

Aircraft Inflight Icing Terminology

RATIONALE

ARP5624 has been reaffirmed to comply with the SAE five-year review policy.

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Documents

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1. SCOPE

This SAE Aerospace Recommended Practice (ARP) provides recommended definitions for terms commonly used in aircraft inflight icing system design and analysis, research, and operations. Some general thermodynamic terms are included that are frequently used in icing analysis, but this document is not meant to be an inclusive list of such terms.

2. REFERENCES

2.1 Applicable Documents

The following publications form 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.

ARP147	Environmental Control System (ECS) Terminology
AIR1168/4	Aerospace Applied Thermodynamics Manual; Ice, Rain, Fog, and Frost Protection
AIR1667	Rotor Blade Electrothermal Ice Protection Design Considerations
AIR4367	SAE Aircraft Ice Detectors and Icing Rate Measuring Instruments
AS5498	Minimum Operational Performance Specification for Inflight Icing Detectors (also EUROCAE ED-103)

2.1.2 FAA Publications

FAA Reports are available through the National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, VA 22161. [Note: Many of these reports are also available in PDF format over the web at <http://actlibrary.tc.faa.gov/>]

FAA regulations are available from Superintendent of Documents, U.S. Government Printing Office, Mail Stop SSOP, Washington, DC 20402-0001.

FAA Advisory Circulars are available from U.S. Department of Transportation, Subsequent Distribution Office, SVC-121.23, Ardmore East Business Center, 3341 Q 75th Ave, Landover, MD 20785.

14 CFR Part 1	Title 14 of the US Code of Federal Regulations, Part 1, Definitions and Abbreviations
14 CFR Part 23	Title 14 of the US Code of Federal Regulations, Part 23, Airworthiness Standards: Normal, Utility, Acrobatic, and Commuter Category Airplanes
14 CFR Part 25	Title 14 of the US Code of Federal Regulations, Part 25, Airworthiness Standards: Transport Category Airplanes
14 CFR Part 29	Title 14 of the US Code of Federal Regulations, Part 29, Airworthiness Standards: Transport Category Rotorcraft
-----	Aeronautical Information Manual, October 1996
-----	U.S. Standard Atmosphere, National Oceanic and Atmospheric Administration, National Aeronautics and Space Administration and United States Air Force

FAA Publications (Continued)

AC 20-73A	Aircraft Ice Protection
AC 29-2C	Certification of Transport Category Rotorcraft
ADS-4	Engineering Summary of Airframe Icing Technical Data, FAA Technical Report, March 1964
DOT/FAA/CT-88/8	Aircraft Icing Handbook, Volumes 1, 2, and 3, March 1991 and subsequent revisions
DOT/FAA/ARI-96/81	Proc. of the FAA International Conference on Aircraft Inflight Icing, August 1996

2.1.3 Other Publications

Aeronautical Information Manual, February 16, 2006

AGARD Icing Testing for Aircraft Engines, August 1978

Forecasters' Guide on Aircraft Icing, Air Weather Service Report No. AWS/TR-80/001, March 1980

Glossary of Meteorology, American Meteorological Society, 2000

International Meteorological Vocabulary – Second Edition, WMO/OMM/BMO – No. 182, 1992

Jane's Aerospace Dictionary, First Edition, 1980, Jane's Publishing Incorporated, 730 Fifth Avenue, New York, NY 10019

The Development of an Advanced Anti-icing/Deicing Capability for U. S. Army Helicopters, Volume I – Design Criteria and Technology Considerations, U.S. Army Report Number USAAMRDL-TR-75-34B, Nov. 1975

3. GENERAL DISCUSSION

There are many sources of definitions for inflight aircraft icing terminology, but these terms have not been consolidated into a single reference document. In many cases the terms are not used in the same way, causing confusion in their use. While this document is intended to be used primarily by icing research and development engineers and certification authorities, it provides the definitions of icing terms helpful to personnel involved with other facets of icing technology. The recommended definitions provided in Section 4 are intended to provide a description of icing terms and their usage so as to promote clarity during discussions of aircraft icing issues. A word shown in capital letters in a definition refers to terms defined in the document. The sources of definitions that appear in other published documents of a regulatory or specification nature are noted in parentheses immediately following the associated definition and are identified as shown below.

A list of terms with associated definitions from other sources is given in Section 5 to provide background information as to how these terms have been defined in the past.

AGARD	AGARD Icing Testing For Aircraft Engines, "Meteorological Icing Conditions", August 1978
ADS-4	Definition from Engineering Summary of Airframe Icing Technical Data, FAA Technical Report, March 1964
AIM	Aeronautical Information Manual, February 16, 2006
AS5498	Definition from the EUROCAE WG54 Minimum Operational Performance Specification for Inflight Ice Detectors (ED-103 and AS5498)
FAA29-2	Definition from 14 CFR 29 Advisory Circular 2C
FAACII	Proceedings of the FAA International Conference on Aircraft Inflight Icing, DOT/FAA/AR-96/81, V. I, August 1996, p. 193
FAAIH	Definition from FAA Aircraft Icing Handbook (DOT/FAA /CT-88/8)
FG	Forecaster's Guide on Aircraft Icing, March 1980
GM	Glossary of Meteorology, 2000
Jane's	Jane's Aerospace Dictionary, 1980

GENERAL DISCUSSION (Continued)

MHDPM	McGraw-Hill Dictionary of Physics and Mathematics, 1978
SAE1168	SAE Aerospace Applied Thermodynamics Manual (AIR1168)
SAE147	SAE Environmental Control System (ECS) Terminology (ARP147)
SAE1667	SAE Rotor Blade Electrothermal Ice Protection Design Considerations (AIR1667)
SAE4367	SAE Aircraft Ice Detectors and Icing Rate Measuring Instruments (AIR4367)
USAAMRDL	U.S. Army Report Number USAAMRDL-TR-75-34A, "The Development of an Advanced Anti-Icing/Deicing Capability for U.S. Army Helicopters, Volume I – Design Criteria and Technology Considerations", Nov. 1975. p. 40-44
WMO	International Meteorological Vocabulary, 1992

Note that the definitions from these sources may be modified to add alternative units. The source(s) of terms that have broad acceptance are not specifically identified.

Some of the terms have multiple definitions, much in the same manner found in a dictionary. Different definitions are numbered. The order of the definitions for terms with multiple definitions does not indicate a preferred order.

Equations have been included to provide more complete definitions for some of the terms. The reader must be cautioned, however, that the particular physical properties used in any of the equations depend upon the situation or problem being addressed by the user. Furthermore, symbols used in different equations may be defined differently. Each equation must be considered independently.

4. LIST OF AIRCRAFT INFLIGHT ICING TERMS AND ABBREVIATIONS WITH RECOMMENDED DEFINITIONS

1D-C PROBE: One-dimensional cloud probe. A version of the OPTICAL ARRAY PROBE (OAP) sensitive to DRIZZLE-sized drops. It is commonly used for cloud research and sometimes for icing certification flights for detecting any particles in the 50 to 300 µm size range.

2D-C PROBE: Two-dimensional cloud probe. A version of the OPTICAL ARRAY PROBE (OAP) that counts and sizes particles in the size range of about 10 to 1000 µm. It is an elaboration of the 1D-C PROBE providing a two-dimensional image of the detected particles so that ICE particles may be recognized and classified by shape. It is commonly used for cloud research and is suitable for icing certification flights for detecting drizzle or ice particles.

ACCRETION: See ICE ACCRETION.

ACCUMULATION PARAMETER: A non-dimensional measure of ice accretion. It is proportional to both the rate at which water impinges on a surface and the total amount of time the surface is exposed to icing conditions.

$$A_c = (LWC \cdot V \cdot \tau) / (\rho \cdot L)$$

where:

LWC = liquid water content

V = free stream velocity

τ = icing exposure time

ρ = density of ice

L = characteristic length

ADHESION BOND STRENGTH: A measure of the degree of adhesion between ICE and a surface (substrate) to which it is attached (or bonded). The degree of adhesion is usually measured in a simple lap shear adhesion test (although tensile adhesion normal to the substrate interface is also an important consideration). The degree of adhesion is expressed in force (e.g., pounds) per unit area (e.g., square inches). Temperature, substrate material, and surface conditions at the ice/substrate interface are important factors to consider when measuring adhesion bond strength.

LIST OF AIRCRAFT INFLIGHT ICING TERMS AND ABBREVIATIONS WITH RECOMMENDED DEFINITIONS
(Continued)

ADIABATIC PROCESS: Any thermodynamic process which takes place in a system without exchange of heat with the surroundings (MHDPM).

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 (AS5498).

AERODYNAMIC PERFORMANCE MONITORING SYSTEM: A SYSTEM that informs another system or the cockpit crew about degradation of aerodynamic performance. Performance degradation may result from ice or other contamination on the MONITORED SURFACE.

AGL: Above ground level.

AIR: Aerospace Information Report

AIRMASS: A widespread body of air, the properties of which can be identified as having been established while that air was situated over a particular region of the earth's surface, and undergoing specific modifications while in transit away from the source region (FAAIH, GM).

ALTITUDE, PRESSURE: See PRESSURE ALTITUDE.

ALTITUDE, STANDARD: See STANDARD ALTITUDE.

ALTOCUMULUS: Mid-level (~6500 to 20,000 ft MSL) white and/or grey, sheet or layer of cloud, composed of laminae, rounded masses, rolls, etc., which are sometimes partly fibrous or diffuse and which may or may not be merged.

ALTOSTRATUS: Mid-level (~6,500 to 20,000 ft MSL) greyish or bluish cloud sheet or layer cloud of striated, fibrous or uniform appearance.

AMBIENT TEMPERATURE: The STATIC TEMPERATURE of the surrounding medium, such as gas or liquid, which comes in contact with the apparatus (MHDPM).

ANTI-ICE VALVE: A control valve, often a pressure-regulator-and-shutoff type, that meters hot air to ANTI-ICING systems.

ANTI-ICE, ANTI-ICING: The prevention of ice accumulation on a protected surface (see DEICE for the removal of accumulated ice from a surface).

APPENDIX C ICING CONDITIONS: Conditions for ICE protection certification found in Appendix C of CFR 14 Part 25 or Part 29.

APMS: Aerodynamic Performance Monitoring System (AS5498).

ARP: SAE Aerospace Recommended Practice.

ARTIFICIAL ICE SHAPE: A structure formed from material other than frozen water, but intended to represent an ICE ACCRETION. Same as SIMULATED ICE SHAPE.

ARTIFICIAL ICING: The process of accreting ice on an aircraft or aircraft surface through the use of a spray rig, such as in an icing tunnel or behind an icing tanker. Same as SIMULATED ICING.

AS: SAE Aerospace Standard

ATMOSPHERE, STANDARD: See STANDARD ATMOSPHERE.

LIST OF AIRCRAFT INFLIGHT ICING TERMS AND ABBREVIATIONS WITH RECOMMENDED DEFINITIONS (Continued)

AUTOMATIC CONTROL: A device or system of devices which autonomously regulates some parameter or output to a reference parameter. Used to automatically modify system operation to drive output performance to a desired value or criteria (SAE147).

BEAD: A freestanding, non-uniform, rounded ICE SHAPE formed away from the main ICE ACCRETION.

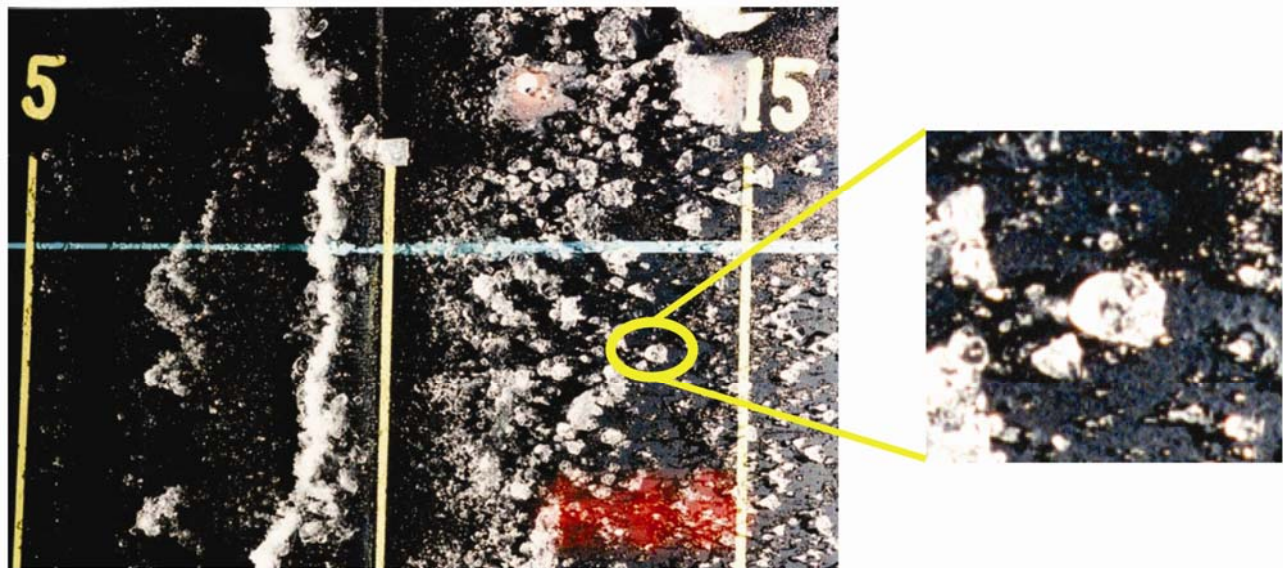


FIGURE 1 - BEAD

BEAK ICE: An ice type normally associated with helicopter rotor blades and consisting of a small accretion on the upper surface, close to the leading edge. It may resemble either a slushy ridge or small HORN type of accretion protruding forward into the airstream, the latter resembling that of a bird's beak. The location of the ice is governed by the low pressure (suction) region, which produces sufficient local cooling to permit water to freeze.

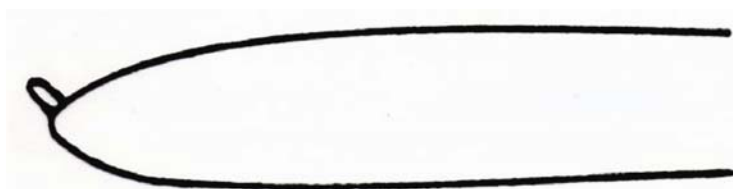


FIGURE 2 - BEAK ICE SKETCH

BIODEGRADABLE: The ability of a substance, when exposed to sunlight, air, and water, to spontaneously break down chemically into compounds which have no harmful environmental effects.

BLEED AIR: Air bled from the compressor of a gas turbine engine for auxiliary use. Commonly used in thermal ice protection systems as a source of heat and motive flow.

BLOWOFF: Water that has been re-entrained into the air after impacting an aircraft surface.

LIST OF AIRCRAFT INFLIGHT ICING TERMS AND ABBREVIATIONS WITH RECOMMENDED DEFINITIONS (Continued)

BOOT RIDGE: An ICE RIDGE that remains on an airfoil aft of the active area of a PNEUMATIC DEICER system after the deicer system has been activated. A sharp, forward facing step to the airflow is often formed. This can occur when ice has accreted on the airfoil over a larger area than that covered by the DEICING system.

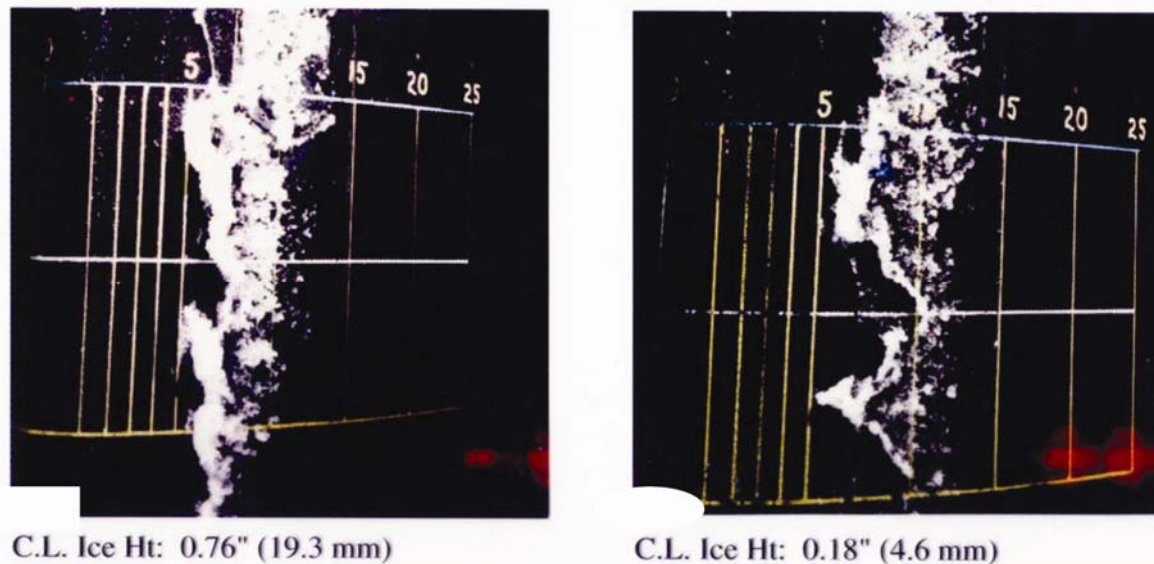


FIGURE 3 - BOOT RIDGES

BOUNDARY LAYER: The layer of air which immediately surrounds an aircraft in flight and transitions from zero velocity to the local FREESTREAM air velocity. An analysis of the boundary layer may be necessary in order to estimate the FILM HEAT TRANSFER COEFFICIENT.

BRIDGING: (1) The formation of an arch of ice over a PNEUMATIC DEICER that is not removed by inflation. (2) The connection of ice between an ice protected and non-ice protected region (see PARTING STRIP).

BRUSH BLOCK: A device used to transmit electrical power through rotating machinery using a stationary held electrically conductive brush (the brush block) maintained in contact with a rotating SLIP RING. Used in rotorcraft and propeller ELECTROTHERMAL ice protection systems.

LIST OF AIRCRAFT INFLIGHT ICING TERMS AND ABBREVIATIONS WITH RECOMMENDED DEFINITIONS (Continued)

BUMPS: Part of GLAZE ICE formations that show a non-uniform rounded shape, typically 4 to 10mm across. They may be covered by ROUGHNESS ELEMENTS.

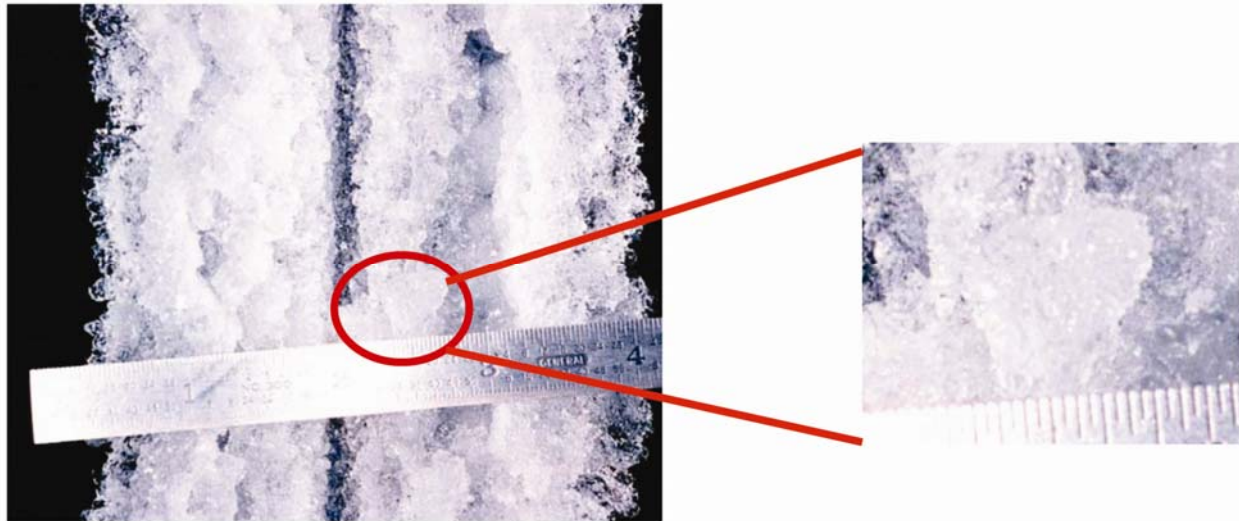


FIGURE 4 - BUMP (SCALE IN INCHES)

CAPILLARY NUMBER: The ratio of viscous forces to surface tension forces. It is sometimes used to describe characteristics of water on the surface of GLAZE ICE.

$$Ca = (\mu \cdot V) / (\sigma)$$

where:

μ = viscosity of water

V = freestream velocity

σ = surface tension, water to air

CFR: Code of Federal Regulations.

CHARACTERISTIC LENGTH: A convenient reference length, such as the chord of an airfoil, used to define the geometric scale for a given problem.

CIRROCUMULUS: A high-level (~20,000 to 30,000 ft MSL) thin white patch, sheet or layer of cloud composed of very small elements in the form of grains, ripples, etc. merged or separated, and more or less regularly arranged, primarily composed of ice crystals, but may also contain small amounts of SUPERCOOLED LIQUID WATER.

CIRROSTRATUS: A high-level (~20,000 to 30,000 ft MSL) transparent, whitish cloud veil of fibrous or smooth appearance, primarily composed of ice crystals but may also contain small amounts of SUPERCOOLED LIQUID WATER.

CIRRUS: A high-level (~20,000 to 30,000 ft MSL) cloud in the form of white, delicate filaments or white or mostly white patches or narrow band, with a fibrous appearance or silky sheet, primarily composed of ice crystals but may also contain small amounts of SUPERCOOLED LIQUID WATER.

CLEAR ICE: (1) Transparent ice that is conformal to the substrate upon which it forms. (2) A term used by pilots to describe GLAZE ICE.

LIST OF AIRCRAFT INFLIGHT ICING TERMS AND ABBREVIATIONS WITH RECOMMENDED DEFINITIONS
(Continued)

COALESCENCE EFFICIENCY: The fraction of water colliding with a surface that merges into or adheres to that surface without being removed by splashing or bouncing. Commonly used by meteorologists.

COLD SOAK: A condition where an object has been exposed to a low temperature over a prolonged period of time. In the context of aircraft icing, this term is often applied to the condition where the fuel has reached a subfreezing temperature for water due to prolonged exposure at cold temperatures. Upon landing at a humid location, **CONDENSATION** can occur on the cold external surfaces of the wing fuel tanks and create a layer of **ICE** that can reduce lift or cause damage due to ice **SHEDDING**.

COLLECTION EFFICIENCY: See **LOCAL IMPINGEMENT EFFICIENCY** and **TOTAL IMPINGEMENT EFFICIENCY**.

COLLISION COALESCENCE PROCESS: A process of drop growth by which two drops collide with one another and coalesce to form a single larger drop.

COLLISION EFFICIENCY: See **LOCAL IMPINGEMENT EFFICIENCY** and **TOTAL IMPINGEMENT EFFICIENCY**.

COMPUTED ICE SHAPE: An **ICE SHAPE** that is generated from computational fluid dynamics (CFD) tools.

CONDENSATION: The process by which a gas is transformed into a liquid. The opposite of **EVAPORATION**.

CONDITIONAL INSTABILITY: The state of a column of air in the atmosphere when its temperature lapse rate is less than the **DRY ADIABATIC LAPSE RATE**, but greater than the **SATURATION ADIABATIC LAPSE RATE**. A parcel of air raised will be unstable (warmer than its surroundings) if **CONDENSATION** occurs.

CONDUCTIVITY, THERMAL: See **THERMAL CONDUCTIVITY**.

CONTINUOUS MAXIMUM ICING CONDITIONS: Icing conditions for **STRATIFORM** clouds as represented in Figures 1 through 3 of Appendix C of CFR 14 Parts 25 and 29. The 99th percentile **LIQUID WATER CONTENT** is shown at specific temperatures and **MEAN EFFECTIVE DIAMETERS**.

CONTROL, AUTOMATIC: See **AUTOMATIC CONTROL**.

CRITICAL ICING CONDITION(S): Aircraft **ICE** protection meteorological and flight condition(s) typically used as the **ICE PROTECTION SYSTEM** design point(s) (SAE1168/4).

CUMULIFORM: Descriptor of cumulus family clouds, the principal characteristic of which is vertical development in the form of rising mounds, domes, or towers.

CUMULONIMBUS: Thunderstorm cloud; **CUMULIFORM** cloud with extreme vertical development occurring as individual cells or continuous cloud with only individual tops discernable. Top of a mature form of this cloud often has a characteristic flattened, anvil-like shape. Can present an extreme icing hazard.

CUMULUS: A generally dense cloud with sharp outlines, developing vertically in the form of rising mounds, domes, or towers, and detached from surrounding clouds and cloud layers.

DATUM TEMPERATURE: (1) The temperature of an unheated surface in an icing environment (FAA/IH). (2) Wet air boundary layer temperature for a body traversing a cloud containing free moisture (ADS-4).

DEFOG: Removal of moisture after it has condensed, usually on a transparent area. (This term may, in common usage, also include the prevention of moisture formation or be used to designate both functions, but this is not technically correct. Prevention of moisture would be anti-fog.)

DEICE OR DEICING: The periodic **SHEDDING** of **ICE ACCRETIONS** by destroying the bond between the ice and the protected surface (see **ANTI-ICE** for prevention of ice formation on a surface).

LIST OF AIRCRAFT INFLIGHT ICING TERMS AND ABBREVIATIONS WITH RECOMMENDED DEFINITIONS
(Continued)

DEICER VACUUM: The application of a partial vacuum to a pneumatic deicer (when inactive) to prevent auto-inflation in the zone of the airfoil where the local pressure is less than the ambient static pressure due to reduced aerodynamic pressures.

DEMISTER: A term used in Europe with the same meaning as DEFOG (SAE147).

DEPOSITION: The process by which a gas is transformed directly into a solid without becoming a liquid. The opposite of SUBLIMATION.

DESIGN TEMPERATURE: The temperature on which the design of a system is based (SAE147).

DEW POINT TEMPERATURE: The temperature to which a given air parcel must be cooled at constant pressure and constant water vapor content in order to achieve saturation with respect to water.

DIELECTRIC: A non-conductor of electric current; often used as insulators for ELECTROTHERMAL ice protection systems.

DRIZZLE: Liquid precipitation in the form of water drops with diameters between 50 and 500 μm .

DROP: A small spherical particle of any liquid; in meteorology, particularly a water drop. There is no defined size limit separating drops from droplets of water, but it is sometimes convenient to denote two disparate size ranges, such as the oft-used distinction of liquid cloud particles (droplets) from liquid precipitation (drops), thereby implying that a maximum diameter of 0.2 mm is the limit for droplets.

DROPLET: Same as DROP, often implying a small drop.

DROPLET REYNOLDS NUMBER: The Reynolds number of the supercooled cloud or water-spray DROPLETs, that is the product of droplet diameter and velocity divided by kinematic viscosity of the FREESTREAM air. The velocity may be either the freestream velocity or the velocity of the droplets relative to the air.

DROPLET TRAJECTORY: The path traced by a water DROPLET in air, usually tracked from a position in the FREESTREAM until either it impacts on a body of interest or it passes the body.

DRY ADIABAT: The line representing the DRY ADIABATIC LAPSE RATE, either drawn on a chart or represented by equations.

DRY ADIABATIC LAPSE RATE: The rate of decrease of temperature with height of a parcel of dry air lifted adiabatically through an atmosphere in HYDROSTATIC EQUILIBRIUM (FAAIH).

DRY AIR RATED TEMPERATURE: Temperature of a supersaturated mixture of air and water if the entire content of the water in the mixture is evaporated at constant enthalpy.

DRY AIR TESTING: Testing carried out in flight where there is no visible moisture or in a facility in which no water spray is introduced.

DRY BULB TEMPERATURE: The STATIC TEMPERATURE of an air-water vapor mixture (SAE147).

DRY GROWTH: Accretion of supercooled DROPLETs creating typically RIME ICE with a surface that is mostly dry and below 0 °C except locally, immediately after droplet collisions.

DYNAMIC PRESSURE: Equal to the product ($0.5 \times \text{fluid density} \times \text{fluid velocity squared}$), and is associated with the kinetic energy of the moving fluid.

LIST OF AIRCRAFT INFLIGHT ICING TERMS AND ABBREVIATIONS WITH RECOMMENDED DEFINITIONS
(Continued)

DYNAMIC TEMPERATURE: The difference between the stagnation or total temperature of a flow and the static temperature; it is the kinetic energy per unit mass of the moving fluid divided by its specific heat at constant pressure.

ECS: Environmental Control Systems

ELASTOMERIC: Exhibiting elastic properties similar to natural rubber. Commonly used in PNEUMATIC DEICER and blanket-type ELECTROTHERMAL ice protection systems.

ELECTROMAGNETIC DEICING SYSTEM: A deicing system in which ice is shed by mechanical acceleration or deflection of the de-iced surface through the use of electro-magnetic forces. Several variations exist depending on detailed design and implementation.

ELECTROTHERMAL: Electrical-resistance-generated energy used to heat the protected surface to a temperature above freezing, evaporate impinging water DROPLETS, melt an ICE ACCRETION, or melt the ice bond layer to allow centrifugal and/or aerodynamic forces to shed the ice.

EJECTOR: A passive, pneumatic device that uses pressurized air to produce a vacuum, or suction, by means of a jet effluxing through an orifice or venturi. Used in ice protection applications to generate vacuum from engine bleed air to maintain the pneumatic de-icers fully deflated during flight.

ENGINE INDUCTION SYSTEM: Systems which provide air to an engine, e.g., the inlet lip, guide vanes, spinner, etc.

ENVIRONMENTAL CONTROL SYSTEM: A system designed to maintain a desired environment (ventilation, temperature, humidity, etc.) within an aircraft.

EVAPORATION: The process by which a liquid in a liquid-gas mixture is transformed into a gas. The opposite of CONDENSATION.

EVAPORATIVE SYSTEM: An ANTI-ICING system that supplies sufficient heat to evaporate all water DROPLETS impinging on the heated surface.

FAILURE: An occurrence which affects the operation of a component such that it can no longer function as intended (AS5498).

FALSE ALARM: An indication of ICE when there is no ice present (AS5498). See also NUISANCE ALARM.

FEATHERS: See ICE FEATHERS.

FEATHER RIDGE: A line of ICE FEATHERS that have grown together to form a continuous surface.

FIDS: FLIGHT ICING DETECTION SYSTEM (AS5498).

FINITE DIFFERENCE METHOD: A computational method for solving a field problem. The field is discretized, that is subdivided into numerous small but finite cells. This process is known as grid- or mesh-generation. The partial differential equations which govern the field are approximated by finite difference equations in terms of values of the unknowns at the cells. This yields a set of algebraic equations which can be solved for the values of the unknowns at each of the cells.

FINITE ELEMENT METHOD: A computational method for solving a field problem. The field is discretized, that is subdivided into numerous small regions called finite elements which are defined by points called nodes. The variation of the unknown parameters between two or more nodes is assumed to be described by shape functions (e.g., linear functions, quadratic functions, etc.). The nodal values of the shape functions effectively become the unknowns. The equations which govern the field are written in such a way that their solution satisfies the governing equations with minimum error.

LIST OF AIRCRAFT INFLIGHT ICING TERMS AND ABBREVIATIONS WITH RECOMMENDED DEFINITIONS
(Continued)

FLIGHT ICING DETECTION SYSTEM (FIDS): A FIDS includes at least one sensor which is directly or indirectly sensitive to the physical phenomena of icing. A FIDS detects ICE ACCRETION on a REFERENCE SURFACE and sends a signal to the flight crew and/or systems. A FIDS may also be used to infer ice thickness, ice accretion rate, LIQUID WATER CONTENT, DROPLET size, and/or accretion location.

FLOW FIELD: A two- or three-dimensional region in which a fluid flow occurs. A flowfield can be described mathematically by expressing the velocity components, pressure, density, and temperature as functions of the spatial coordinates.

FLUX: The amount of some quantity flowing across a given area per unit time (MHDPM).

FORECAST ICING CONDITIONS: Environmental conditions expected by a weather service to be conducive to the formation of inflight icing on aircraft.

FOREIGN OBJECT DAMAGE (FOD): Damage caused to a system by debris or by an item that is not part of the system.

FORWARD SCATTERING SPECTROMETER PROBE (FSSP): A commercially-available instrument for counting and sizing individual cloud DROPLETs in flight. Droplets are sized by detecting and scaling the amount of light they scatter at small angles out of a narrow illuminating beam.

FREESTREAM: The air surrounding an aircraft in flight that is not disturbed by the aircraft's passage. Relative to aircraft icing, the undisturbed air is assumed sufficiently free from local airflow variations such that the icing DROPLET trajectories (relative to the aircraft) are not altered.

FREEZING DRIZZLE: DRIZZLE that falls in liquid form but freezes upon impact with the ground or exposed objects.

FREEZING FOG: A SUPERCOOLED CLOUD in contact with the ground and which freezes upon impact with the ground or exposed objects.

FREEZING FRACTION: The ratio of the mass of water that freezes at a point on a surface to the total mass of incoming water at that point.

FREEZING LEVEL: The altitude of the 0 °C (32 °F) temperature level. In the case of multiple 0 °C (32 °F) temperature levels, the lowest such level.

FREEZING POINT DEPRESSANT ICE PROTECTION SYSTEM: A deicing or anti-icing system which introduces a freezing point depressant, typically a glycol compound, to the impinging DROPLETs, causing the impinging water to have a freezing temperature lower than the local airflow temperature. The impinging water mixture then evaporates or is shed from the surface.

FREEZING PRECIPITATION: Any form of liquid precipitation that freezes upon impact with the ground or exposed objects, that is, FREEZING RAIN or FREEZING DRIZZLE.

FREEZING RAIN (FZRA): Rain that falls in liquid form, but freezes upon impact with the ground or exposed objects.

FROST: Ice crystals formed on a surface by water vapor DEPOSITION from the atmosphere.

FROZEN PRECIPITATION: Precipitation, once liquid, in a frozen state, including SNOW PELLETS and ICE PELLETS.

LIST OF AIRCRAFT INFLIGHT ICING TERMS AND ABBREVIATIONS WITH RECOMMENDED DEFINITIONS
(Continued)

FROZEN RIVULET: A frozen sinuous stream of water contained by surface tension forming streaks of ice that are parallel to the streamlines on an aircraft surface.

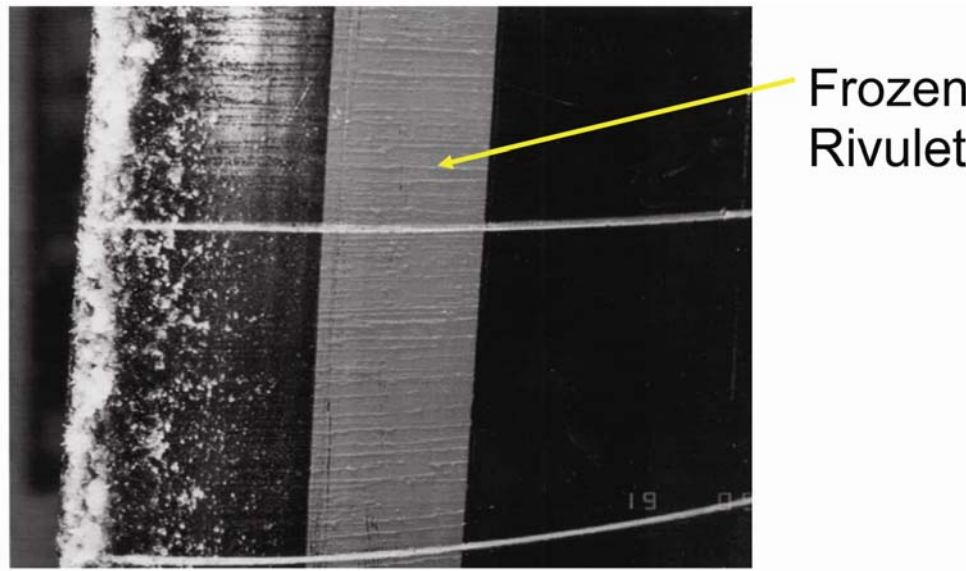


FIGURE 5 - FROZEN RIVULET

FUSION: The process of freezing.

GEOMETRY: The qualitative study of shape and size (MHDPM).

G-FORCE: The dimensionless unit expressing the acceleration acting on a body in terms of the acceleration of earth's gravity (1G, 2G, etc.).

**LIST OF AIRCRAFT INFLIGHT ICING TERMS AND ABBREVIATIONS WITH RECOMMENDED DEFINITIONS
(Continued)**

GLAZE FEATHERS: ICE FEATHERS that are transparent or translucent in appearance.



FIGURE 6 - GLAZE FEATHERS (SMALL MARKINGS - 1/16 INCH)

GLAZE ICE: Transparent or translucent ice formed by liquid water DROPLETs that do not freeze immediately on impact and has HORNS.

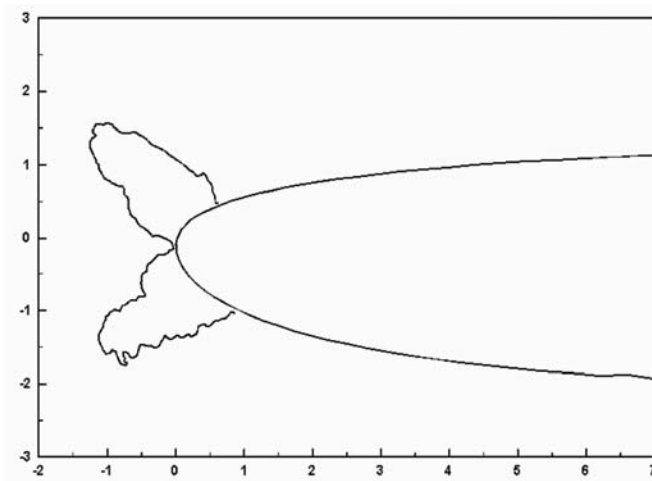


FIGURE 7 - GLAZE ICE TRACING AND PHOTOGRAPH SHOWING HORNS

GLIME: Same as MIXED ICE.

GLYCOL: A common freezing point depressant used in fluid ICE PROTECTION SYSTEMs.

GRAUPEL: Heavily rimed ICE CRYSTALS, often called SNOW PELLETS; often indistinguishable from very small soft HAIL except for the size convention that hail must have a diameter greater than 5 mm. Sometimes distinguished by shape into conical, hexagonal, and lump (irregular) graupel (GM).

LIST OF AIRCRAFT INFLIGHT ICING TERMS AND ABBREVIATIONS WITH RECOMMENDED DEFINITIONS
(Continued)

HAIL: Solid precipitation in the form of balls or pieces of ice with diameters ranging from 5 mm to more than 50 mm (FAA29-2).

HANDLING QUALITIES: The flight characteristics of an aircraft that are associated with the stability and controllability of the flight vehicle, the stall characteristics of the lifting surfaces, and the dynamics and aerodynamics of the aircraft. The term is commonly used to describe a pilot's perception of aircraft response to control commands, emphasizing aerodynamic changes caused by INFLIGHT ICE ACCRETION when used in an icing context.

HEAT TRANSFER COEFFICIENT, OVERALL: The single heat transfer coefficient which describes the heat transfer rate through the section under consideration. It is the combination of all the individual heat transfer paths through the section and is usually expressed in units of $W/m^2 \cdot ^\circ K$ (Btu/h-ft² · °F).

HEAT TRANSFER COEFFICIENT, SURFACE OR FILM: The heat transfer coefficient of the thin layer of fluid immediately adjacent to the surface and is usually expressed in units of $W/m^2 \cdot ^\circ K$ (Btu/h-ft² · °F).

HEAVY ICING: SAE does not recommend a definition at this time. See Section 5 for previous definitions and Appendix A for discussion.

HIGHLIGHT: The forward most point on the leading edge of an airfoil, usually along the chord line. The minimum x-coordinate of an airfoil or nacelle cross-section.

HOARFROST: See FROST.

HORIZONTAL EXTENT: The horizontal distance of an ICING ENCOUNTER (FAAIH).

HORN: A prominence rising from the surrounding ice surface formed in WET GROWTH conditions. Horns typically form a continuous spanwise ICE RIDGE on straight to low sweep angle leading edges.

HOT WIRE ANEMOMETER: A velocity measurement device that measures heat transfer in a FLOW FIELD by passing electrical current through a thin element exposed to the flow. In its most common form, the device maintains a constant temperature in the element and measures the current required to maintain the temperature.

HUMIDITY, RELATIVE: See RELATIVE HUMIDITY.

HUMIDITY, SPECIFIC: See SPECIFIC HUMIDITY.

HYDROSTATIC EQUILIBRIUM: The state of a fluid whose surfaces of constant pressure and constant mass (or density) coincide and are horizontal throughout (FAAIH, GM).

ICE: Any form of frozen water found on an aircraft including CLEAR ICE, GLAZE ICE, MIXED ICE, RIME ICE, RUNBACK ICE, FROST, SNOW, ICE CRYSTALS, BEADS, FEATHERS, etc.

ICE ACCRETION: A growth, buildup, or formation of ice on an aircraft surface.

ICE CAP: An ICE ACCRETION which forms astride a curved surface, such as on the leading edge of a wing. This ice may be difficult to shed even when the ice bond has melted due to the mechanical lock that can be formed with the surface.

ICE-CONTAMINATED TAILPLANE STALL (ICTS): Premature flow separation from the suction surface of a horizontal tail caused by an ICE ACCRETION on the leading edge. The tail angle of attack where ICTS occurs is affected by the tail airfoil design, the ICE SHAPE and roughness, Reynolds & Mach numbers, and elevator deflection angle.

ICE CRYSTAL: Any one of a number of macroscopic, crystalline forms in which ice appears, including hexagonal columns, hexagonal platelets, dendritic crystals, ICE NEEDLES, and combinations of these forms (GM).

**LIST OF AIRCRAFT INFLIGHT ICING TERMS AND ABBREVIATIONS WITH RECOMMENDED DEFINITIONS
(Continued)**

ICE CRYSTAL CLOUD: A cloud consisting entirely of ICE CRYSTALS; to be distinguished in this sense from liquid water clouds and MIXED CLOUDS.

ICE DEPTH GAGE: A device used to measure ICE thickness or the height of an ice feature, such as an ice HORN, from the surface of the article upon which the ice has accreted. Since the surface of the ice is usually irregular, these devices are often set up to measure over a small area.



FIGURE 8 - ICE DEPTH GAGE

ICE DETECTOR: A device that informs the cockpit crew or a system about ICE ACCRETION on monitored airplane surfaces.

ICE FEATHERS: Individual structures of ICE formed from discrete points on the surface of a body that fan out as they grow. They may be found adjacent to the main ICE SHAPE, they may grow into it or into each other, or the main ice shape itself may be comprised of an assemblage of feathers. The name derives from the crystalline structure of RIME ice feathers which resemble that of a bird's feather (see also GLAZE FEATHERS, RIME FEATHERS, and FEATHER RIDGE).

ICE INGESTION: Class of tests to determine ability of engine to swallow various cubes of ICE, ice-water slush, and sometimes hailstones at specified flow rates (Jane's).

ICE INSPECTION LIGHT: A light mounted on the airframe that illuminates the wing leading edge or some other REFERENCE SURFACE to allow flight crew observation of ICE ACCRETION at night.

ICE KNIFE: A heated tool that cuts a profile through an ICE SHAPE to prepare it for an ICE TRACING.

ICE NEEDLES: Long ice crystals of needlelike appearance.

ICE PELLETS: Type of precipitation consisting of transparent or translucent pellets of ice 5 mm or less in diameter, generally frozen water drops.

ICEPHOBIC: A surface property exhibiting a reduced adhesion to ICE, literally, "ice-hating" (FAAIH).

ICE PLATE: Strong plate on fuselage skin in plane of propellers (Jane's).

LIST OF AIRCRAFT INFLIGHT ICING TERMS AND ABBREVIATIONS WITH RECOMMENDED DEFINITIONS
(Continued)

ICE POINT: The temperature at which a mixture of air-saturated pure water and pure ice may exist in equilibrium at a pressure of one atmosphere (GM).

ICE PROTECTION SYSTEM (IPS): Any airborne DEICING or ANTI-ICING system (depending on the necessary degree of protection and the capability to provide that protection) that has the function of protecting an aircraft surface against ICE ACCRETION. A deicing system allows some ICE to accrete on the protected surface before removing it (partially or totally) periodically, whereas an anti-icing system prevents the formation of ice on a surface. Commonly separated into airframe, powerplant, propeller or rotor ice protection systems. These divisions may overlap or interact depending on aircraft design.

ICE RIDGE: A raised strip of ICE usually oriented along the span of an aircraft surface. It may form as part of an ICE ACCRETION or may form as the result of partial ice removal by an ice protection system. Several different types of ice ridges have been identified including BOOT RIDGE, RUNBACK RIDGE, and FEATHER RIDGE.

ICE ROD: Standard ingestion-test size: 3.18 cm (1.25 in) in diameter by 30.5 cm (12 in) long (Jane's).

ICE SHAPE: The profile of ICE formed on an aircraft component. This shape may be calculated or may be based on actual accumulation during natural, tanker, or tunnel icing tests.

ICE SHAPE DETERMINATION: A term indicating whether a specific icing code has the theoretical capability to produce a COMPUTED ICE SHAPE.

ICE TRACING: A record of the profile of an ICE SHAPE.

ICING: The building or accreting of ICE on a surface.

ICING CLOUD: A cloud containing SUPERCOOLED LIQUID WATER drops of sufficient concentration and size to produce ice on an airborne aircraft's surface.

ICING CODE: A computer program that models the ICE ACCRETION process in aircraft icing conditions.

ICING CONDITION: The presence of SUPERCOOLED LIQUID WATER drops and temperature conducive to aircraft icing.

ICING ENCOUNTER: A series of ICING EVENTS consecutively penetrated until an interruption of more than some selected distance is experienced (FAAIIH).

ICING EVENT: A portion of a subfreezing cloud over which the cloud properties are approximately constant (FAAIIH).

ICING INTENSITY: The rate of ICE ACCRETION on any aircraft component. Rates may be categorized as LIGHT, MODERATE, HEAVY, or SEVERE. See Appendix A for discussion.

ICING LIMITS: (1) Distance from the HIGHLIGHT to the end of the ICE ACCRETION on both the upper and lower surfaces of an airfoil. (2) Usually upper and lower temperature limits, corresponding to one (sometimes two) flight levels.

ICING RATE METER: A sensor system that indicates the rate of ICE ACCRETION.

ICING TANKER: An aircraft equipped with a water-spray rig so that an artificial icing cloud can be produced in order to cause icing on another aircraft following close behind.

ICING TUNNEL: A wind tunnel equipped with spray bars and a refrigeration system such that the tunnel air can be kept at sub-freezing temperatures and water spray can be introduced upstream of the test article in order to simulate in-flight icing conditions.

LIST OF AIRCRAFT INFLIGHT ICING TERMS AND ABBREVIATIONS WITH RECOMMENDED DEFINITIONS
(Continued)

IMPACT ICE: ICE formed due to the collision of SUPERCOOLED WATER DROPLETS and an aircraft surface, either in flight, in an icing tunnel, or behind an icing tanker.

IMPINGEMENT EFFICIENCY: See LOCAL IMPINGEMENT EFFICIENCY and TOTAL IMPINGEMENT EFFICIENCY.

IMPINGEMENT EFFICIENCY CURVE: The curve or plot which gives, as a function of position, LOCAL IMPINGEMENT EFFICIENCY.

IMPINGEMENT LIMIT: The farthest aft location on a body at which water DROPLETs impact. This applies to both the upper or lower surface for a body such as an airfoil. This distance can be measured either as the x distance from the leading edge or as the surface distance from the stagnation point.

INERTIA PARAMETER: A non-dimensional parameter that appears in the water-droplet equations of motion when they are non-dimensionalized. Impingement efficiency and IMPINGEMENT LIMITs are dependent on the inertia parameter, on the body shape and angle of attack, and on the DROPLET Reynolds number.

INERTIAL SEPARATOR: A device used to reduce the effects of icing on turboprop aircraft or helicopter engines. The high velocity inlet air is forced to execute a sharp turn in order to enter the engine inlet. The heavier water droplets are unable to execute this turn, and are subsequently separated and discharged from the inlet. Can also be referred to as a PARTICLE SEPARATOR.

INFLATION CYCLE: The length of time between successive inflations of the PNEUMATIC DEICER.

INFLATION SEQUENCE: The order of inflation of sections of the PNEUMATIC DEICER system (i.e., inboard wing, outboard wing, empennage).

INFLIGHT: From weight off wheels to weight on wheels (AS5498).

INFRARED IMAGERY: A non-contacting method of temperature measurement wherein the radiation generated by the temperature of an object is measured in such way that its temperature can be ascertained. A two-dimensional image is formed indicating the temperature variation across the surface of the object.

INTERCYCLE ICE: ICE that accretes on a deiced surface between DEICING system actuation cycles.

INTERMITTENT MAXIMUM ICING CONDITIONS: Icing conditions for convective clouds as represented in Figure 4 of CFR 14 Parts 25 and 29, Appendix C. The 99th percentile LIQUID WATER CONTENT is shown at specific temperatures and MEAN EFFECTIVE DIAMETERS.

INTRUSIVE: A type of FIDS in which the sensing element is located in the FREESTREAM or near FREESTREAM.

IPS: ICE PROTECTION SYSTEM

ISD&IS: Icing Severity Detection and Indication System

JAR: Joint Aviation Requirement

KCAS: Knots Calibrated Air Speed

LANGMUIR DISTRIBUTION: A family of five hypothetical, symmetrical LWC vs. drop size distributions originally devised for analyzing ROTATING MULTICYLINDER (RMC) measurements. The table gives the drop diameter as a fraction or multiple of the MEDIAN VOLUMETRIC DIAMETER (MVD) for the center of each of the seven LWC intervals in each column. The table illustrates the distributions in terms of a/a_0 , where a is the average diameter in each group and a_0 is the median volumetric diameter. Distribution "D" is commonly used for ICE ACCRETION computations on airfoils as assumed in 14 CFR-25,29 Appendix C.

LIST OF AIRCRAFT INFLIGHT ICING TERMS AND ABBREVIATIONS WITH RECOMMENDED DEFINITIONS
(Continued)

TABLE 1

%LWC	A	B	C	D	E
5%	1.00	0.56	0.42	0.31	0.23
10%	1.00	0.72	0.61	0.52	0.44
20%	1.00	0.84	0.77	0.71	0.65
30%	1.00	1.00	1.00	1.00	1.00
20%	1.00	1.17	1.26	1.37	1.48
10%	1.00	1.32	1.51	1.74	2.00
5%	1.00	1.49	1.81	2.22	2.71

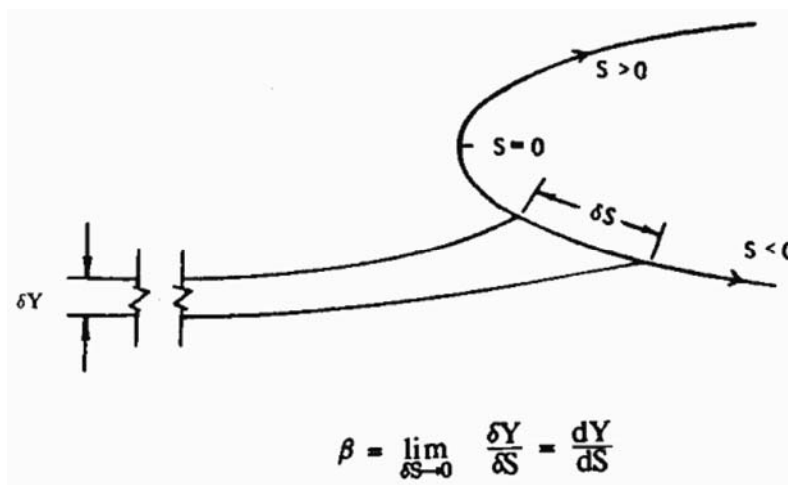
LATENT FAILURE: A failure that is unrecognized until it is made known to the cockpit crew or maintenance personnel (AS5498).

LATENT HEAT: The heat released or absorbed per unit mass by a SYSTEM in a reversible, isobaric-isothermal change of phase. In meteorology, the latent heats of EVAPORATION (or CONDENSATION), FUSION, and SUBLIMATION of water at 0 °C are respectively: $L_v = 2.501 \times 10^6$ J/kg, $L_f = 3.337 \times 10^5$ J/kg, $L_s = 2.834 \times 10^6$ J/kg.

LIGHT ICING: SAE does not recommend a definition at this time. See Section 5 for previous definitions and Appendix A for discussion.

LIQUID WATER CONTENT: The total mass of water contained in liquid drops within a unit volume or mass of cloud or precipitation, usually given in units of grams of water per cubic meter or kilogram of dry air (g/m^3 , g/kg).

LOCAL IMPINGEMENT EFFICIENCY, β : The ratio of water droplet mass flux at a specific location on the surface of a body to the droplet mass flux in the freestream. Other names have been used for this term including: impingement efficiency, local catch efficiency, collection efficiency, water catch efficiency, and local water catch efficiency.

FIGURE 9 - LOCAL IMPINGEMENT EFFICIENCY, β

**LIST OF AIRCRAFT INFLIGHT ICING TERMS AND ABBREVIATIONS WITH RECOMMENDED DEFINITIONS
(Continued)**

LOCAL CATCH EFFICIENCY: See LOCAL IMPINGEMENT EFFICIENCY and TOTAL IMPINGEMENT EFFICIENCY.

LOCAL WATER CATCH EFFICIENCY: See LOCAL IMPINGEMENT EFFICIENCY and TOTAL IMPINGEMENT EFFICIENCY.

LUDLAM LIMIT: The combination of TOTAL TEMPERATURE, LWC, MVD, and airspeed at which not all supercooled water DROPLETs freeze within their catchment area and the forward growth of ice is diminished.

LWC: LIQUID WATER CONTENT.

MAGNETOSTRICTIVE: The property of a ferromagnetic material that causes it to change dimensions when subjected to a magnetic field. In ICE DETECTORS, a shift in resonant frequency of the ice-covered magnetostrictive material when subjected to an alternating magnetic field is used to indicate ICE buildup.

MED: MEAN EFFECTIVE DIAMETER.

MEAN EFFECTIVE DIAMETER (MED): A term used with the ROTATING MULTICYLINDER method for measuring LWC in clouds. A DROPLET diameter which, when assigned to the midpoint of one of the LANGMUIR DISTRIBUTIONS, gives the best agreement between the computed and measured differential ice mass accumulations on a set of ROTATING MULTICYLINDERS. The MED is approximately equal to the MVD.

MEDIAN VOLUMETRIC DIAMETER (MVD): The drop diameter which divides the total LIQUID WATER CONTENT present in the drop distribution in half, i.e., half the water volume will be in larger drops and half the volume in smaller drops. (Also sometimes called Median Volume Diameter.)

MICRON (μm): One millionth of a meter (10^{-6}m). (Also known as micrometer.)

MIXED CLOUD: Cloud in which ice particles are intermingled with liquid SUPERCOOLED WATER drops.

MIXED CONDITIONS: A mixture of liquid SUPERCOOLED WATER drops and ICE CRYSTALS existing within the same cloud environment. Also called a mixed-phase condition.

MIXED ICE: Simultaneous appearance of both GLAZE ICE and RIME ICE characteristics. It is translucent or transparent at the stagnation region, transitioning to opaque ICE FEATHERS at the sides.

LIST OF AIRCRAFT INFLIGHT ICING TERMS AND ABBREVIATIONS WITH RECOMMENDED DEFINITIONS (Continued)

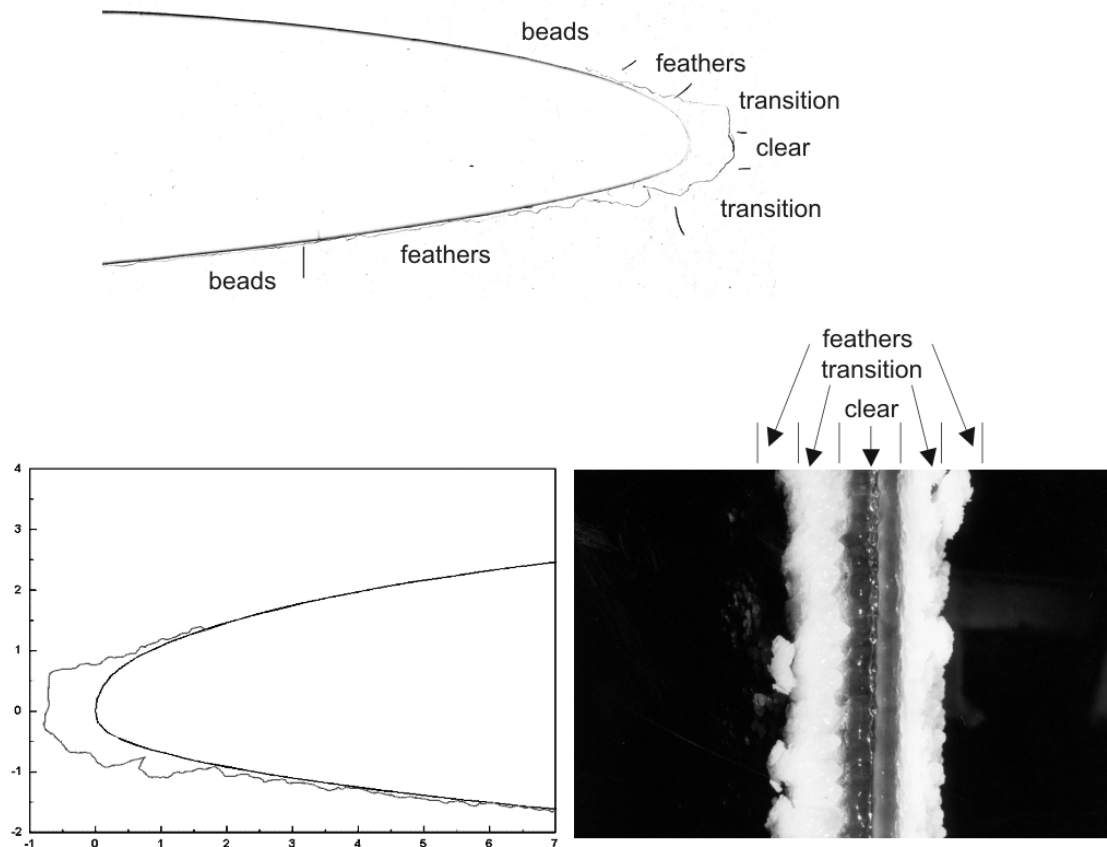


FIGURE 10 - MIXED ICE COMPONENT DESCRIPTION, TRACING (IN INCHES) AND PHOTOGRAPH

MIXED PHASE ICING/MIXED ICING: Icing in a cloud composed of SUPERCOOLED DROPLETS and ICE CRYSTALS.

MODERATE ICING: SAE does not recommend a definition at this time. See Section 5 for previous definitions and Appendix A for discussion.

MOIST ADIABAT: The line representing the MOIST ADIABATIC LAPSE RATE, either drawn on a chart or represented by equations.

MOIST ADIABATIC LAPSE RATE: The rate of decrease of temperature with altitude of a saturated air parcel through an atmosphere in HYDROSTATIC EQUILIBRIUM.

MOIST ADIABATIC PROCESS: See SATURATION ADIABATIC PROCESS.

MONITORED SURFACE: The surface of concern regarding ice hazard (e.g., the leading edge of a wing). ICE ACCRETION on the monitored surface may be measured directly or correlated to ice accretion on a REFERENCE SURFACE.

LIST OF AIRCRAFT INFLIGHT ICING TERMS AND ABBREVIATIONS WITH RECOMMENDED DEFINITIONS (Continued)

MSL: Mean Sea Level

MTBF: Mean Time Between Failures.

MTBUR: Mean Time Between Unscheduled Removals.

MULTISTEP ICE ACCRETION PROCEDURE: A time-stepping procedure used in computer code icing simulations to compute the ICE ACCRETION. The procedure calculates the amount of ice accumulated on the surface during a specified time increment and then repeats that calculation over a sufficient number of time increments that add up to the desired exposure time. The flowfield, IMPINGEMENT EFFICIENCY, energy and mass balances, and ice thickness distribution are recomputed on every time step for the ICE SHAPE geometry from the previous step.

MVD: MEDIAN VOLUMETRIC DIAMETER. (Also sometimes called Median Volume diameter.)

NATURAL ICING: Icing caused by supercooled DROPLETs created without human intervention.

NAVIER-STOKES EQUATIONS: The partial differential equations which express the law of conservation of momentum for unsteady, viscous, compressible flow of a Newtonian fluid. For three dimensional flows they comprise three equations, one for each coordinate direction. The Navier-Stokes equations, together with the continuity and energy equations, constitute a set of equations which can yield exact solutions for laminar Newtonian flows. For turbulent flows these equations must be supplemented by turbulence models which can be a source of significant error. For practical flows the Navier-Stokes equations must be solved by numerical methods and solutions are very demanding of computer resources.

NAVIER-STOKES SOLVER: A computer code which numerically solves the Navier-Stokes and ancillary equations.

NIMBOSTRATUS: A cloud type, gray colored and often dark, rendered diffuse by more or less continuously falling rain, SNOW, SLEET, etc., and not accompanied by lightning, thunder, or HAIL.

NODULES: Smooth, individual ICE structures similar to GLAZE FEATHERS that grow nearly perpendicular to the general airflow direction. They are usually found on the aircraft surface aft of the main ICE ACCRETION.

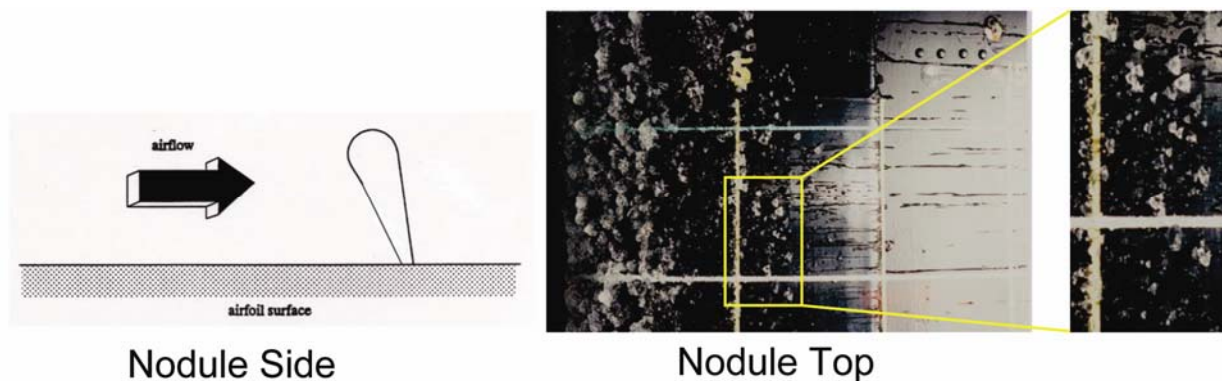


FIGURE 11 - NODULES

NUCLEATION: The process of initiation of a new phase in a SUPERCOOLED (for liquid) or SUPERSATURATED (for solution or vapor) environment; the initiation of a phase change of a substance to a lower thermodynamic energy state (vapor to liquid CONDENSATION, vapor to solid DEPOSITION, liquid to solid freezing) (GM).

NUISANCE ALARM: An undesired indication of ICE or ICING (AS5498). For example, an indication where the icing condition or duration does not require action. See also FALSE ALARM.

**LIST OF AIRCRAFT INFLIGHT ICING TERMS AND ABBREVIATIONS WITH RECOMMENDED DEFINITIONS
(Continued)**

NUSSELT NUMBER: A local dimensionless coefficient of heat transfer often defined as:

$$Nu_L = (h_L \cdot L)/k$$

where:

h_L = heat transfer coefficient

L = CHARACTERISTIC LENGTH

k = thermal conductivity

OAT: Outside Air Temperature. Same as AMBIENT TEMPERATURE.

OBSERVED ICING: Actual ICE observed visually on the aircraft by the flight crew, or identified by on-board sensors.

OPTICAL ARRAY PROBE (OAP): A commercially-available instrument for counting and sizing individual, precipitation-sized particles in flight. Particles are sized by electronically measuring the cross-section of the magnified shadows of particles passing through a narrow light beam by means of a linear array of miniature photodetectors.

PANEL METHOD: A method for obtaining solutions for potential flows. Panel methods use superposition of large numbers of simple potential flow solutions to obtain solutions for potential flows over complex two- and three-dimensional bodies. The body surface is sub-divided into a large number of panels (usually quadrilaterals) and distributions of very simple solutions, typically sources, sinks and/or vortices, are placed on the panels. The overall flow is required to be tangent to the body surface at control points usually located at the centroid of each panel; this yields a set of algebraic equations which are solved for the strengths of the distributions on the panels. Panel methods are very fast and undemanding of computer resources because only the body surface, not the entire flowfield, needs to be discretized and because only a single relatively simple partial differential equation needs to be solved.

PARTING STRIP: A heated zone designed to part the ice at the specified location on a protected surface. These heated zones prevent BRIDGING to non-heated areas or alternatively separate ICE ACCRETIONS to allow aerodynamic shedding.

PHASE CHANGE: The process of changing from one physical state to another physical state. In ECS, phase change is usually in reference to materials selected that will change phase at a specific operating point or range. Significant heat transfer occurs when most materials change phase. This provides a significant thermodynamic advantage over absorbing or desorbing heat through the process of raising or lowering the temperature of a substance that does not change phase. Phase change materials are used passively or in a thermodynamic cycle such as the refrigeration system vapor cycle (SAE147).

PICCOLO TUBE: A pressurized high temperature tube behind the surface to be protected (such as an airfoil or engine inlet leading edge) that distributes heated air.

PIREPS: PIlot REPortS. Commonly used by pilots to record meteorological events experienced during INFLIGHT operations (SAE1168/4).

PNEUMATIC BOOT: Same as PNEUMATIC DEICER.

PNEUMATIC DEICER: A mechanical deicer usually made from fabric and ELASTOMERIC materials, having internal tubes (or passageways) either chordwise or spanwise direction, which are periodically inflated.

LIST OF AIRCRAFT INFLIGHT ICING TERMS AND ABBREVIATIONS WITH RECOMMENDED DEFINITIONS
(Continued)

POTENTIAL FLOW: Flow in which the velocity distribution can be obtained by taking the gradient of a potential function. Potential flow prevails when viscous effects are negligible and the FREESTREAM flow is uniform. A single linear partial differential equation governs incompressible potential flows and compressible potential flows in which perturbations to the freestream flow are small. Solutions can therefore be superimposed and these flows can be solved using panel methods.

POTENTIAL ICING CONDITIONS: Atmospheric conditions conducive to ICE ACCRETION on aircraft components. These conditions are typically defined by visible moisture and temperatures colder than a specific temperature. These conditions are normally defined by the aircraft manufacturer.

PRANDTL NUMBER: The ratio of momentum diffusivity to thermal diffusivity. (Jane's)

$$Pr = (\mu \cdot c_p) / \lambda$$

where:

μ = viscosity

c_p = specific heat at constant pressure

λ = thermal diffusivity

PREDICTOR-CORRECTOR PROCEDURE: A well-developed process of iterating to a converged solution for a given grid point or line of points in a marching procedure, whether temporal or spatial. In this process, first the equations are solved for the new predicted values and subsequently the predicted values are used to update the solution or "correct" it. This process is used for trajectory calculations in LEWICE3D and LEWICE 2.0. The predictor-corrector approach is applied to the complete ICE ACCRETION calculation in the ONERA and HERICE codes. (The codes first predict a final ICE SHAPE and then that ICE shape is used to determine the changes in parameters such as IMPINGEMENT LIMITs or LOCAL COLLECTION EFFICIENCY and this information is then used to go back and recalculate the ICE SHAPE assuming a linear variation in icing parameters from the initial values to the "predicted" final values.)

PRESSURE ALTITUDE: The altitude corresponding to a given pressure in the STANDARD ATMOSPHERE.

PRESSURE, DYNAMIC: See DYNAMIC PRESSURE.

PRESSURE, STATIC: See STATIC PRESSURE.

PRESSURE, TOTAL: See TOTAL PRESSURE.

PRIMARY AUTOMATIC FIDS: A FIDS that automatically activates ANTI-ICING or DEICING systems (AS5498).

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 (AS5498).

RAIN: Precipitation near the ground or aloft in the form of liquid water drops which have diameters >0.5 mm (500 μ m).

RAM TEMPERATURE RISE: That positive increment of temperature achieved by reducing the relative velocity between the aircraft and the ambient air. When the relative velocity is reduced to zero the ram temperature rise is equivalent to the DYNAMIC TEMPERATURE.

RECOVERY FACTOR: A correction applied to account for the fact that true stagnation temperature cannot be realized, even when heat transfer effects are taken into account. It is defined as the ratio of the difference between the surface and local (just outside the boundary layer) temperatures to the difference between the stagnation and local temperatures.

$$r = (T_{\text{surf}} - T_s) / (T_{\text{stag}} - T_s)$$

**LIST OF AIRCRAFT INFLIGHT ICING TERMS AND ABBREVIATIONS WITH RECOMMENDED DEFINITIONS
(Continued)**

where:

T_{surf} = surface temperature

T_{stag} = stagnation temperature

T_s = static temperature

RECOVERY TEMPERATURE: The temperature that an adiabatic wall aligned with the local flow direction will reach in steady flow. The recovery temperature lies between the static and stagnation temperatures of the flow. It is somewhat less than the stagnation temperature because of heat transfer from the highly retarded relatively warm fluid very near the wall to the faster moving cooler fluid slightly farther from the wall.

$$T_r = T_o[1 + r(\gamma - 1)/2 M^2]$$

where:

T_o = freestream static temperature

r = recovery factor

γ = specific heat ratio

M = Mach number

RELATIVE HEAT FACTOR: The ratio of heat carried to an aircraft surface by impinging water to that convected away by the airstream.

REDUNDANCY: The presence of more than one independent means for accomplishing a given function or flight operation (AS5498).

REFERENCE SURFACE: (1) The surface where a visual cue is located remotely from the surface of concern regarding the ice hazard (for example, a propeller spinner). (2) The surface where a FIDS sensor makes its measurement (e.g., the INTRUSIVE part of a probe system) (AS5498).

RELATIVE HUMIDITY: The ratio of the partial pressure of water vapor in the air to the saturation vapor pressure with respect to water (GM).

RESIDUAL ICE: ICE remaining immediately after an actuation cycle of a DEICING type of ice protection system.

REYNOLDS NUMBER: A non-dimensional parameter that gives a measure of the ratio of inertia forces to viscous forces in a fluid flow. The Reynolds number is the product of flow length scale and velocity divided by kinematic viscosity of the fluid. The length scale may be the size of the body over which flow occurs or some other pertinent length.

$$Re = \rho_a V L / \mu$$