD hazard.

3.6 Human Factors

Design of any ROGIDS should include consideration of the applicable human factors enumerated in FAA Human Factors Design Standard HF-STD-001. As a minimum, each design shall consider the following factors:

3.6.1 Installation

Mounting location is dependent on local factors. For vehicle mounted units this includes vehicle type, cab type, and optional equipment installed.

Mounting of the ROGIDS shall not interfere with the primary deicing/anti-icing functions of the deicing equipment. The mounting location of the sensor shall be such that it can obtain a clear scan of aircraft surfaces to be monitored. The ROGIDS display shall be mounted in a location easily visible to the operator responsible for checking the monitored surface during or after deicing/anti-icing operations.

The ROGIDS shall be compatible with the physical and environmental conditions of installation. Installation of the equipment should permit ease of access for maintenance and testing. Each element of the ROGIDS shall be designed, or distinctly and permanently marked, to minimize the probability of incorrect assembly that could result in the malfunctioning of the system.

3.6.2 Hazards

The ROGIDS shall not present a hazard to personnel or property when in normal use. ROGIDS using laser-based or other potentially hazardous imaging technologies shall use an eye-safe design.

3.6.3 Interface Design

The display design shall:

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

b. Provide information that is immediately discernible. Results provided by the system shall be readily interpretable by a trained operator.

c. Provide a clear indication when the ROGIDS is inoperative.

d. Provide adequate display readability during normal operating conditions.

e. In the event that the display does not encompass the entire surface to be checked, the interface shall be designed in a way that allows the operator to clearly identify the location of the area displayed in relation to the overall wing (or other entire surface to be checked). This is to ensure that no part of the surface to be checked has been omitted or erroneously duplicated.

3.7 Safety Requirements

3.7.1 Safety Assessment

A structured safety assessment shall be conducted to evaluate the failure modes and their effects on system operation.

The intent is to ensure that ground and flight crew are not presented with misleading information (false negatives) generated by system malfunctions which would allow dispatch and takeoff of an aircraft with contamination on the critical surfaces within the performance defined in Sections 4 and 5 of this AS/MOPS. System malfunctions may include:

a. Malfunctions that are readily detected by the trained operator; and

b. Malfunctions not detectable by the trained operator.

Acceptable structured assessment procedures include but are not limited to:

a. System Safety Assessment;

b. Functional Hazard Assessment;

c. Failure Modes and Effects Analysis; and

d. Fault Tree Analysis.

Appropriate software and hardware design assurance levels shall be selected based on a structured safety assessment process.

Overall equipment failure rate, including active failures, shall be provided by the ROGIDS manufacturer.

3.7.2 Latent Failure Rate

Appendix D contains background material and rationale for the determination of the acceptable latent failure rate.

The acceptable rate for latent failures that lead to false negatives shall be on the order of 1 in 10 000 deicing events (10^{-4} per deicing events).

Fault Tree Analysis and Failure Modes and Effects Analysis shall be conducted and documented to establish that the equipment false negative rate due to malfunction is less than the acceptable rate as defined above.

3.8 ROGIDS Operation

3.8.1 ROGIDS Controls

The operation of ROGIDS controls in all possible positions, combinations and sequences, shall not be detrimental to the continued normal operation of the ROGIDS.

ROGIDS controls that are not intended to be adjusted in normal operation shall not be readily accessible to the ground crew.

3.8.2 Data Processing

Following acquisition, the processing and interpretation of data by the ROGIDS shall be automatic.

The system shall be designed in such a manner as to preclude the display of invalid output data.

3.8.3 Built In Test Equipment (BITE)

The ROGIDS shall include a confidence (BITE) test. The test function shall be automatic during operation.

The BITE shall support the safety objectives and the reliability requirements of this document. BITE shall provide a clear indication of detected ROGIDS failures to the operator.

3.8.4 Nuisance Alarms

Nuisance alarms should be minimized.

3.8.5 Operating Weather Conditions

The ROGIDS shall perform its intended function during weather conditions consistent with ground icing operations.

3.9 Qualification Tests

3.9.1 Responsibility for Testing

The manufacturer of the product shall be responsible for the performance and documentation of all required tests specified in Sections 5, 6, and 7 to demonstrate compliance with this AS/MOPS.

3.9.2 Test Article

The tests shall be conducted with one or more ROGIDS that are in full conformity with production build.

3.10 Test Plan(s)

The manufacturer shall prepare a test plan or test plans detailing at a minimum the following:

a. Purpose of Test;

b. Scope;

c. Test article configuration (the test shall be conducted with one or more ROGIDS that are in full conformity with the production build);

d. Applicable and reference documents;

e. Test administration:

    1. Test activities and Responsibilities; and

    2. Quality assurance.

f. Test Documentation and data recording/capture;

g. Pass/Fail Criteria;

h. Pass/Fail Reporting;

i. Actions to be taken in event of failure;

j. Test Equipment:

    1. Calibration;

    2. Safety and Hazards; and

    3. Material and handling.

k. Test Procedures to be prepared; and

l. Test Reports to be prepared.

3.11 Test Procedures

The manufacturer shall prepare test procedures detailing at a minimum the following:

a. Purpose;

b. Scope;

c. Test article configuration (the test shall be conducted with one or more ROGIDS that are in full conformity with the production build);

d. Applicable and reference documents;

e. General Instructions:

    1. Test activities and Responsibilities;

    2. Quality Assurance and Inspection;

    3. Standard Test Conditions;

    4. Test Equipment Calibration; and

    5. Test Documentation.

f. Test Equipment Hardware and Software;

g. Test Configuration;

h. Test Sequence;

i. Test Procedures

j. Pass/Fail Criteria;

k. Pass/Fail Reporting; and

l. Actions to be taken in event of failure.

3.12 Test Report

The ROGIDS manufacturer shall prepare a test report detailing the following:

a. The part number and serial number, which identifies the ROGIDS as tested, and hardware/software revision numbers as applicable;

b. A description of the test facility and test procedures used; and

c. Results of all tests and technical data that substantiate the manufacturer’s performance specifications.

The foregoing information shall be cross referenced to the appropriate sections of this AS/MOPS.

3.13 Compliance checklist

The manufacturer shall provide a declaration that design, verification, validation, testing and analysis confirms that the equipment complies with all the requirements of this document. A compliance checklist shall be provided to facilitate this task. It is acceptable for the compliance check to provide a cross reference between requirements in this document and manufacturer documents demonstrating compliance.

3.14 Manufacturer's Performance Specifications

The manufacturer shall provide performance specifications for the ROGIDS. These shall include the maximum and minimum detection distances and angles.

3.15 Operating Procedures

A set of operating procedures for each specific ROGIDS shall be developed.

The manufacturer shall clearly identify all operational limitations.

4. MINIMUM PERFORMANCE SPECIFICATION

This section defines the minimum performance criteria that shall be used for the design of ROGIDS.

4.1 Frozen Contamination Detection

ROGIDS shall be able to detect and communicate the presence of:

a. Clear Ice Pre-Deicing;

b. Residual Clear Ice Post-deicing; and

c. Residual Clear Ice Post-deicing During Precipitation.

ROGIDS performance standards for detection of frost, snow and slush on a critical surface have not been defined.

ROGIDS performance related to the detection of frost, snow and/or slush may be addressed in future versions of this document.

4.1.1 Detection Threshold

The ROGIDS detection threshold shall ensure the detection of clear ice of 0.5 mm thickness or less, continuously distributed over an area of 315 cm², or less.

4.1.2 Ice Above the Detection Threshold

The ROGIDS shall detect and indicate the presence of ice on the monitored surface in excess of the detection threshold.

4.2 Monitored Surface Finish, Illumination Conditions, and ROGIDS Performance

The material, the surface finish and/or the surface treatment of the monitored surface shall not adversely affect the ROGIDS performance.

The ROGIDS shall not be adversely affected by the transition between two or more surface finishes and/or illumination conditions.

4.3 Fluid Foaming Effects

The ROGIDS performance shall not be affected by foaming in applied deicing/anti-icing fluids.

5. MINIMUM PERFORMANCE SPECIFICATION IN ENVIRONMENTAL TEST CONDITIONS

5.1 Introduction

a. The environmental tests described in this section will determine the ROGIDS ability to operate in conditions representative of those that may be encountered in actual operation.

b. Tests 1-7 in Table 1, Required Tests, are mandatory. All seven tests shall be completed in full and passed.

c. Unless otherwise specified, the tests shall be conducted using ALL components of the ROGIDS.

d. Tests 1-6 specified in Table 1 have been adapted from RTCA DO-160E: Environmental Conditions and Test Procedures for Airborne Equipment. Guidance for adapting the specified DO-160E tests to ROGIDS testing is provided in the comments section for each test.

e. For Test 4 in Table 1 (Fluids Susceptibility - ROGIDS External Components), it is permissible to remove the internal components of the ROGIDS for the duration of the test. However, Test 5 in Table 1 (Fluids Susceptibility - ROGIDS System) shall be performed using a fully functioning ROGIDS.

f. Table 2 provides a series of recommended tests. While these tests are optional, it is strongly recommended that the listed tests applicable to the ROGIDS operational environment be performed, and the results be reported.

5.1.1 Alternative References

In addition to recommended tests 9 and 16 in Table 2, SAE Surface Vehicle Recommended Practice J1211 is a good source of information on the environmental challenges electronic equipment face in the automotive environment, and contains useful optional additional test recommendations and procedures.

5.2 Test Plan, Procedures, and Reports

A test plan and test procedures shall be prepared in accordance with 3.10 and 3.11.

A report of test results shall be prepared in accordance with 3.12.

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

5.3 Acceptance Criteria

In some of the tests specified in Tables 1 and 2, an ice detection test is called for in the comments column. The purpose of this test is to determine whether the ROGIDS has survived the environmental test and can still detect ice.

When “Perform an ice detection test” is called for in the comments column of the tests in Tables 1 and 2, at a minimum the following shall be done:

Using the four test plates described in Appendix B (Table B1 – Test Plates), develop a patch of clear ice of 0.5 mm thickness and a circular area of 315 cm^2 on each plate. A method for development of the ice patch is described in Transport Canada publications TP 14449 and TP 14450. There is no need for deicing/anti-icing fluid during this test; therefore the test plates may be mounted vertically, perpendicular to the ROGIDS. Place the ROGIDS at the manufacturer's specified minimum operational distance from the test samples. Take an individual image of each of the four ice patches. Place the ROGIDS at the manufacturer's specified maximum operational distance from the test samples. Take an individual image of each of the four ice patches. If the ROGIDS correctly detects all four patches at both the minimum and maximum operational distances (a total of 8 correct images), the test is passed. If the ROGIDS does not correctly detect all four ice patches at both the minimum and maximum operational distances, the test is failed.

The ice detection test described above shall also be used when DO 160E states DETERMINE COMPLIANCE WITH APPLICABLE EQUIPMENT PERFORMANCE STANDARDS.

5.4 Actions to be Taken in Event of Failure

If it is determined that the failure of a test may have been caused by incorrect environmental conditions or test setup it is permissible to correct those deficiencies and rerun that test.

If it is determined that the failure of a test is due to system deficiency, the deficiency shall be corrected and all tests shall be rerun with the new system, unless the manufacturer can prove conclusively that the correction will only affect a limited set of tests.

6. MINIMUM OPERATIONAL PERFORMANCE TESTS

6.1 Performance Tests – General

The purpose of the performance capability tests is to demonstrate that the ROGIDS complies with the Minimum Performance Specification.

Appendix A lists the tests to be performed. Appendices B and C give the test parameters.

Conduct tests for the detection of clear ice:

a. In a controlled (laboratory) environment with and/or without deicing/anti-icing fluids, and in visibility conditions associated with rain and with freezing fog;

b. Under foamed fluid in a controlled (laboratory) environment;

c. In natural conditions with deicing/anti-icing fluids, and in visibility conditions associated with snow; and

d. On a wing surface in natural light conditions.

6.1.1 Test Plan, Procedures, and Reports

Detailed test plans, test procedures, and a report of test results shall be prepared.

The test procedures, ice thickness and area measurements, combined fluid thickness, fluid names, sensor sight angle and distance, visibility conditions, precipitation characteristics, and detection results for each test conducted shall be documented.

All test procedures, including the test set-up, and any deviations, and/or non-conformances to the test procedures shall be documented. Where physical facility limitations exist which influence the set-up and conduct of the tests, these limitations shall be noted.

TABLE 1 - REQUIRED TESTS

Test #	Conditions	Applicable Document	Comments
1	Ground Survival Low Temperature Test and Short-Time Operating Low Temperature Test.	DO-160E/ ED14E Section 4.5.1	Use Category B3. The test shall be performed on all ROGIDS components exposed to the external environment. Use a survival low temperature of -40 °C and a short-time operating low temperature of -30 °C. Conduct an ice detection test (see AS5681, Section 5.3), during the Short-Time Operating Temperature Test – 'operate and test period' (DO-160E, Figure 4-1, T4 to T5).
2	Operating Low Temperature Test.	DO-160E/ ED14E Section 4.5.2	Use Category B1 and a low temperature of -30 °C. The test shall be performed on all ROGIDS components exposed to the external environment. Conduct an ice detection test (see AS5681, Section 5.3) during the test period (DO-160E, Figure 4-2, T2 to T3).
3	Temperature Variation.	DO-160E/ ED14E Section 5	Use temperature change rate Category A, with +25 °C as the test operating high temperature. In the test procedure described in DO-160E, Section 5.3.1, for Paragraphs C and E, perform the ice detection test (see AS5681, Section 5.3) at the end of the temperature change period instead of performing "DETERMINE COMPLIANCE WITH THE APPLICABLE EQUIPMENT PERFORMANCE STANDARDS" during the temperature change period.
4	Fluids Susceptibility – ROGIDS External Components	DO-160E/ ED14E Section 11	Perform only the spray test (DO 160E, Section 11.4.1). This test may be performed using only the ROGIDS enclosure(s) and external components (including cables, wiring harnesses and connectors) exposed to the external environment (The internal electronic and mechanical components may be removed.) Perform the Test with Neat (undiluted) propylene glycol-based SAE Anti-Icing Fluid Types II, III, and IV at +23 °C. Tests with different fluid types may be run concurrently on separate identical systems. DO-160E specifies that the equipment be operated for 10 min at the end of the 24-h spray test. This is not required in this test. At the completion of the 24-h spray test, conduct a thorough visual inspection of all components (enclosures, windows, cables, connectors, seals, etc.). All components shall show no evidence of corrosion or functional deterioration. Verify that there is no deicing/anti-icing fluid ingress into any enclosure, connector or cable. The "DETERMINE COMPLIANCE WITH THE APPLICABLE EQUIPMENT PERFORMANCE STANDARDS" test called for at the end of the 160 h heating cycle is optional. Conduct the Waterproofness Test (Table 1, Test 6) immediately following the completion of the Fluids Susceptibility – ROGIDS External Components Test on all test specimens. Verify that there is no water ingress at the completion of the Waterproofness Test.

TABLE 1 - REQUIRED TESTS (CONTINUED)

Test #	Conditions	Applicable Document	Comments
5	Fluids Susceptibility - ROGIDS System	DO-160E/ ED14E Section 11	Perform only the Spray Test (DO-160E, Section 11.4.1). The test shall be performed on all ROGIDS components exposed to the external environment. Perform the test using a Neat propylene glycol-based SAE Type I Deicing Fluid, diluted to a 50% concentration with water, and heated to +50 °C. This test shall be performed using a fully functional ROGIDS system. For the 160 h heating cycle, the test shall be run at the manufacturer's specified maximum survival temperature. Conduct the 'Waterproofness Test' (Table 1, Test 6) immediately following the completion of the 'Fluids Susceptibility – ROGIDS System Test' on all components. Verify that there is no water ingress at the completion of the 'Waterproofness Test'.
6	Waterproofness	DO-160E/ ED14E Section 10	Note: This test is performed at the end of Tests 4 and 5. It does not need to be repeated separately. Use Category R. The test shall be performed on all ROGIDS components exposed to the external environment.
7	Radio Frequency Emission	FCC 15.109(B)	Category FCC Class A

TABLE 2 - RECOMMENDED TESTS

Test #	Conditions	Documents Section	Comments
1	Ground Survival High Temperature Test and Short-Time Operating High Temperature Test	DO-160E/ ED14E Section 4.5.3	Use a ground survival high temperature of +60 °C. For the Short-Time Operating High Temperature Test, use the manufacturer's specified short-time operating high temperature.
2	Operating High Temperature	DO-160E/ ED14E Section 4.5.4	Perform the test using an operating high temperature of at least +25 °C.
3	Operational Shock	DO-160E/ ED14E Section 7 And/Or SAE J1211 Section 4.8	Categories A and D (DO-160E)
4	Vibration	DO-160E/ ED14E Section 8 And/Or SAE J1211 Section 4.7	Category S (DO-160E)
5	Sand and Dust	DO-160E/ ED14E Section 12 And/Or SAE J1211 Section 4.5	Category S (DO-160E).
6	Fungus Resistance	DO-160E/ ED14E Section 13.0	
7	Salt Fog	DO-160E/ ED14E Section 14	This test is required if the ROGIDS is to be used in a salt atmosphere or exposed to salt fog.
8	Magnetic Effect	DO-160E/ ED14E Section 15	
9	Power input	SAE J1211 Sections 4.9, 4.10, 4.11	
10	Voltage spike	DO-160E/ ED14E Section 17 And/Or ISO 7637-2	Category B (DO-160E)

TABLE 2 - RECOMMENDED TESTS (CONTINUED)

Test #	Conditions	Documents Section	Comments
11	Icing	DO-160E/ ED14E Section 24	Category C
12	Electrostatic Discharge	DO-160E/ ED14E Section 25	
13	Audio Frequency Susceptibility	DO-160E/ ED14E Section 18	
14	Induced Signal Susceptibility/EMI	DO-160E/ ED14E Section 19	
15	Radio Frequency Susceptibility (ISO 7637)	EN 50082-2 Or DO160E Section 20	
16	Humidity	DO160E/ ED14E Section 6.0	Category C

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.

6.1.4 Warm-up Period

All tests shall be conducted after the warm-up period specified by the manufacturer.

6.1.5 Test Parameters

Conduct tests using:

a. Flat test plates representative of aircraft surface materials and finishes (Appendix B, Table B1 and Figure B1); and

b. Deicing and anti-icing fluids meeting SAE specifications (AMS1424 and AMS1428).

For test purposes, the following surfaces have been selected: bare aluminum; grey, white and red painted aluminum; white and red painted fiber reinforced composite; and deicing boot material.

6.2 Tests in Simulated Precipitation Conditions

The test conditions listed below were designed for testing in simulated precipitation conditions. These tests may be performed in equivalent natural conditions.

6.2.1 Test Applications

The tests for ROGIDS in a controlled environment address three applications:

a. Detection of Clear Ice Pre-Deicing;

b. Detection of Residual Clear Ice Post-deicing; and

c. Detection of Residual Clear Ice Post-deicing During Precipitation.

6.2.2 Test Principles

To demonstrate the capability to identify clear ice, the artificial precipitation conditions created in a temperature-controlled climatic chamber are considered to be consistent with natural icing conditions.

The tests have been adapted from and use similar principles as laboratory test procedures used to establish endurance times for aircraft deicing/anti-icing fluids (SAE Types I, II, III, and IV). These test procedures are described in ARP5485 and ARP5945.

6.2.3 Detection of Clear Ice Pre-Deicing

6.2.3.1 Test Outline

Conduct tests in Appendix A, Table A1, to demonstrate the capability of a ROGIDS to identify clear ice on an untreated surface.

a. Ensure the plates are clean and dry. The ambient air temperature is recommended to be less than or equal to -5 °C.

b. Develop a circular layer of clear ice on each plate. Ensure the clear ice has a maximum thickness of 0.5 mm and a maximum area of 315 cm².

c. Take an image of the test plate with the ROGIDS.

d. Measure and record the ice thickness. Record any false positive indication on the area of the plate not covered by clear ice.

e. Complete for all the illumination conditions defined in Appendix C. The illumination conditions that will be considered include daylight, night-time illumination and a condition with shadows on the test plate.

f. Tests shall be completed with the ROGIDS placed at two locations:

   1. Far - A ROGIDS at manufacturer’s specified minimum operational sight angle and maximum distance.

   2. Near - A ROGIDS at manufacturer’s specified minimum distance and maximum operational sight angle.

g. False Positive Tests: Once each clear ice test is complete, a plate without clear ice will be placed above the original plate and tests shall be carried out with the ROGIDS in the far and near locations for each illumination condition.

6.2.3.2 Pass/Fail Criteria

a. False negatives

For each test in test set 1 (pre-deicing) the ROGIDS shall always correctly detect and indicate the presence of clear ice on each half or quadrant of the clear ice sample irrespective of:

1. The plate finish under the clear ice;
2. Illumination of clear ice sample;
3. Sensor location (near, far); and
4. Ambient Air Temperature.

b. False positives

For each clean plate test in test set 1 the ROGIDS shall not indicate the presence of ice irrespective of:

1. The plate finish;
2. Illumination of plate;
3. Sensor location (near, far); and
4. Ambient Air Temperature.

6.2.4 Detection of Residual Clear Ice Post-deicing

6.2.4.1 Test Outline

Conduct the tests in Appendix A, Table A2, to demonstrate the capability of a ROGIDS to identify residual clear ice beneath a deicing/anti-icing fluid layer. For these tests commercially available ethylene and propylene glycol based Type I, II, III and IV deicing/anti-icing fluids shall be used. If the ROGIDS is intended to be used with other glycol based fluids (e.g., diethylene) or non-glycol based fluids, then additional tests with these fluids will be required.

a. Ensure the plates are clean and dry. The ambient air temperature is recommended to be less than or equal to -5 °C.

b. Develop a circular layer of clear ice on each plate. Ensure the clear ice has a maximum thickness of 0.5 mm and a maximum area of 315 cm^2 after the deicing/anti-icing fluid has been applied. For the thick ice test the ice thickness shall be 10 mm ± 1 mm. For these tests the plates shall be horizontal in order to ensure a consistent and representative deicing/anti-icing fluid thickness over the ice.

c. Prior to application of the fluid, ensure that the ROGIDS is capable of detecting the ice. Measure and record the ice thickness.

d. Apply the appropriate fluid tempered and prepared in accordance with Appendix B, B.2. A retainer placed on the plate may be used to ensure that the required thickness is achieved. The procedure for the application of the fluid is as follows:

1. Apply Type I fluid to produce an average fluid thickness of 0.1 mm ± 0.05 mm.
2. Apply Type II fluid to produce an average fluid thickness of 3.0 mm ± 0.5 mm.
3. Apply Type III fluid to produce an average fluid thickness of 1.0 mm ± 0.02 mm.
4. Apply Type IV fluid to produce an average fluid thickness of 3.0 mm ± 0.5 mm.

e. Perform the test.

f. One clear ice sample may be used for more than one test.

NOTE: The fluid will dissolve the clear ice; therefore minimize the time between the fluid application and the performance of the test.

g. Complete under the night-time illumination conditions.

h. Complete with the ROGIDS placed at two locations:

1. Far - A ROGIDS at manufacturer's specified minimum operational sight angle and maximum distance.

2. Near - A ROGIDS at manufacturer's specified minimum distance and maximum operational sight angle.

i. False positive tests: Perform the tests with all fluids. Once each of the tests using 0.5 mm ice samples are completed, plates without ice shall be placed above the original plates and tests with fluid only shall be carried out with the ROGIDS in the far and near locations.

6.2.4.2 Pass/Fail Criteria

a. False negatives

For each test in test set 2 (post-deicing), the ROGIDS shall detect and indicate the presence of clear ice on each half or quadrant of the clear ice sample irrespective of:

1. The plate finish under the clear ice

2. Illumination of clear ice sample

3. Sensor location (near, far)

4. Ice thickness

5. Fluid type

b. False positives

For each of the clean plate tests in test set 2, excluding Tests 2-25, 2-26, 2-27, 2-28, 2-53, 2-54, 2-55 and 2-56, the ROGIDS shall not indicate the presence of ice irrespective of:

1. The plate finish

2. Fluid type

3. Sensor location (near, far)

6.2.5 Detection of Residual Clear Ice Post-deicing During Precipitation

6.2.5.1 Test Outline

Conduct the tests in Appendix A, Table A3 to demonstrate the capability of a ROGIDS to identify residual clear ice beneath a deicing/anti-icing fluid layer in the obscured visibility conditions specified in Appendix B. For these tests, propylene glycol based Type I and IV deicing/anti-icing fluids shall be used.

a. Ensure the plates are clean. The recommended ambient air temperature for each test is specified in Table A3.

b. Develop a circular layer of clear ice on each plate. Ensure the clear ice has a maximum thickness of 0.5 mm and a maximum area of 315 cm² after the deicing/anti-icing fluid has been applied. For this test the plates shall be horizontal in order to ensure a consistent and representative deicing/anti-icing fluid thickness over the clear ice.

c. Create the specified precipitation conditions encompassing the ROGIDS field of view.

d. Prior to application of the fluid, ensure that the ROGIDS is capable of detecting the clear ice. Measure and record the ice thickness.

e. Apply the appropriate fluid tempered and prepared in accordance with Appendix B, B.2. A retainer placed on the plate may be used to ensure that the required thickness is achieved. The procedure for the application of the fluid is as follows:

    1. Apply Type I fluid to produce an average fluid thickness of 0.1 mm ± 0.05 mm.

    2. Immediately following the Type I fluid application, apply the Type IV fluid over the Type I fluid to produce an average combined fluid thickness of 3 mm ± 0.5 mm.

f. Perform the test.

g. One clear ice sample may be used for more than one test.

    NOTE: The fluid will slowly dissolve the clear ice; therefore minimize the time between the fluid application and the performance of the test.

h. Complete tests for all the illumination conditions listed in the test matrix in Appendix A, Table A3, and defined in Appendix C. The illumination conditions that shall be considered include daylight, night-time illumination and a condition with shadows on the test plate.

i. Complete tests with the ROGIDS placed at the far location (the manufacturer's specified minimum operational sight angle and maximum distance).

j. False positive tests: Repeat the tests on plates without ice. Once each ice test is complete, a plate without ice will be placed above the original plate and tests with fluid only shall be performed with the ROGIDS at the far location.

6.2.5.2 Pass/Fail Criteria

a. False negatives

For each test in test set 3 (post-deicing with precipitation) the ROGIDS shall detect and indicate the presence of clear ice on each half or quadrant of the clear ice sample irrespective of:

1. The plate finish under the clear ice;
2. Illumination of clear ice sample;
3. Sensor location (far);
4. Fluid types;
5. Ambient Air Temperature; and
6. Precipitation.

b. False positives

For each designated clean plate test in test set 3 the ROGIDS shall not indicate the presence of ice irrespective of:

1. The plate finish;
2. Illumination of plate;
3. Sensor location (far);
4. Fluid types;
5. Ambient Air Temperature; and
6. Precipitation.

6.3 Fluid Foaming Effects (in Laboratory)

Verify that the ROGIDS performance is not affected by foaming of applied deicing fluids. A specially formulated fluid (described below) shall be applied as specified in the following test procedure.

The test surface shall be a flat aircraft type 2024 aluminum alloy plate painted with grey polyurethane (as described in Appendix B, Table B1, Note 1), 1 m x 1.5 m long with the long edge inclined at 10 degrees to the horizontal.

6.3.1 Test Outline for Fluid Foaming Effects

Conduct the test with a 315 cm^2 circular ice patch centered laterally 125 cm from the top of the plate. As the fluid is warm, the ice will melt. Thus the initial ice patch thickness will, by necessity, be greater than 0.5 mm. Ensure the resulting ice patch thickness for the test is not more than 0.5 mm.

The environmental conditions for the test shall be as follows:

1. No precipitation; and
2. The ambient air temperature shall be -10 °C or lower.

6.3.1.1 Fluid Preparation

a. Fluid Composition

The fluid used shall be a specially formulated fluid that replicates the foaming characteristics of certain deicing fluids. The formulation of the fluid shall consist of the components given in Table 3.

CAUTION: This fluid is for testing purposes only, and not for use in aircraft deicing procedures.

TABLE 3 - FORMULATION FOR FOAMING TEST DEICING FLUID[1]

Component	Percent by Weight
Propylene Glycol	61.0
Water	38.5
Dioctyl sulfosuccinate docusate sodium	0.5
[1]This mixture shall result in a fluid with a Brix of approximately 38 degrees. The fluid shall be homogeneous and completely miscible with water.	

b. Equipment for Fluid Foaming

Use a laboratory blender (Waring model number 7012G, or equivalent) with a 1 L glass mixing container.

c. Modification and Calibration of Equipment

In order to measure the speed of the blender, the following modification is recommended: Place the blender on a stand and elongate the rotating shaft at the base. Use a non-contact optical tachometer to measure the rotation speed with the mixing container in place. Place 700 mL of the test fluid in the 1 L glass container and determine the dial setting in order to get a mix speed of 3400 rpm ± 200 rpm.

d. Heating of Fluid

Heat 2000 mL of the test fluid to +60 °C ± 5 °C (140 °F ± 9 °F).

e. Foaming of Fluid

Separate the fluid into three equal batches. Pour the fluid into the blender glass container and mix each batch for 15 s at a speed of 3400 rpm ± 200 rpm.

6.3.1.2 Fluid Application

Apply the 2000 mL of fluid to the plate immediately below the upper edge in a uniform back-and-forth motion to distribute the fluid as evenly as possible. Apply the fluid within 90 s of blending the first batch of fluid. Ensure that the ice patch is covered with the foamed fluid.

6.3.1.3 Conduct of Test

Conduct the test with the ROGIDS placed at the far location (at manufacturer's specified minimum operational sight angle and maximum distance) in the night-time illumination condition.

Photographs of the foamed fluid and the ice sample shall be taken at the end of the test and shall be included in the test report.

6.3.1.4 Pass/Fail Criteria

a. The ROGIDS shall not indicate the presence of ice where none is present; and

b. The ROGIDS shall indicate the presence of ice where ice is present.

6.4 Testing in Natural Conditions – Snow Precipitation Tests

There is no practical method available for generation of artificial snow that has all of the important characteristics of natural snow for testing of ROGIDS over the necessary distances. Therefore, the snow tests shall be conducted outdoors in natural snow conditions.

6.4.1 Purpose of the Tests

The purpose of the tests is to demonstrate that the ROGIDS complies with the minimum performance specifications for the detection of clear residual ice covered with deicing/anti-icing fluids in obscured visibility conditions associated with natural snow.

6.4.2 Test Principles

The tests have been adapted from and use the same principles as laboratory test procedures to establish Endurance Times for aircraft deicing/anti-icing fluids (SAE Types I, II, III, and IV). These test procedures are described in ARP5485 and ARP5945.

6.4.3 Test Outline

Conduct the tests in Appendix A, Table A4 to demonstrate the capability of a ROGIDS to identify residual clear ice beneath a deicing/anti-icing fluid layer in the precipitation conditions specified in Appendix B. For these tests, propylene glycol based Type I and IV deicing/anti-icing fluids shall be used.

Conduct tests with snow precipitation between the plates and the sensor(s), and encompassing the sensor field of view. Protect the plates from precipitation until the start of the test.

a. Ensure the plates as defined in Appendix B are clean; the ambient air temperature is recommended to be less than or equal to 0 °C.

b. Develop a circular layer of clear ice on each plate. Ensure the clear ice has a maximum thickness of 0.5 mm and a maximum area of 315 cm² after the deicing/anti-icing fluid has been applied. For this test the plates shall be horizontal in order to ensure a consistent and representative deicing/anti-icing fluid thickness over the clear ice.

c. Prior to application of the fluid, ensure that the ROGIDS is capable of detecting the clear ice. Measure and record the ice thickness.

d. Apply the appropriate fluid tempered and prepared in accordance with Appendix B, B.2. A retainer placed on the plate may be used to ensure that the required thickness is achieved. The procedure for the application of the fluid is as follows:

    1. Apply Type I fluid to produce an average fluid thickness of 0.1 mm ± 0.05 mm.

    2. Immediately following the Type I fluid application, apply the Type IV fluid over the Type I fluid to produce an average combined fluid thickness of 3 mm ± 0.5 mm.

e. Remove the plate protection and immediately perform the test.

f. One clear ice sample may be used for more than one test.

NOTE: The fluid will dissolve the ice; therefore minimize the time between the fluid application and the performance of the test.

g. Conduct tests in both daylight and night-time natural conditions.

The maximum level of night-time illumination shall not exceed the level specified in Appendix C, Paragraph C2, ‘Night-time illumination’.

h. Conduct tests with the ROGIDS placed at the far location (the manufacturer’s specified minimum operational sight angle, and maximum distance).

i. False positive tests: Repeat the tests on plates without ice. Once each ice test is complete, a plate without ice will be placed above the original plate and tests with fluid only shall be performed with the ROGIDS at the far location.

6.4.3.1 Pass/Fail Criteria

a. False negatives

For each test the ROGIDS shall detect and indicate the presence of clear ice on each half of the clear ice sample irrespective of:

1. The plate finish under the clear ice;
2. Illumination of ice sample;
3. Sensor location (far);
4. Fluid types;
5. Temperature; and
6. Precipitation.

b. False positives

For each designated clean plate test in test set 4, the ROGIDS shall not indicate the presence of ice irrespective of:

1. The plate finish;
2. Illumination of plate;
3. Sensor location (far);
4. Fluid types;
5. Temperature; and
6. Precipitation.

6.5 Testing in Natural Conditions – Illumination

6.5.1 Purpose of Test

The purpose of this test is to verify that the ROGIDS performance is not adversely affected by natural and artificial visible and non-visible light typically found at deicing facilities.

6.5.1.1 Test Outline for Illumination Condition Effects

a. Conduct tests on a wing surface of at least 10 m^2 in two configurations: (a) wing clean and dry, and (b) wing treated with Type I fluid diluted per Appendix B.

b. Conduct tests at an operational deicing facility with typical lighting.

c. The environmental conditions for the test shall be:

   1. No precipitation;

   2. Conduct one test in daylight under clear sky conditions;

   3. Conduct one test at night-time;

   4. Conduct 2 twilight tests. One morning twilight test (between half an hour before sunrise and sunrise) and one evening twilight test (between sunset and half an hour after sunset); and

   5. An ambient air temperature of -10 °C or lower is recommended to ensure that ice samples do not degrade.

   A summary matrix of tests is given in Appendix A, Table A5.

d. Conduct tests with no ice present, and tests with ice patches ≤0.5 mm thick ice over a circular area ≤315 cm^2 at leading edge (LE), mid-chord, and trailing edge (TE) locations.

e. Apply Type I ethylene glycol or propylene glycol fluid to the section of the wing to be tested. The section of the wing that is treated shall include the ice patches, shall be greater than 10 m^2, and shall extend over the full chord.

f. Perform the test within a short period of time following fluid application to minimize ice patch degradation.

g. Complete with the ROGIDS placed at two locations:

   1. Far - A ROGIDS at manufacturer's specified minimum operational sight angle and maximum distance.

   2. Near - A ROGIDS at manufacturer's specified minimum distance and maximum operational sight angle.

6.5.1.2 Pass/Fail Criteria

a. The ROGIDS shall not indicate the presence of ice where none is present.

b. The ROGIDS shall indicate the presence of ice where ice is present.

6.6 Actions to be Taken in Event of Failure

If it is determined that the failure of a test may have been caused by incorrect environmental conditions or test setup it is permissible to correct those deficiencies and rerun that test.

If it is determined that the failure of a test is due to system deficiency, the deficiency shall be corrected and all tests shall be rerun with the new system, unless the manufacturer can prove conclusively that the correction will only affect a limited set of tests.

7. INSTALLED EQUIPMENT OPERATIONAL EVALUATION

Certain ROGIDS performance parameters may be affected by the end-user's physical installation and shall be verified after installation. This section specifies the operational evaluation that shall be performed to verify the performance of the ROGIDS when installed for in-service use.

7.1 Purpose of Evaluation

The purpose of the operational evaluation is to perform a qualitative assessment to verify that the ROGIDS performance is not adversely affected by normal operating conditions and environment.

The following are conditions or events that may adversely affect the operation of the ROGIDS:

a. Illumination effects;

b. Fluid foaming effects;

c. Compatibility with monitored surface (e.g., the ROGIDS shall not produce false positives due to the material, the surface finish and/or surface treatment of the monitored aircraft surface);

d. Effects of precipitation; and

e. Effects of non-frozen contaminants (e.g., grease, dirt, fuel) on the monitored surface.

7.2 General

The installed equipment operational evaluation addresses conditions arising during in-service operations that are not covered by the minimum operational performance tests of Section 6. Although ROGIDS may be hand-held, pedestal or vehicle mounted in-service, the evaluations specified in this section are based on a vehicle-mounted operation. Hand-held or pedestal mounted installations may warrant adaptation of this section, as appropriate.

The evaluation will be performed during actual aircraft deicing operations.

Prior to starting this evaluation, conduct a conformity inspection to ensure that the ROGIDS has been installed in accordance with the manufacturer's instructions.

The ROGIDS shall be operated in accordance with the manufacturer's operating procedures. During this evaluation the equipment shall not be subject to environmental conditions that exceed the manufacturer's specified operating environment.

Any ground-based electrical and mechanical equipment likely to be operated in proximity of the ROGIDS during normal operations shall be activated during this evaluation.

7.2.1 Operational Evaluation Plan, Procedures, and Reports

Detailed test plans, test procedures, and a report of test results shall be prepared in accordance with Section 3. Where physical facility limitations exist which influence the set-up and conduct of the operational evaluation, these limitations shall be noted.

7.2.2 Required Equipment and Personnel

At a minimum, conduct the evaluation using:

a. A ROGIDS installed on the vehicle in accordance with the manufacturer's installation instructions;

b. Operational aircraft when specified herein;

c. Deicing and anti-icing fluids meeting SAE specifications (AMS1424 and AMS1428); and

d. Operator(s) trained to use all equipment being used in the conduct of these tests.

7.3 Operational Evaluation

7.3.1 Evaluation Scenarios

The total number of deicing operations that will be evaluated are provided in FAA AC 120-107, Section 7 or TC AC No. 602-001, Section 5 for the initial evaluation and follow-on evaluations. The evaluations shall include as wide a variety of the aircraft types and sizes expected to be deiced at the airport as possible. Table 4 provides guidance on the distribution of the various evaluation conditions.

TABLE 4 - DISTRIBUTION OF EVALUATION CONDITIONS

Condition[1]	Morning Twilight	Day	Evening Twilight	Night
No Precipitation	5%	15%	5%	5%
Precipitation	5%	45%	5%	15%
[1] 'No precipitation' evaluations should include frost. Precipitation evaluations shall include snow and should include other forms of precipitation, such as freezing drizzle, light freezing rain, freezing fog and rain on a cold-soaked wing.				

7.3.2 Evaluation Conditions – Reporting Anomalies

Observe and note any anomalies in ROGIDS performance (e.g., false positives and false negatives) before and after fluid application due to the following:

a. Illumination effects: Artificial and natural;

b. Fluid foaming effects;

c. Compatibility with monitored surface;

d. Effects of precipitation;

e. Effects of non-frozen contaminants; and

f. Other.

Any anomalies identified during the evaluation shall be documented.

7.3.3 Display

Verify that the operator has an unobstructed view of the displayed data when in the normal operating position.

Display readability shall be adequate for data interpretation during normal operating conditions.

Verify that the display allows the operator to easily correlate the ROGIDS detection image with the surface being monitored.

7.3.4 Controls Accessibility and Operation

Verify that all necessary controls are readily accessible and operable from the operator's normal operating position.

7.3.5 Electromagnetic Interference Effects

Verify that the ROGIDS is not the source of electromagnetic interference to other equipment and is not adversely affected by electromagnetic interference from other equipment or systems.

7.3.6 Dynamic Effects

Verify that the ROGIDS performance is not adversely affected by dynamic conditions during normal operations (e.g. wind buffeting, or deicing vehicle vibration).

7.3.7 Equipment Usability

Evaluate the ROGIDS usability in operational conditions to ensure that it performs its intended function without excessive workload such that the operators cannot be relied upon to perform their tasks accurately or completely.

7.3.8 Safety Precautions

Verify that there are no unusual characteristics or hazards to personnel or property (e.g., laser radiation, etc.) resulting from operation of the ROGIDS.

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 operator 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 Actions to be Taken in Event of Anomalies

Anomalies shall be investigated to determine the cause.

If it is determined that an anomaly is due to system (operator and/or equipment) deficiency, the deficiency shall be identified, corrected, and all tests shall be rerun with the new system, unless the manufacturer can prove conclusively that the correction will only affect a limited set of tests.

8. NOTES

8.1 A change bar (l) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.

APPENDIX A - TEST MATRICES

TABLE A1 - TEST SET 1 – DETECTION OF CLEAR ICE PRE-DEICING

Test #	Test Plate	Sensor Location	Illumination
1-1	1	Far	Daylight
1-2	2	Far	Daylight
1-3	3	Far	Daylight
1-4	4	Far	Daylight
1-5	1	Near	Daylight
1-6	2	Near	Daylight
1-7	3	Near	Daylight
1-8	4	Near	Daylight
1-9	1	Far	Night-time
1-10	2	Far	Night-time
1-11	3	Far	Night-time
1-12	4	Far	Night-time
1-13	1	Near	Night-time
1-14	2	Near	Night-time
1-15	3	Near	Night-time
1-16	4	Near	Night-time
1-17	1	Far	Shadow
1-18	2	Far	Shadow
1-19	3	Far	Shadow
1-20	4	Far	Shadow
1-21	1	Near	Shadow
1-22	2	Near	Shadow
1-23	3	Near	Shadow
1-24	4	Near	Shadow

Test Parameters:

1. Sensor Location: Minimum Sight Angle and Maximum Distance (Far) and Maximum Sight Angle and Minimum Distance (Near).
2. Precipitation Type: None
3. Recommended Temperature: ≤-5 °C
4. Fluid Type Required: None
5. See Appendices B and C for definitions of parameters.

TABLE A2 - TEST SET 2 – DETECTION OF RESIDUAL CLEAR ICE POST-DEICING AT FAR LOCATION

Test #	Test Plate	Fluid Type Required	Sensor Location
2-1	1	Type I (E base) over ice	Far
2-2	2	Type I (E base) over ice	Far
2-3	3	Type I (E base) over ice	Far
2-4	4	Type I (E base) over ice	Far
2-5	1	Type I (P base) over ice	Far
2-6	2	Type I (P base) over ice	Far
2-7	3	Type I (P base) over ice	Far
2-8	4	Type I (P base) over ice	Far
2-9	1	Type II (P base) over ice	Far
2-10	2	Type II (P base) over ice	Far
2-11	3	Type II (P base) over ice	Far
2-12	4	Type II (P base) over ice	Far
2-13	1	Type III (P base) over ice	Far
2-14	2	Type III (P base) over ice	Far
2-15	3	Type III (P base) over ice	Far
2-16	4	Type III (P base) over ice	Far
2-17	1	Type IV (E base) over ice	Far
2-18	2	Type IV (E base) over ice	Far
2-19	3	Type IV (E base) over ice	Far
2-20	4	Type IV (E base) over ice	Far
2-21	1	Type IV (P base) over ice	Far
2-22	2	Type IV (P base) over ice	Far
2-23	3	Type IV (P base) over ice	Far
2-24	4	Type IV (P base) over ice	Far
2-25	1	Type I (P base) over thick ice	Far
2-26	2	Type I (P base) over thick ice	Far
2-27	3	Type I (P base) over thick ice	Far
2-28	4	Type I (P base) over thick ice	Far

Test Parameters:

1. Sensor Location: Minimum Sight Angle and Maximum Distance (Far).
2. Precipitation Type: None
3. Recommended Temperature: ≤-5 °C
4. Illumination: Night-time
5. See Appendices B and C for definitions of parameters.

NOTE: In the fluid type required column, P designates propylene glycol and E designates ethylene glycol.

TABLE A2 - TEST SET 2 – DETECTION OF RESIDUAL CLEAR ICE POST-DEICING AT NEAR LOCATION (CONTINUED)

Test #	Test Plate	Fluid Type Required	Sensor Location
2-29	1	Type I (E base) over ice	Near
2-30	2	Type I (E base) over ice	Near
2-31	3	Type I (E base) over ice	Near
2-32	4	Type I (E base) over ice	Near
2-33	1	Type I (P base) over ice	Near
2-34	2	Type I (P base) over ice	Near
2-35	3	Type I (P base) over ice	Near
2-36	4	Type I (P base) over ice	Near
2-37	1	Type II (P base) over ice	Near
2-38	2	Type II (P base) over ice	Near
2-39	3	Type II (P base) over ice	Near
2-40	4	Type II (P base) over ice	Near
2-41	1	Type III (P base) over ice	Near
2-42	2	Type III (P base) over ice	Near
2-43	3	Type III (P base) over ice	Near
2-44	4	Type III (P base) over ice	Near
2-45	1	Type IV (E base) over ice	Near
2-46	2	Type IV (E base) over ice	Near
2-47	3	Type IV (E base) over ice	Near
2-48	4	Type IV (E base) over ice	Near
2-49	1	Type IV (P base) over ice	Near
2-50	2	Type IV (P base) over ice	Near
2-51	3	Type IV (P base) over ice	Near
2-52	4	Type IV (P base) over ice	Near
2-53	1	Type I (P base) over thick ice	Near
2-54	2	Type I (P base) over thick ice	Near
2-55	3	Type I (P base) over thick ice	Near
2-56	4	Type I (P base) over thick ice	Near

Test Parameters:

1. Sensor Location: Maximum Sight Angle and Minimum Distance (Near).
2. Precipitation Type: None
3. Recommended Temperature: ≤-5 °C
4. Illumination: Night-time
5. See Appendices B and C for definitions of parameters.

NOTE: In the fluid type required column, P designates propylene glycol and E designates ethylene glycol.

TABLE A3 - TEST SET 3 – DETECTION OF RESIDUAL CLEAR ICE POST-DEICING DURING PRECIPITATION – SIMULATED PRECIPITATION

Test #	Precipitation Type	Precipitation Rate g/dm²/h	Recommended Temperature °C	Test Plate	Fluid Type Required	Illumination
3-1	Rain	65-80	> = -5	1	Type IV P Over Type I P Over Ice	Daylight
3-2	Rain	65-80	> = -5	2	Type IV P Over Type I P Over Ice	Daylight
3-3	Rain	65-80	> = -5	3	Type IV P Over Type I P Over Ice	Daylight
3-4	Rain	65-80	> = -5	4	Type IV P Over Type I P Over Ice	Daylight
3-5	Freezing Fog	Visibility < 100m	< = -5	1	Type IV P Over Type I P Over Ice	Daylight
3-6	Freezing Fog	Visibility < 100m	< = -5	2	Type IV P Over Type I P Over Ice	Daylight
3-7	Freezing Fog	Visibility < 100m	< = -5	3	Type IV P Over Type I P Over Ice	Daylight
3-8	Freezing Fog	Visibility < 100m	< = -5	4	Type IV P Over Type I P Over Ice	Daylight
3-9	Rain	65-80	> = -5	1	Type IV P Over Type I P Over Ice	Night-time
3-10	Rain	65-80	> = -5	2	Type IV P Over Type I P Over Ice	Night-time
3-11	Rain	65-80	> = -5	3	Type IV P Over Type I P Over Ice	Night-time
3-12	Rain	65-80	> = -5	4	Type IV P Over Type I P Over Ice	Night-time
3-13	Freezing Fog	Visibility < 100m	< = -5	1	Type IV P Over Type I P Over Ice	Night-time
3-14	Freezing Fog	Visibility < 100m	< = -5	2	Type IV P Over Type I P Over Ice	Night-time
3-15	Freezing Fog	Visibility < 100m	< = -5	3	Type IV P Over Type I P Over Ice	Night-time
3-16	Freezing Fog	Visibility < 100m	< = -5	4	Type IV P Over Type I P Over Ice	Night-time
3-17	Rain	65-80	> = -5	1	Type IV P Over Type I P Over Ice	Shadow
3-18	Rain	65-80	> = -5	2	Type IV P Over Type I P Over Ice	Shadow
3-19	Rain	65-80	> = -5	3	Type IV P Over Type I P Over Ice	Shadow
3-20	Rain	65-80	> = -5	4	Type IV P Over Type I P Over Ice	Shadow
3-21	Freezing Fog	Visibility < 100m	< = -5	1	Type IV P Over Type I P Over Ice	Shadow
3-22	Freezing Fog	Visibility < 100m	< = -5	2	Type IV P Over Type I P Over Ice	Shadow
3-23	Freezing Fog	Visibility < 100m	< = -5	3	Type IV P Over Type I P Over Ice	Shadow
3-24	Freezing Fog	Visibility < 100m	< = -5	4	Type IV P Over Type I P Over Ice	Shadow

Test Parameters:

1. Sensor at Minimum Sight Angle and Maximum Distance (Far).

2. See Appendices B and C for definitions of parameters.

NOTE: In the fluid type required column, P designates propylene glycol.

TABLE A4 - TEST SET 4 – DETECTION OF RESIDUAL CLEAR ICE POST-DEICING DURING PRECIPITATION – NATURAL SNOW

Test #	Precipitation Type	Precipitation Rate g/dm²/h	Recommended Temperature °C	Test Plate	Fluid Type Required	Illumination
4-1	Snow	>15 and <50	< = 0	1	Type IV P Over Type I P Over Ice	Daylight
4-2	Snow	>15 and <50	< = 0	2	Type IV P Over Type I P Over Ice	Daylight
4-3	Snow	>15 and <50	< = 0	3	Type IV P Over Type I P Over Ice	Daylight
4-4	Snow	>15 and <50	< = 0	4	Type IV P Over Type I P Over Ice	Daylight
4-5	Snow	>15 and <50	< = 0	1	Type IV P Over Type I P Over Ice	Night-time
4-6	Snow	>15 and <50	< = 0	2	Type IV P Over Type I P Over Ice	Night-time
4-7	Snow	>15 and <50	< = 0	3	Type IV P Over Type I P Over Ice	Night-time
4-8	Snow	>15 and <50	< = 0	4	Type IV P Over Type I P Over Ice	Night-time

Test Parameters:

1. Sensor Location: Minimum Sight Angle and Maximum Distance (Far).

2. See Appendices B and C for definitions of parameters.

NOTE: In the fluid type required column, P designates propylene glycol.

TABLE A5 - TEST SET 5 – MATRIX OF ILLUMINATION CONDITION TESTS

Test #	Fluid Type Required	Illumination	Sky Condition	Location of Ice
5-1	Dry Wing	Daylight	Clear	No ice
5-2	Dry Wing	Night-time	Any	No ice
5-3	Dry Wing	Morning	Twilight	No ice
5-4	Dry Wing	Evening	Twilight	No ice
5-5	Dry Wing	Daylight	Clear	Ice LE
5-6	Dry Wing	Night-time	Any	Ice LE
5-7	Dry Wing	Morning	Twilight	Ice LE
5-8	Dry Wing	Evening	Twilight	Ice LE
5-9	Dry Wing	Daylight	Clear	Ice mid-chord
5-10	Dry Wing	Night-time	Any	Ice mid-chord
5-11	Dry Wing	Morning	Twilight	Ice mid-chord
5-12	Dry Wing	Evening	Twilight	Ice mid-chord
5-13	Dry Wing	Daylight	Clear	Ice TE
5-14	Dry Wing	Night-time	Any	Ice TE
5-15	Dry Wing	Morning	Twilight	Ice TE
5-16	Dry Wing	Evening	Twilight	Ice TE
5-17	Type I (E base or P base)	Daylight	Clear	No ice
5-18	Type I (E base or P base)	Night-time	Any	No ice
5-19	Type I (E base or P base)	Morning	Twilight	No ice
5-20	Type I (E base or P base)	Evening	Twilight	No ice
5-21	Type I (E base or P base)	Daylight	Clear	Ice LE
5-22	Type I (E base or P base)	Night-time	Any	Ice LE
5-23	Type I (E base or P base)	Morning	Twilight	Ice LE
5-24	Type I (E base or P base)	Evening	Twilight	Ice LE
5-25	Type I (E base or P base)	Daylight	Clear	Ice mid-chord
5-26	Type I (E base or P base)	Night-time	Any	Ice mid-chord
5-27	Type I (E base or P base)	Morning	Twilight	Ice mid-chord
5-28	Type I (E base or P base)	Evening	Twilight	Ice mid-chord
5-29	Type I (E base or P base)	Daylight	Clear	Ice TE
5-30	Type I (E base or P base)	Night-time	Any	Ice TE
5-31	Type I (E base or P base)	Morning	Twilight	Ice TE
5-32	Type I (E base or P base)	Evening	Twilight	Ice TE

Test Parameters:

1. Sensor Location: Minimum Sight Angle and Maximum Distance (Far) and Maximum Sight Angle and Minimum Distance (Near).

2. Precipitation Type: None

3. Recommended Temperature: ≤-10 °C

4. See Appendices B and C for definitions of parameters.

NOTE: In the fluid type required column, P designates propylene glycol and E designates ethylene glycol.

APPENDIX B - DETAILED TEST PARAMETERS

B.1 SCOPE

The test conditions required to demonstrate the ability of the ROGIDS to comply with the performance specifications of Sections 3 and 4 use the same principles as laboratory test procedures to establish endurance times for aircraft deicing/anti-icing fluids (SAE Types I, II, III, and IV). These test procedures are described in ARP5485 and ARP5945.

B.1.1 Safety

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 necessary precautionary measures to ensure the health and safety of all personnel involved.

B.2 FLUID SAMPLE SELECTION PROCEDURE FOR SAE TYPE I FLUIDS

B.2.1 Requirements

B.2.1.1 Production Batch

The sample shall be a fluid taken from a manufacturer’s production batch.

B.2.1.2 Fluid Selection

Fluid selection for Type I shall include ethylene glycol or propylene glycol based fluids as listed in Appendix A, Tables A2 and A3.

B.2.1.3 Fluid Concentration

All Type I fluid tests shall be performed using a fluid with a freezing point between -28 °C and -43 °C.

B.2.1.4 Manufacturer's Documentation

a. Fluid name, fluid type and batch number.

b. The freezing point versus refraction at 20 °C data for the fluid.

B.2.2 Condition of the Sample to be Used for Test

To minimize dissolving of the ice sample, it is strongly recommended that the fluid be applied as cold as possible, at a minimum, it should be applied 3 °C above the freezing point of the fluid. The sample’s refractive index shall be measured and recorded. Research has shown (Transport Canada publication Feasibility of ROGIDS Test Conditions Stipulated in AS5681) that lower levels of ice sample degradation occur when the temperature of the fluid is close to its freeze point.

B.3 FLUID SAMPLE SELECTION PROCEDURE FOR SAE TYPE II, III, AND IV FLUIDS

B.3.1 Requirements

B.3.1.1 Production Batch

The sample shall be a neat sample taken from a manufacturer’s production batch.

B.3.1.2 Viscosity

The viscosity shall be equal to or greater than the lowest on-wing viscosity specified for the fluid in the specific holdover time (HOT) guidelines available from FAA or TC.

B.3.1.3 Fluid Selection

Fluid selection for Type II, Type III and Type IV shall include ethylene glycol or propylene glycol based fluids as listed in Appendix A, Tables A2 and A3.

B.3.1.4 Fluid Concentration

All tests shall be performed with neat 100% fluids.

B.3.1.5 Fluid Manufacturer's Documentation

a. Fluid name, fluid type and batch number.

b. The freezing point versus refraction at 20 °C data for the fluid.

B.3.2 Condition of the Sample

To minimize dissolving of the ice sample, it is recommended that the fluid be applied as cold as possible; at a minimum, it should be applied above the freezing point of the fluid. The sample's refractive index shall be measured and recorded.

B.4 TEST PROCEDURE - GENERAL

B.4.1 Purpose

This section establishes the minimum requirements for test equipment and test procedures used to demonstrate the ability of the ROGIDS to comply with the performance specifications of Sections 4 and 5.

Section B.4 covers requirements that are common to many or all conditions (except where otherwise noted). Section B.5 establishes the specific requirements for each precipitation condition.

B.4.2 ROGIDS Sensor and Plate Test Set-up

The size and surface finishes of the test plates shall be as described in Table B1 and are illustrated in Figure B1.

Develop the ice sample on each plate over a circular area of 315 cm². The ice sample shall be positioned so that it is equally distributed over both surface finishes of the pertinent test plates, where applicable. If the ice sample cannot be formed on the test surface the area where the ice sample is to be formed may be minimally roughened.

For the tests involving shadow illumination, the shadow shall be created to cover either the top or the bottom half of the ice sample, thereby creating four equal and distinct quadrants (two surface finishes, each with two illumination conditions on the sample).

Tests shall be performed with the ROGIDS placed at two locations unless otherwise noted:

a. Far: One ROGIDS at manufacturer's specified minimum operational sight angle and maximum distance.

b. Near: One ROGIDS at manufacturer's specified minimum distance and maximum operational sight angle.

TABLE B1 - TEST PLATES

ALL TEST PLATES	
Dimensions	500 mm long x 300 mm wide. Recommended thickness = 3 mm
TEST PLATE 1	
Material	Aircraft type 2024 Aluminum alloy
Surface finish	Half area (150 mm wide) grey polyurethane (Note 1) Half area bare aluminum (150 mm wide) Average surface roughness: Ra ≤ 0.2 µm
TEST PLATE 2	
Material	Aircraft type 2024 Aluminum alloy
Surface finish	Half area (150 mm wide) white polyurethane (Note 1) Half area (150 mm wide) red polyurethane (Note 1)
TEST PLATE 3	
Material	Fiber Reinforced Composite (Note 2)
Surface finish	Half area (150 mm wide) white polyurethane (Note 1) Half area (150 mm wide) red polyurethane (Note 1)
TEST PLATE 4	
Material/ Surface finish	Deicing Boot Exterior Surface Material (Note 3)

NOTES:

1. Test plate surfaces shall be prepared using typical aircraft surface preparation procedures. Record paint manufacturer, brand name, paint identification, and paint application method, and final finishing procedure.

2. Fiber reinforced composite surface shall be smooth and suitable for application of aircraft surface finishes.

3. The boot material should be attached to a flat test surface to give an exposed surface finish as near to flat as possible. Stretching the material may assist in this process.

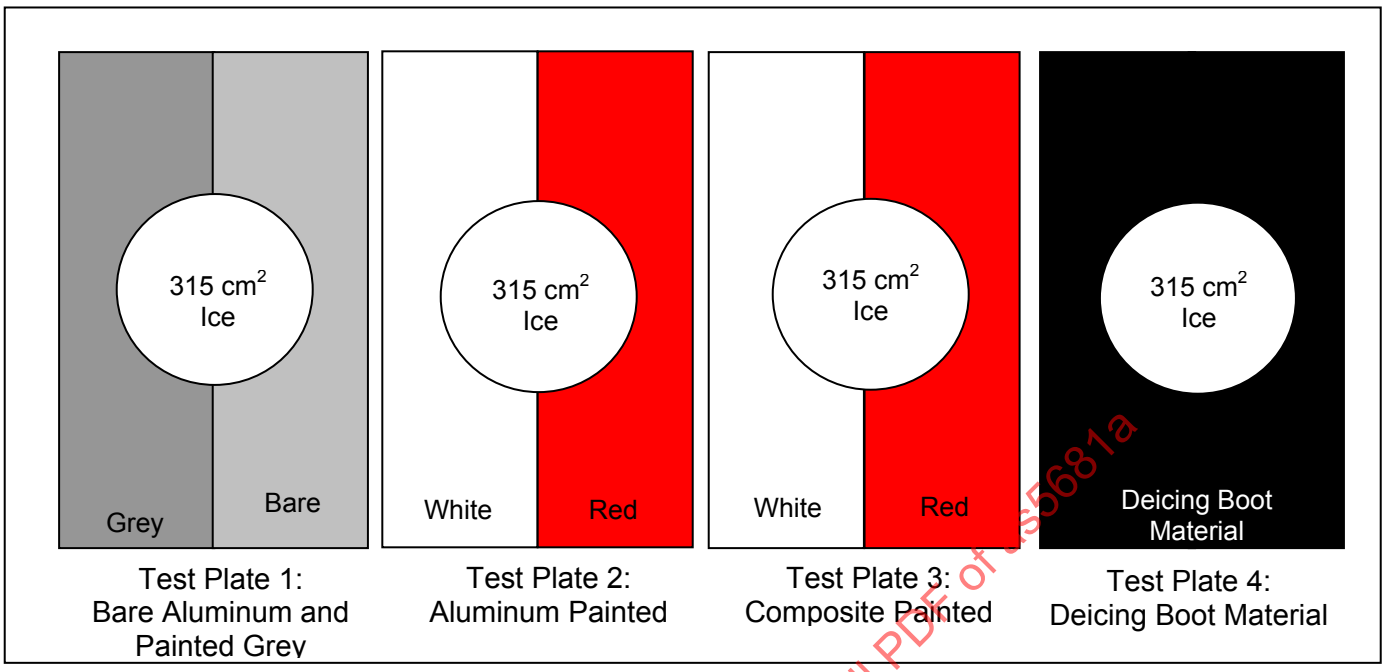

FIGURE B1 - RECOMMENDED SURFACE FINISH AND ICE SAMPLE LOCATION

B.4.3 General Test Procedures

The tests may be run with multiple co-located plates (Table B1, Figure B1) and ROGIDS (far and near) simultaneously. If test facility constraints limit the evaluation of the ROGIDS, those limitations shall be documented and reported as per 3.9.4.

B.4.3.1 Calibration and Measurement Methods

All test equipment used in the performance of these tests shall be identified by make, model, serial number and the calibration expiration date, and/or the valid period of calibration, where appropriate. When appropriate, all test equipment calibration standards shall be traceable to national and/or international standards.

B.4.3.2 Visibility

For visibility tests in freezing fog conditions, a calibrated airport transmissometer or equivalent equipment is recommended.

B.4.3.3 Suggested Methods for Ice Thickness Evaluation

A fluid film thickness gauge may be used. The gauge may be slightly heated to ensure that the reference surfaces of the gauge are directly in contact with the plate.

B.4.3.4 Test Plate Cleanliness

The test plates shall be free of all visible contamination, smears, or stains. Contamination shall be removed between test runs by washing with hot water immediately followed by an ethanol rinse. Allow the plates to dry after rinse and ensure that they are at the temperature required for the specific test.

B.5 PRECIPITATION PARAMETERS FOR TESTING OF ROGIDS

B.5.1 Freezing Fog Test Equipment and Test Parameters

The environmental chamber and associated equipment shall be such that active precipitation is present between the ROGIDS and the test surface that is being detected. The spray equipment producing the precipitation shall provide a droplet median volume diameter of 22 µm ± 5 µm. The combination of precipitation rate and range shall be adjusted to give conditions equivalent to a field visibility of 100 m or less with the ROGIDS operating at its maximum range when in service. The ambient air temperature is recommended to be less than or equal to -5 °C.

B.5.2 Rain Test Equipment and Test Parameters

The environmental chamber and associated equipment shall be such that active precipitation is present between the ROGIDS and the test surface that is being detected. The spray equipment producing the precipitation shall provide a droplet median volume diameter of 1000 µm ± 200 µm. The intensity shall be between 65 and 80 g/dm^2/h and the ambient air temperature is recommended to be ≥ -5 °C.

B.5.3 Snow Test Equipment and Test Parameters:

Tests shall be conducted in natural snow conditions with a precipitation rate ≥15 g/dm^2/h and ≤50 g/dm^2/h. Actual precipitation rate, wind speed, and temperature during the tests shall be recorded.

At the time of the publication of this document, no known technology exists to produce sufficient quantities of artificial snow, of an acceptable quality, in an environmental chamber. Therefore, until such equipment becomes available, the snow test shall be performed outdoors in natural conditions.