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Aerospace — Aircraft de-icing/anti-icing non-Newtonian fluids, ISO type II

iTeh STANDARD PREVIEW

Aéronautique et espace — Liquides non newtoniens ISO type II de dégivrage/antigivrage des aéronefs

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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International Standard ISO 11078 was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 9, *Air cargo and ground equipment*.

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Annexes A and B form an integral part of this International Standard.

Aerospace — Aircraft de-icing/anti-icing non-Newtonian fluids, ISO type II

1 Scope

This International Standard establishes the requirements for non-Newtonian fluids used in the removal and prevention of frozen deposits of frost, ice and snow on exterior surfaces of parked aircraft.

It establishes the minimum requirements for an environmental test chamber and test procedure to carry out anti-icing performance tests according to the current materials specification for ISO type II aircraft de-icing/anti-icing non-Newtonian fluids.

WARNING — Products meeting the requirements of this International Standard can be adversely affected by mixing with other de-icing/anti-icing fluids.

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2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 1518:1992, *Paints and varnishes — Scratch test.*

ISO 2719:1988, *Petroleum products and lubricants — Determination of flash point — Pensky-Martens closed cup method.*

ISO 3013:1974, *Aviation fuels — Determination of freezing point.*

ISO 9002:1994, *Quality systems — Model for quality assurance in production, installation and servicing.*

ISO 11076:1993, *Aerospace — Aircraft de-icing/anti-icing methods with fluids.*

ISO 11077:1993, *Aerospace — Self-propelled de-icing/anti-icing vehicles — Functional requirements.*

OECD, *Guidelines for testing of chemicals. Section 3 — Degradation and Accumulation. Ready Biodegradability, 301 D Closed Bottle Test.*[1)]

AMS 2470H, *Anodic Treatment, Aluminium Alloys, Chromic Acid Process.*[2)]

AMS 2475D, *Protective Treatment, Magnesium Base Alloys.*

AMS 4037L, *Aluminium Alloy Sheet and Plate, 4.4Cu — 1.5Mg — 0.60Mn (2024,-T3 Flat Sheet,-T351 Plate), Solution Heat Treated, UNS A92024.*

AMS 4041M, *Aluminium Alloy Sheet and Plate, Alclad, 4.4Cu — 1.5Mg — 0.6Mn, (Alclad 2024 and 1-1/2 % Alclad 2024,-T3 Flat Sheet; 1-1/2 % Alclad 2024-T351 Plate).*

AMS 4049H, *Aluminium Alloy Sheet and Plate, Alclad, 5.6Zn — 2.5Mg — 1.6Cu — 0.23Cr (Alclad 7075-T6 Sheet,-T651 Plate), Solution and Precipitation Heat Treated.*

AMS 4376E, *Magnesium Alloy Plate, 3.0Al — 1.0Zn (AZ31B-H26), Cold Rolled and Partially Annealed.*

1) This publication is available from OECD, 2, rue André-Pascal, 75 775 Paris cedex 16, France.

2) AMS Standards are available from the Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096, USA.

AMS 4911F, *Titanium Alloy Sheet, Strip, and Plate, — 6Al-4V, Annealed.*

ASTM A 109M-90a, *Specification for Steel, Carbon, Cold-Rolled Strip [Metric].*[3]

ASTM C 672-91, *Test Method for Scaling Resistance of Concrete Surfaces Exposed to Deicing Chemicals.*

ASTM D 891-89, *Test Methods for Specific Gravity of Liquid Industrial Chemicals.*

ASTM D 1193-77 (1983), *Specification for Reagent Water.*

ASTM D 1331-89, *Test Methods for Surface and Interfacial Tension of Solutions of Surface-Active Agents.*

ASTM D 1747-89, *Test Method for Refractive Index of Viscous Materials.*

ASTM D 2196-86, *Test Method for Rheological Properties of Non-Newtonian Materials by Rotational (Brookfield) Viscometer.*

ASTM E 70-90, *Test Method for pH of Aqueous Solutions with the Glass Electrode.*

ASTM F 483-90, *Method for Total Immersion Corrosion Test for Aircraft Maintenance Chemicals.*

ASTM F 484-83, *Test Method for Stress Crazing of Acrylic Plastics in Contact with Liquid and Semi-liquid Compounds.*

ASTM F 485-90, *Test Method for Effects of Cleaners on Unpainted Aircraft Surfaces.*

ASTM F 502-83, *Test Method for Effects of Cleaning and Chemical Maintenance Material on Painted Aircraft Surfaces.*

ASTM F 519-77, *Method for Mechanical Hydrogen Embrittlement Testing of Plating Processes and Aircraft Maintenance Chemicals.*

ASTM F 945-85, *Test Method for Stress-Corrosion of Titanium Alloys by Aircraft Engine Cleaning Materials.*

ASTM F 1105-90, *Test Method for Preparing Aircraft Cleaning Compounds, Liquid Type, Solvent Base, for Storage Stability Testing.*

ASTM F 1110-90, *Test Method for Sandwich Corrosion Test.*

ASTM F 1111-88, *Test Method for Corrosion of Low-Embrittling Cadmium Plate by Aircraft Maintenance Chemicals.*

MIL-A-8243D, *Anti-Icing and De-Icing Defrosting Fluids.*

MIL-P-83310, *Plastic Sheet, polycarbonate, transparent.*[4]

DIN 65 321:1989, *Aerospace; Acrylic sheets, panes and moulded parts; Technical specification.*[5]

WL 5.1416:1992, *Aerospace; acrylic material, cast, crosslinked, in 5.1415 material, biaxially stretched and crack propagation resistant.*

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3 Definitions

For the purposes of this International Standard, the following definitions apply.

3.1 non-Newtonian fluid: Fluid whose viscosity is shear dependent and time dependent.

3.2 pseudoplastic behaviour: Decrease of viscosity with an increase in shear rate.

3.3 lot: All compound produced in a single production run from the same batches of raw materials under the same fixed conditions and presented for vendor's inspection at one time.

NOTE 1 The compound may be packaged in smaller quantities under the basic lot approval provided lot identification is maintained.

3.4 preproduction test: Test to determine conformance to all technical requirements of this International Standard.

3.5 acceptance test: Test to determine conformance to the requirements given in 4.2.4, 4.2.8, 4.2.10 and 6.1.

3) ASTM standards are available from American Society of Testing and Materials, 1916 Race Street, Philadelphia, PA 19103, USA.

4) US Government Publications are available from the Commanding Officer, Naval Publications and Forms Center, 5801 Tabot Avenue, Philadelphia, PA 19120, USA.

5) Available from DIN (Deutsches Institut für Normung, e.V.), D-10772 Berlin, Germany.

3.6 periodic test: Test to determine conformance to the requirements given in clauses 9 and 10.

4 Performance requirements

4.1 Composition

The fluid shall be based on a freezing-point depressant with additives so that the finished product is suitable for its intended use and shall meet all the requirements of this International Standard.

If based on glycol, it shall contain an inhibitor in order to minimize the potential fire hazard resulting from interaction between aqueous glycol solutions and noble metal electrodes impressed with a direct current potential.

4.2 Physical properties

The fluid shall have the following properties.

4.2.1 Appearance

The fluid shall be free from visible impurities. The fluid may be either coloured or uncoloured, at the purchaser's request. A dyed fluid shall not be coloured red-orange (CI Solvent Orange 59 or equivalent) which is used in ISO type I fluid, or blue-green which is used for ramp de-icers.

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4.2.2 Flash point

The flash point shall not be lower than 100 °C (212 °F) in accordance with ISO 2719.

4.2.3 Specific gravity

The specific gravity shall be within ± 1,5 % of the nominal value, determined in accordance with ASTM D 891.

4.2.4 pH

The pH of the fluid as determined in accordance with ASTM E 70 shall be within ± 0,5 units of the declared value.

4.2.5 Storage stability

The fluid shall offer enough stability to guarantee two years storage in accordance with the storage requirements given in ISO 11076. Compliance with this requirement shall be demonstrated by testing the fluid in accordance with ASTM F 1105. The fluid shall not show any separation from exposure to heat or cold nor an increase in turbidity compared to a freshly-made control sample, or any change in rheological properties.

4.2.6 Thermal stability

4.2.6.1 The fluid, when subjected to a temperature of 70 °C (158 °F) for 30 d, in accordance with the test procedure described in 4.2.6.2 shall not show any insoluble deposit, any precipitation or severe turbidity. Further, the aged product shall not have a pH change of more than ± 0,5 from the initial value and the Brookfield viscosity at (20 ± 0,5) °C after the test shall neither be reduced by more than 20 % nor increased by more than 10 % compared with the initial value.

The fluid shall meet the criteria of the anti-icing performance tests specified in clause 9.

4.2.6.2 Determine the Brookfield viscosity of the sample in accordance with 6.1 at 20 °C (68 °F) and the pH value in accordance with 4.2.4 before starting the test.

Place 350 ml of the fluid to be tested in a jar of 500 ml equipped with a sealed cap. Place the sealed jar in the oven at 70 °C ± 2 °C (158 °F ± 3,6 °F) for 30 d. After removing and cooling the fluid, examine visually and compare with the non-aged control fluid. Measure the pH value and the Brookfield viscosity over the range of − 30 °C to + 20 °C (− 22 °F to + 68 °F) and compare the results with the initial values.

4.2.7 Hard water compatibility

The fluid diluted 1 + 1 (by volume) with standard hard water (as specified in 4.2.7.1), when submitted to the stability test specified in 4.2.7.2, shall not show any insoluble deposit or increase in turbidity greater than the freshly made control sample diluted 1 + 1 (by volume) with ASTM D 1193 Type IV water. The pH value of the tested sample shall be within ± 0,5 of the initial value.

4.2.7.1 Composition of standard hard water

Dissolve 400 mg ± 5 mg of calcium acetate [$(CH_3COO)_2Ca.2H_2O$] and 280 mg ± 5 mg of magnesium sulfate ($MgSO_4.7H_2O$) in 1 l of ASTM D 1193 Type IV water.

4.2.7.2 Stability test of diluted solution

Heat 350 ml of the diluted fluid at 95 °C ± 2 °C (203 °F ± 3,6 °F) in a 500 ml glass jar fitted with a sealed cap or a water condenser for 30 d.

At the end of this period, perform a visual inspection and pH measurement and compare the results with those of the fresh sample.

4.2.8 Freezing point

The freezing point of the fluid shall not be greater than the following values, determined in accordance with ISO 3013.

Concentrated fluid	– 32 °C max. (– 25,6 °F max.)
Diluted fluid	– 10 °C max. (+ 14 °F max.)

The diluted fluid shall be a mixture 1 + 1 (by mass) with ASTM D 1193 Type IV water.

4.2.9 Surface tension

When measured in accordance with ASTM D 1331, the surface tension of the fluid as delivered shall not be greater than 40×10^{-3} N/m (40 dyn/cm) at 20 °C (68 °F).

4.2.10 Refractive index

The refractive index of the fluid, as determined in accordance with ASTM D 1747, shall be within ± 0,001 5 units of the nominal value at 20 °C (68 °F).

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5 Materials compatibility

The materials compatibility tests given in the following subclauses shall be performed on the following samples:

a) concentrated fluid;

b) fluid diluted 1 + 1 with ASTM D 1193 Type IV water.

5.1 Corrosion of metal surfaces

5.1.1 Sandwich corrosion

Specimens, after test, shall not show a sandwich corrosion rating worse than 1, when tested in accordance with ASTM F 1110.

5.1.2 Total immersion corrosion

The fluid shall neither show evidence of corrosion nor cause a change in mass per unit area of any single test panel greater than that given in table 1, when tested in accordance with ASTM F 483.

Table 1 — Maximum permitted daily change in mass per unit area

Test panel	Relevant standard	Maximum permitted daily change mg/cm^2
Aluminium alloy anodized in accordance with AMS 2470	AMS 4037	0,3
Aluminium alloy	AMS 4041	0,3
Aluminium alloy	AMS 4049	0,3
Magnesium alloy, dichromate treated in accordance with AMS 2475	AMS 4376	0,2
Titanium alloy	AMS 4911	0,1
Carbon steel, temper 5	ASTM A 109	0,8

5.1.3 Low-embrittling cadmium plate

Test panels coated with low-embrittling cadmium plate shall not show a daily change in mass per unit area greater than 0,3 mg/cm^2, when tested in accordance with ASTM F 1111.

5.1.4 Stress corrosion resistance

The fluid shall not cause cracks in titanium specimens when tested in accordance with heat method A of ASTM F 945.

5.1.5 Hydrogen embrittlement

The fluid shall be non-embrittling when tested in accordance with ASTM F 519 using a test specimen of either type 1a, 1c or 2a.

5.2 Effect on plastic

5.2.1 Acrylic plastic

The fluid, when heated to 65 °C ± 2 °C (149 °F ± 3,6 °F), shall not craze, stain or discolour DIN 65 321, stretched WL 5.1416 acrylic plastic when tested in accordance with ASTM F 484.

5.2.2 Polycarbonate plastic

The fluid shall not craze, stain or discolour MIL-P-83310 polycarbonate plastic when testing using the general procedure specified in ASTM F 484 except that the specimens shall be stressed for 10 min ± 1 min to an outer fibre stress level of 13,793 MPa (2 000 psi).

5.3 Effect on painted surfaces

5.3.1 A painted surface, to which the fluid has been applied for 7 d at 22 °C ± 1 °C (71,6 °F ± 1,8 °F), shall withstand a load of 1 200 g when tested in accordance with ISO 1518.

5.3.2 The fluid, heated to 65 °C ± 2 °C (149 °F ± 3,6 °F) and applied to a painted surface having an initial surface temperature of 22 °C (71,6 °F), shall not produce any streaking, discoloration, or blistering of the paint film, determined in accordance with ASTM F 502.

5.4 Effect on upainted surfaces

The fluid, tested in accordance with ASTM F 485, shall neither produce streaking nor leave any stain requiring polishing to remove.

6 Rheological properties

The fluid shall exhibit non-Newtonian flow behaviour. Over the temperature range −30 °C to + 20 °C (22 °F to + 68 °F), the fluid shall exhibit pseudoplastic behaviour determined in accordance with ASTM D 2196.

NOTE 2 ISO type II fluids containing pseudoplastic thickeners provide protection against the buildup of frozen deposits.

6.1 Viscosity

For quality control purposes, the manufacturer shall report the typical viscosity values, measured in accordance with ASTM D 2196 and expressed in millipascal seconds (mPa·s), for its qualified product.

The measurements shall be carried out using a Brookfield type LVT viscometer with Nos. 1 and 2 spindles or an SC 4-34/13 R small sample adaptor.

The measurements shall be carried out at rotation speeds of 0,3 min^{-1}, 6 min^{-1} and 30 min^{-1}.

The temperatures at which the measurements are made and the spindle number shall also be reported.

NOTE 3 The number (type) of the applied spindle should be in accordance with the recommendations of the viscometer manufacturer.

The viscosity of the delivered fluid shall be within ± 10 % of the typical values.

6.2 Shear stability

The anti-icing performance requirements specified in annex A shall be met after the product is pumped and sprayed with industrial spray equipment, in accordance with ISO 11077, used for de-icing/anti-icing of aircraft.

6.2.1 The following laboratory test has been found suitable for simulating the shear effect of several types of industrial spray equipment.

Place a test vessel containing the fluid into a Brookfield counter-rotating mixer and operate for 5 min ± 10 s under the following conditions:

Rotation speed (calibrated when rotating in water before each test series)	3 500 min^{-1} ± 100 min^{-1}
Material of test vessel	Glass
Distance from blade to bottom of test vessel	25 mm ± 2 mm
Diameter of test vessel	85 mm ± 5 mm
Fluid volume	500 ml ± 10 ml
Initial temperature of test fluid	20 °C ± 1 °C (68 °F ± 3,6 °F)

The fluid shall be de-aerated for at least 24 h after shearing, before any further testing for anti-icing performance and rheological properties.

6.2.2 The vendor shall inform the customer of the results of the anti-icing performance tests and changes of viscosity values.

7 Film stability

7.1 Application

This test has been designed to examine the effect of exposure of a film of the applied product to different environmental factors to ensure that there is no buildup of film thickness after consecutive applications or gel formation.

7.2 Exposure to dry air

The product as delivered, after exposure in a controlled cabinet at a relative humidity of 50 % to 60 % over a period of time which results in a mass reduction of (20 ± 1) %, shall have a maximum viscosity of 500 mPa·s at 20 °C ± 0,5 °C (68 °F ± 1,8 °F) when measured with a Brookfield LVT viscometer at 3 min^{-1} using spindle No. 1.

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7.3 Thin film thermal stability

The fluid, when applied in thin layer of 250 µm ± 25 µm on a 20° sloped aluminium alloy test plate and exposed to a temperature of 100 °C ± 2 °C (212 °F ± 3,6 °F) for 30 min ± 1 min, shall not form a film which is insoluble in water.

7.4 Pavement scaling resistance

The condition of the surface shall show a rating not greater than 2, after 50 freeze/thaw cycles determined in accordance with the general procedure specified in ASTM C 672, except that a 1 + 3 (*V*/*V*) solution of the fluid in tap water shall be substituted for the calcium chloride specified.

8 Environmental requirements

8.1 Biodegradability

The fluid shall meet local requirements for biodegradability and shall not have an overall biodegradability of less than 90 %. Results of biodegradability studies conducted in accordance with the OECD Ready Biodegradability Closed Bottle Test 301 D, for biodegradability and bioassays, shall be provided by the fluid manufacturer to the purchaser and shall contain not less than the following information:

a) a statement of ecological behaviour of the fluid;

b) the total oxygen demand (TOD) of the fluid, expressed in pounds of oxygen per pound of fluid;

c) percentage of fluid degraded in 5 days [5 day biological oxygen demand (BOD)];

d) concentration, expressed as a percentage by mass, of sulfur, halogens, phosphate, nitrate and heavy metals (lead, chromium, cadmium and mercury).

8.2 Aquatic toxicity

The aquatic toxicity shall meet the local requirements.

8.3 Toxicity

The toxicity shall meet the local requirements.

9 Anti-icing performance

ISO type II fluids shall protect against formation of frozen deposits for a minimum of 4 h in the high humidity endurance test and for a minimum of 30 min in the water spray endurance test, as specified in annex A.

The test procedure and test equipment is also specified in annex A.

10 Aerodynamic performance

Before approval to this specification, the fluid manufacturer shall demonstrate acceptable aerodynamic performance, in accordance with the test method specified in annex B.

11 Quality assurance provisions

11.1 Responsibility for inspection

The vendor of the product shall supply all samples for vendor's tests and shall be responsible for performing all required tests. Results of such tests shall be reported to the purchaser as specified in 11.5.

The purchaser reserves the right to sample and to perform any confirmation testing deemed necessary to ensure that the product conforms to the requirements of this International Standard.

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11.2 Frequency of testing

11.2.1 Preproduction tests

Preproduction tests shall be performed:

a) prior to initial shipment of the product to a purchaser;

b) when a change in material, processing or both requires reapproval as in 11.4.2;

c) when the purchaser deems confirmation testing to be necessary.

11.2.2 Periodic tests

Periodic tests shall be performed biannually.

11.2.3 Acceptance tests

Acceptance tests shall be performed on each lot.

11.3 Sampling

11.3.1 Preproduction and periodic tests

Sufficent product from a single production lot shall be taken at random to perform all required tests.

11.3.2 Acceptance tests

Sufficient product shall be taken at random from each lot to perform all required tests.

11.4 Approval

11.4.1 The preproduction compound shall be approved by the purchaser before fluid for production use is supplied. Result of tests on production fluid shall be essentially equivalent to those on the approved sample fluid.

11.4.2 The vendor shall use ingredients, manufacturing procedures and methods of inspection on the production fluid which are essentially the same as those used on the approved preproduction sample. If necessary to make changes in ingredients, formulation or manufacturing procedures, the vendor shall submit for reapproval a statement of proposed changes. The results of retesting for anti-icing and aerodynamic performance as specified in clauses 9 and 10 respectively as well as those for any other test deemed necessary by the purchaser shall also be submitted.

11.5 Test reports

11.5.1 Preproduction and periodic test reports

The vendor of the fluid shall furnish, before the initial shipment, a report showing the results of preproduction tests.

In addition, the accepted and preferably independent testing facility or facilities carrying out periodic tests shall determine the fluid specimen properties listed in table 2. These results shall be compared to those given in the manufacturer's documentation of their anti-icing and aerodynamic performance tests and shall be reported.

Both reports shall include the following:

a) reference to this International Standard, i.e. ISO 11078;

b) the manufacturer's product identification;

c) the lot number; and

d) the lot quantity.

Table 2 — Fluid properties

Specimen properties	Relevant subclause
Freezing point	4.2.8
Viscosity	6.1
Surface tension	4.2.9
Refractive index	4.2.10

11.5.2 Acceptance test report

The vendor of the fluid shall furnish with each shipment a report quoting the test results of the acceptance tests and certifying that the fluid is of the same composition and properties as the approved sample compound. This report shall include the following:

a) reference to this International Standard, i.e. ISO 11078.

b) the manufacturer's product identification;

c) the lot number;

d) the quantity shipped; and

e) the purchase order number.

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11.6 Resampling and retesting

If any sample in the above tests fails the specified requirements, disposition of the fluid may be based on the results of testing three additional samples for each nonconforming lot. Failure by any retest sample to meet the specified requirements shall be cause for rejection of the fluid lot and no additional testing shall be permitted. Results of all tests shall be reported.

Material safety data sheets (MSDS) shall be provided to the user prior to or concurrent with the report of the preproduction test results.

Annex A
(normative)

Test methods to determine the anti-icing performance

A.1 General

The test methods described in this annex are intended to determine the anti-icing laboratory endurance times exhibited by candidate ISO type II fluids.

A.2 Principle

The test fluids to be evaluated are applied to a test plate exposed to two types of freezing conditions and their anti-icing performance is evaluated by measuring the minimum exposure time before a specified degree of freezing occurs.

A.3 Apparatus

Usual laboratory apparatus and, in particular, the following.

NOTE 4 Other spray and humidity control apparatus which meets the requirements given in table A.1 may also be used.

A.3.1 Test chamber, having a minimum volume of 1 m^3 for each 2,25 dm^2 test panel area (or 8 m^3 for the minimum test plate dimensions described in A.3.2). A window, if installed, shall be double-glazed to prevent condensation and shall provide a clear view of the test plate; in the absence of a window, the test plate should be monitored using a video camera or equivalent recording device mounted inside the test chamber. The chamber shall be fitted with a door or equivalent entry port to allow for fluid application to the test plate, ice catch measurements and inspection of the test plate and spray nozzle system.

The test chamber shall be capable of air temperature control in the range − 5 °C to 0 °C (23 °F to 32 °F) with an accuracy of ± 0,5 °C (± 0,9 °F); the temperature sensing device shall be mounted at the exit side of the air recirculating system and shall be within 0,5 m of the side of the test plate but outside the direct line of the spray nozzle when in use. The air exchange rate in the chamber shall correspond to an average horizontal air velocity of 0,2 m/s ± 0,05 m/s measured 5 cm above the surface of the test plate.

The chamber shall also be capable of humidity control at a relative humidity of (96 ± 2) % when the air temperature is 0 °C (32 °F) in the absence of any visible precipitation such as mist, fog or drizzle, i.e there shall be no water droplets having a diameter greater than 4 µm determined in accordance with one of the test methods described in A.5.4.1. Under these conditions of relative humidity and air temperature and in the presence of a horizontal air velocity of 0,2 m/s, the frost accumulation rate on the plate [cooled to − 5 °C (23 °F)] shall be 1,2 g/dm^2 ± 0,2 g/dm^2 after a period of 4 h.

The humidity shall be produced using a saturated water vapour generator housed in the exit side of the air recirculating system and controlled using a suitably calibrated humidity sensor linked to a control system. When a high humidity condition is required, the humidity sensor shall be placed 5 cm above the surface of the test plate on the centreline of the upper edge of the test plate.

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Both the air temperature and humidity sensing devices shall be linked to a continuous pen recorder or electronic data acquisition system as a means of checking the environmental control characteristics of the test chamber throughout the course of a test run.

A.3.2 Test plate, constructed from aluminium alloy complying with AMS 4037L polished to surface roughness of arithmetical mean deviation, R_a, of 0,1 µm to 0,2 µm, and inclined at 10° ± 0,2° to the horizontal for both water spray and high humidity anti-icing tests.

The upper surface of the test plate shall comprise at least six separate panels each measuring 30 cm × 10 cm and separated by dividers protruding about 5 mm above the surface of the test plate to remove the possibility of cross-contamination between different fluids applied to adjacent panels. The test plate shall be clearly marked using a permanent marking pen:

a) with a horizontal line running across each panel, 25 mm from the upper edge of the test plate; this marking is used to estimate the degree of ice