



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

MINIMUM OPERATIONAL PERFORMANCE SPECIFICATION FOR INFLIGHT ICING DETECTION SYSTEMS

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FOREWORD

1. The development of this document was jointly accomplished by EUROCAE Working Group 54 and the Society of Automotive Engineers (SAE) AC-9C through a consensus process. It was approved for publication by the Council of EUROCAE on June 2001.
2. EUROCAE and SAE Inc. are respectively, international and US not-for-profit making organisations, formed to advance the art and science of aviation and aviation electronic systems for the benefit of the public.
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CHAPTER 1

GENERAL

1.1 PURPOSE AND SCOPE

The objective of this Minimum Operational Performance Specification is to specify the minimum performance of onboard inflight icing detection systems. Throughout the document, these devices are referred to as Flight Icing Detection Systems (FIDS). These systems are intended to either provide information which indicates the presence of ice accreted in flight on monitored surfaces or indicate the presence of icing conditions in the atmosphere. They may operate the aeroplane anti-ice/deice systems. Detection of ice accreted on the ground is not considered in this document but can be found in ED-104. This MOPS was written for the use of FIDS on aeroplanes only, as defined in section 1.5. Use on other aircraft may require additional considerations.

Chapter 1 of this document provides information required to understand the need for the equipment characteristics and tests defined in the remaining chapters. It describes typical equipment applications and operational objectives and is the basis for the performance criteria stated in Chapter 2 to Chapter 4. Definitions essential to proper understanding of this document are also provided in Chapter 1.

Chapter 2 contains general design requirements for an onboard FIDS.

Chapter 3 contains the Minimum Operational Performance Specification for the equipment, defining performance under icing conditions likely to be encountered in flight.

Chapter 4 describes the environmental test conditions which provide a laboratory means of determining the overall performance characteristics of the equipment under conditions representative of those which may be encountered in actual operations.

Chapter 5 describes recommended test procedures for demonstrating compliance with Chapter 3.

Chapter 6 specifies the performance required of the installed equipment. Ground and flight tests for the installed equipment are included when performance cannot be adequately determined through testing under standard test conditions.

1.2 APPLICATIONS

Compliance with this Minimum Operational Performance Specification is recommended as a means of assuring that the equipment will satisfactorily perform its intended functions under all icing conditions likely to be encountered in flight.

Any regulatory application of this document in whole or in part is the sole responsibility of appropriate government agencies.

As the measured values of equipment performance characteristics may be a function of the method of measurement, standard test conditions and methods of test 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.

1.3

FUNCTIONALITY AND DESCRIPTION OF SYSTEM

Icing instrumentation systems provide information to the flight crew and/or aeroplane systems concerning inflight icing. Components of the system may be intrusive or non-intrusive to the airflow. The system may be directly or indirectly sensitive to the physical phenomena of inflight icing. Some possible icing instrumentation technologies include: latent heat of fusion, changes in the natural frequency of vibrating components, visual cues, ultrasonic waves, optical methods such as IR cameras, the friction between a rotating cylinder and scraper, etc. Icing instrumentation systems are divided into 2 types: FIDS and Aerodynamic Performance Monitoring Systems (APMS). FIDS are further divided into those that detect ice accretion and those that detect icing conditions.

A FIDS that detects ice accretion informs the flight crew and/or systems about the presence of ice accretions on reference aeroplane surfaces. FIDS that detect ice accretion may also inform the crew or a system about ice thickness, ice accretion rate, liquid water content, cloud droplet size, and/or accretion location. This MOPS only defines testing for ice detection, ice thickness, ice accretion rate, and liquid water content. FIDS that detect ice accretion may be located on or remote from the monitored aeroplane surfaces.

A FIDS that detects icing conditions provides information to the flight crew and/or aeroplane systems concerning atmospheric icing conditions. The output of a FIDS that detects icing conditions informs the flight crew and/or aeroplane systems about the presence of atmospheric conditions that are conducive to the accretion of ice on aeroplane surfaces. A FIDS that detects icing conditions is not necessarily sensitive to the presence of ice accretions.

A FIDS may include a processing unit to perform signal processing, sensor monitoring, data communication or other functions. The processing unit may either be integrated with or separate from the sensor(s). A FIDS may be connected to a device to provide information to the cockpit crew. The FIDS may communicate with other onboard equipment or systems.

An Aerodynamic Performance Monitoring System (APMS) informs the flight crew and/or aeroplane systems about aerodynamic performance degradation, which may be due to ice accretions, over monitored surfaces. This aerodynamic performance degradation may result in degraded aeroplane performance and handling qualities. An APMS is not directly sensitive to ice accretions. These systems are not considered in this specification.

1.4 SYSTEM CLASSIFICATION

1.4.1 Classification By Use

This MOPS will consider two classes of Flight Icing Detection Systems (FIDS) that detect ice accretion or icing conditions: ADVISORY systems and PRIMARY systems.

An ADVISORY FIDS annunciates the presence of ice accretion or icing conditions. The cockpit crew is responsible for monitoring the icing as defined in the Aeroplane Flight Manual (AFM). Typical methods include monitoring:

- total air temperature
- visible moisture criteria
- visible ice accretion
- specific airframe ice accretion thickness
- FIDS

Activation by the cockpit crew of the anti-icing or deicing system(s) remains a requirement. The ADVISORY FIDS provides information to advise the cockpit crew of the presence of ice accretion or icing conditions, but it can only be used in conjunction with other means to determine the need or timing of anti-icing or deicing system activation.

A PRIMARY FIDS annunciates the presence of ice accretion or icing conditions and may also provide information to other aeroplane systems. The PRIMARY FIDS can further be classified as PRIMARY automatic or PRIMARY manual. In a PRIMARY automatic system, the FIDS automatically activates anti-icing or deicing systems. In a PRIMARY manual system, the cockpit crew activates the ice protection systems based on the FIDS annunciation.

1.4.2 Classification By Sensing Method

Flight Icing Detection Systems that detect ice accretion and are covered by this document include the following classes:

- FIDS that make a measurement on a reference surface correlated to ice accumulation on a monitored surface (i.e. probe type sensors)
- FIDS that make a direct measurement on a reference surface which is part of a monitored surface (i.e. flush mounted sensors)
- FIDS that make a remote measurement on a reference surface which is part of a monitored surface (i.e. optical camera methods)

In addition, this document includes FIDS that detect icing conditions. This document considers all FIDS that detect icing conditions as a single class.

1.5 DEFINITIONS AND ABBREVIATIONS

1.5.1 Definitions

Advisory FIDS

A FIDS that provides the cockpit crew with an additional indication of ice or icing, but the cockpit crew still activates ice protection systems based on Aeroplane Flight Manual (AFM) criteria (typically when the total air temperature is below a threshold level and visible moisture is present) and not solely based on the FIDS.

Aeroplane	A fixed-wing vehicle that travels through air supported by the dynamic action of air against its lifting surfaces.
Anti-icing	The prevention of ice formation on a surface.
APMS	An Aerodynamic Performance Monitoring System informs the cockpit crew or another system about degradation of aerodynamic performance (these systems are not considered in this MOPS).
Component	A part of a system (e.g., sensor, processor, or display).
Deicing	The removal of ice accumulation from a surface.
Failure	An occurrence which affects the operation of a component such that it can no longer function as intended.
FIDS	Flight Icing Detection System. A FIDS includes at least one sensor which is directly or indirectly sensitive to the physical phenomena of icing.
Frost	Frozen moisture condensed from the atmosphere.
Glaze Ice	Transparent or translucent ice formed by liquid water droplets which do not freeze immediately on impact.
Ice	Any form of frozen water including glaze ice, rime ice, frost, runback ice, snow, and ice crystals.
Ice Detector	Informs the cockpit crew or a system about ice accretion on monitored aeroplane surfaces.
Icing Conditions	The presence of atmospheric moisture and temperature conducive to aeroplane icing.
Inflight	From weight off wheels to weight on wheels.
Intrusive	A FIDS in which the sensing component is located outside the boundary layer.
LWC	Liquid water content. Expressed in mass of water per unit volume of air.
Monitored Surface	The surface of concern regarding ice hazard (e.g., the leading edge of the wing).
Nuisance Alarm	An undesired indication of ice or icing.
Primary Automatic FIDS	A FIDS that automatically activates anti-icing or deicing systems.
Primary Manual FIDS	A FIDS that provides the cockpit crew with an indication of ice or icing and the cockpit crew is required to activate the ice protection systems based on the FIDS.
Reference Surface	The surface where a FIDS sensor makes its measurement (e.g., the intrusive part of a probe system).
Rime Ice	A milky, opaque ice formed by the rapid freezing of supercooled droplets.
Runback Ice	Ice formed from the freezing or re-freezing of water leaving thermally protected surfaces onto unprotected surfaces.
Supercooled	Liquid cooled below the freezing point without solidification or crystallization.
System	A combination of components which are interconnected to perform one or more functions

1.5.2 Abbreviations

AIR	Aerospace Information Report
APMS	Aerodynamic Performance Monitoring System
ARP	Aerospace Recommended Practices
AS	Aerospace Standard
CFR	Code of Federal Regulations
ED	EUROCAE Document
EUROCAE	European Organization for Civil Aviation Equipment
FAR	Federal Aviation Regulation
FIDS	Flight Icing Detection System
FMECA	Failure Modes Effects and Criticality Analysis
FOD	Foreign Object Damage
JAR	Joint Aviation Requirement
KTAS	Knots True Air Speed
LWC	Liquid water content. Expressed in mass of water per unit volume of air.
MOPS	Minimum Operational Performance Specification
MVD	Median volumetric diameter. Defined in the FAA Aircraft Icing Handbook.
SAE	Society of Automotive Engineers

1.6 REFERENCES

NOTE: *Title 14 of the US Code of Federal Regulations (14 CFR), Federal Aviation Regulation (FAR) Part XX documents are referred to as "FAR XX" in the body of this document.*

1.6.1 Reference Documents

The following documents are incorporated by reference:

EUROCAE ED-14D – Environmental Conditions and Test Procedures for Airborne Equipment

RTCA DO-160D – Environmental Conditions and Test Procedures for Airborne Equipment

EUROCAE ED-12B – Software Considerations in Airborne Systems and Equipment Certification

RTCA DO-178B – Software Considerations in Airborne Systems and Equipment Certification

JAR 23 First Issue – Normal, Utility, Aerobatic and Commuter Category Aeroplanes

JAR 25 Change 14 – Large Aeroplanes

14 CFR Part 23 Amendment 23-53 (FAR 23) – Airworthiness Standards: Normal, Utility, Acrobatic, and Commuter Category Airplanes

14 CFR Part 25 Amendment 25-98 (FAR 25) – Airworthiness Standards: Transport Category Airplanes

14 CFR Part 21 Amendment 21-76 (FAR 21) – Certification Procedures for Products and Parts

1.6.2**Applicable Documents**

EUROCAE ED-79/SAE ARP4754 – Certification Considerations for Highly-Integrated or Complex Aircraft Systems – November 1996

EUROCAE ED-104 – Minimum Operational Performance Specification for Ground Ice Detection Systems

SAE ARP4761 – Guidelines and Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment – December 1996

JSSG-2010-5 Joint Service Specification Guide– Crew Systems Aircraft Lighting Handbook – October 30, 1998

SAE AIR4367 – Aircraft Ice Detectors and Icing Rate Measuring Instruments

SAE ARP4256 - Design Objectives for Liquid Crystal Displays for Part 25 (Transport) – December 1996

MIL-STD-1472E – Human Engineering

SAE AS8034 – Minimum Performance Standard for Airborne Multipurpose Electronic Displays – Reaffirmed May 1993

FAA Aircraft Icing Handbook DOT/FAA/CT-88/8-1 – Updated Sept 93

FAA AC 20.73 – Advisory Circular – Aircraft Ice Protection – April 21, 1971

FAA AC 23.1419-2A – Certification of Part 23 Airplanes for Flight in Icing Conditions – August 19, 1998

FAA AC 25.1419-1 – Certification of Transport Category Airplanes for Flight in Icing Conditions

JAR-E - Engines

14 CFR Part 33 Amendment 33-19 (FAR 33) – Airworthiness Standards: Aircraft Engines

14 CFR Part 91 Amendment 91-258 (FAR 91) – General Operating and Flight Rules

14 CFR Part 121 Amendment 121-271 (FAR 121) – Certification and Operations: Domestic, Flag, and Supplemental Air Carriers and Commercial Operators of Large Aircraft

14 CFR Part 135 Amendment 135-75 (FAR 135) – Air Taxi Operators and Commercial Operators

JAR/OPS 1 – Commercial Air Transportation (Aeroplanes)