Australian Government
Civil Aviation Safety Authority

PRINCIPLE

(OPS.22) Aircraft ground de-icing / anti-icing program

June 2024

Acknowledgement of Country

The Civil Aviation Safety Authority (CASA) respectfully acknowledges the Traditional Custodians of the lands on which our offices are located and their continuing connection to land, water and community, and pays respect to Elders past, present and emerging.

Inside front cover artwork: James Baban.

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Terminology

Acronyms and abbreviations

Table 1. List of acronyms and abbreviations

Acronym/abbreviation	Description
AC	advisory circular
AMC	acceptable means of compliance
AOC	air operator's certificate
CAC	clean aircraft concept
CASA	Civil Aviation Safety Authority
CASR	*Civil Aviation Safety Regulations 1998*
DAQCP	IATA de-icing/anti-icing quality control pool
GM	guidance material
HOT	hold over time
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
PIC	pilot in command
QA	quality assurance
SAE	standard aerospace equipment

Definitions

Table 2. List of definitions

Term	Definition
active frost	An aviation weather condition describing when frost is forming. Active frost occurs when the surface temperature is at or below 0ºC and at or below the dew point.
air transport operation	A passenger transport operation, a cargo transport operation, or a medical transport operation, that is conducted for hire or reward, or is prescribed by an instrument issued under regulation 201.025 of CASR.
anti-icing	A precautionary procedure by which clean aircraft surfaces are protected against the formation of ice and frost and the accumulation of snow and slush for a limited period of time.

Term	Definition
cold-soak effect	The wings of aeroplanes are said to be 'cold-soaked' when they contain very cold fuel as a result of having just landed after a flight at high altitude or from having been refuelled with very cold fuel. The following factors contribute to cold-soaking: • temperature and quantity of fuel in fuel cells • type and location of fuel cells • length of time at high altitude • temperature of refuelled fuel • time since refuelling.
clear ice	Whenever precipitation falls on a cold-soaked aeroplane on the ground, clear icing may occur. Even in ambient temperatures between –2°C and +15°C, ice or frost can form in the presence of visible moisture or high humidity if the aeroplane structure remains at 0°C or below. Clear ice is very difficult to detect visually and may break loose during or after take-off.
critical surfaces	The critical surfaces should be determined by the aircraft manufacturer, but may include wings, control surfaces, propellers, horizontal stabilizers, vertical stabilizers or any other stabilizing surface on an aircraft. These surfaces should be completely free of ice, snow, slush or frost before take-off.
de-icing	The process that removes ice, snow, slush or frost from aircraft surfaces.
de-icing/anti-icing	A procedure combining both the de-icing process and the anti-icing process that can be performed in either a one or two step process. **One-step de-icing/anti-icing:** heated anti-icing fluid is used to de-ice the aircraft and remains on the surface to provide anti-icing capability. **Two-step de-icing/anti-icing:** this procedure contains two distinct steps. The first step, de-icing, is followed by the second step, anti-icing, as a separate fluid application.
drizzle	Fairly uniform precipitation composed exclusively of fine drops (diameter less than 0.5 mm [0.02 in]) very close together. Drizzle appears to float while following air currents although, unlike fog droplets, drizzle falls to the ground.
fog and ground fog	A visible aggregate of minute water particles (droplets) in the air reducing the horizontal visibility at the Earth’s surface to less than 1 kilometre.
freezing fog	A fog formed of supercooled water droplets that freeze upon contact with exposed objects and form a coating of rime/clear ice.
freezing rain and freezing drizzle	Rain or drizzle in the form of supercooled water droplets that freeze upon impact with any surface.
frost	A deposit of small, white ice crystals formed on the ground or other surfaces. Frost is formed by sublimation, that is, when water vapour is deposited upon a surface with a temperature equal to or below freezing.
high humidity	An atmospheric condition where the relative humidity is close to saturation.

Term	Definition
hoar frost	A greyish-white crystalline deposit of frozen water vapour formed on surfaces in clear, still weather. Note: For the purposes of this document, CASA's definition differs from the World Meteorological Organization definition of hoar frost.
holdover time	The estimated amount of time that the anti-icing fluid will prevent the formation of ice and frost and the accumulation of snow on the protected (treated) surfaces of an aeroplane.
organisation	A product or service provider, operator, business, and company, as well as aviation industry organisations.
precipitation intensity	An indication of the amount of precipitation collected per unit time interval, expressed as light, moderate or heavy. Intensity is defined according to the type of precipitation occurring, based either on rate of fall for rain and ice pellets or visibility for snow and drizzle. The rate of fall criterion is based on time and does not accurately describe the intensity at a particular time of observation.
rain	Precipitation of liquid water particles, either in the form of drops of more than 0.5 mm in diameter or smaller drops that, in contrast to drizzle, are widely separated.
rime	A deposit of ice, produced by freezing of supercooled fog or cloud droplets on objects at temperatures below or slightly above freezing. It is composed of grains separated by air, sometimes adorned with crystalline branches.
shear force	A force applied laterally on an anti-icing fluid. When applied to a Type II, III or IV fluid, the shear force will reduce the viscosity of the fluid; when the shear force is no longer applied, the anti-icing fluid should recover its viscosity. For instance, shear forces are applied whenever the fluid is pumped, forced through an orifice or when subjected to airflow. If excessive shear force is applied, the thickener system could be permanently degraded, and the fluid viscosity may fall outside the range set by the manufacturer and tested for certification. Fluid degraded in this manner should not be used for operational purposes.
slush	Water-saturated snow that will be displaced with a splatter by a heel-and-toe slap-down motion against the ground.

Reference to regulations

Unless specified otherwise, all subregulations, regulations, Divisions, Subparts and Parts referenced in this Principle are references to the *Civil Aviation Safety Regulations 1998* (CASR).

1. Assessment scope

Regulation 91.705 places an obligation on the pilot in command (PIC) to ensure the aircraft wings, flaps, control surfaces, rotors, propellers, horizontal stabilisers or vertical stabilisers and, in some cases, the top of the aircraft fuselage, are not contaminated by frost, ice or snow prior to take-off. Parts 121, 133, 135 and 138 further prescribe that an operator must have procedures in their exposition/operations manual for:

- the inspection of the aircraft by the PIC before a flight for which frost or freezing conditions exist or are forecast
- carrying out de-icing and anti-icing measures before a flight for which these measures are necessary.

De-icing an aircraft, and the application of anti-icing fluids to an aircraft, are an aircraft servicing activity which must be conducted by trained personnel. Typically, an operator will contract a third-party organisation that specialise in the de-icing and anti-icing fluid application to an aircraft.

The assessment of an operator's ground de-icing/anti-icing program involves assessing the operator's procedures for:

- servicing
- flight operations
- training and assessment of personnel.

Both an airworthiness inspector (AWI) and flying operations inspector (FOI) are required to complete the assessment of the ground de-icing/anti-icing program.

1.1 Approval

Ground de-icing/anti-icing programs do not require approval under the regulations. However, if CASA issues a certificate under regulations 119.075 or 138.045, CASA is taken to have approved the operator's exposition/operations manual.

Additionally, an operator may determine that a variation to their exposition/operations manual to add ground de-icing/anti-icing procedures is a significant change under regulations 119.020 or 138.012 as applicable.

1.2 Assessment worksheet user instructions

This principle provides guidance to the inspector when using the associated Worksheet (OPS.22) Aircraft ground de-icing/anti-icing program. The worksheet provides inspectors with a regulation-based tool for recording the outcomes of the assessment. It is set out as follows:

- user instructions
- assessment worksheets
- assessment summary
- approval data sheet.

2. Assessment

2.1 Ground de-icing/anti-icing program

The exposition/operations manual should include the ground de-icing/anti-icing program. An operator may choose to conduct its own ground de-icing/anti-icing operations or contract them out to a specialist ground de-icing/anti-icing third-party provider. Where contracted to a third-party provider, many elements of the program will be included in the third-party provider's documentation. In this instance, the operator will need to confirm the third-party documentation addresses the requirements of their ground de-icing/anti-icing program and their specific aircraft requirements. It may be necessary for the operator to create a local area manual that links internal processes and procedures with the third-party documentation.

The ground de-icing/anti-icing program may consist of a statement that aircraft will not take-off in ground icing conditions. In this instance, the exposition/operations manual must provide detailed guidance in accordance with sections 2.2 and 2.3 of this principle.

The exposition/operations manual should, for a scheduled air transport operation, provide instructions to flight crew on the ground de-icing/anti-icing procedures required in a specific location. Where the requirement for aircraft ground de-icing/anti-icing is conducted on an ad hoc basis, such as non-scheduled air transport, the operator will normally rely on the expertise of a specialist ground de-icing/anti-icing third-party provider. In this instance, the exposition/operations manual may list approved servicing companies that meet their requirements.

Typically, the ground de-icing/anti-icing program consists of the following elements:

- a management plan
- aircraft-specific procedures
- hold over time (HOT) tables and procedures
- clean aircraft concept (CAC) explanation
- contamination checks
- communications
- training
- description of de-icing/anti-icing
- emergency response plan
- the reporting system.

2.2 Clean aircraft concept (CAC)

The exposition/operations manual must provide instructions to the PIC to confirm that, prior to take-off, the aircraft is free from ice, snow or frost (contaminates) on the external surfaces, including propellors and rotors, except as permitted in the flight manual. To be suitable, the exposition/operations manual should detail a pre-take off contamination inspection to ensure that critical surfaces are free of ice, snow, slush and frost and that the anti-icing fluid has not failed. Instructions should include what actions the PIC must take if the hold over time has expired. On larger aircraft types, the exposition/operations manual may include details of a 'representative area' (typically on the upper wing surface) to assist flight crew with their assessment. To be suitable, the exposition/operations manual will provide guidance on the location of the representative area and limitations that may apply to its use. Instructions should also include when an external inspection is required by qualified ground personnel to confirm the aircraft is free from contaminants.

The exposition/operations manual must state that the PIC has final responsibility for the CAC.

2.3 Weather and icing conditions

The exposition/operations manual should provide guidance to flight crew on atmospheric and ambient conditions, such as frost, snow, freezing fog, freezing drizzle, freezing rain, rain, drizzle, fog or high humidity combined with the cold-soak effect that can cause aircraft icing on the ground.

> Note: High humidity combined with cold-soak effect can occur at temperatures well above freezing point.

To be suitable, the inspector should confirm the guidance includes:

- the effect of mixed or changing atmospheric conditions
- the difficulty of identifying clear ice or failed ant-icing fluids
- operations on ramps, taxiways and runways contaminated by water, slush or snow
- hazards associated with jet blast or strong winds blowing contaminates on to the aircraft
- the effect of warm aircraft surfaces exposed to frozen precipitation during below freezing point temperatures
- when de-icing or anti-icing may be ineffective in providing sufficient protection against freezing rain, freezing drizzle, heavy snow, or any combination where high water content is present in freezing precipitation
- conditions when anti-icing fluids are no longer effective (e.g. below -30°C).

The exposition/operations manual should include information on how the operator uses meteorological information to make decisions on what de-icing/anti-icing methods are used on the aircraft. Use of this information will interact with the HOT which determines how long the fluid will work based on the ambient temperature, precipitation type and precipitation intensity. Weather types can be, but are not limited to, the following:

- ice pellets
- hail
- small hail
- snow
- snow grains
- freezing drizzle
- freezing fog
- freezing rain
- freezing unknown.

The exposition/operations manual may refer to 'Ice Detection and Warning systems' which can be ground based and/or aircraft mounted devices that detect icing conditions.

2.4 De-icing/anti-icing fluids

De-icing and anti-icing are considered to be an aircraft servicing activity.

The exposition/operations manual must provide guidance to personnel on the types of de-icing anti-icing fluids to be used. De-icing/anti-icing fluids are classed as types I, II, III and IV. Type I fluids have a relatively low viscosity which changes mainly as a function of temperature. Types II, III and IV fluids contain a thickener system and therefore have a higher viscosity which changes as a function of shear force, fluid/water ratio and fluid temperature. Type II, III and IV fluids have better anti-icing properties than type I fluids.

The exposition/operations manual must contain a statement to ensure that an aircraft that has previously had an application of anti-icing fluid, that has subsequently become contaminated, does not receive a further

coating of anti-icing fluid directly on top of the contaminated film. When it becomes necessary to apply another coating of anti-icing fluid, the aircraft surfaces must first be treated with de-icing fluid prior to any additional anti-icing fluid being applied.

2.4.1 De-icing/anti-icing fluid residue

The safety risks associated with fluid residue on an aircraft, from a previous anti-icing fluid application, must be addressed (see section 2.4 of this principle). Fluid residue coming into contact with water can rehydrate and swell. If this occurs in a critical area on an aircraft, and subsequently the anti-icing fluid refreezes, it creates a safety risk for the operation of that aircraft.

During a contamination check, another safety risk consideration is whether the runways have been treated by a de-icing compound. Runway de-icing fluid (RDF) must be removed from an aircraft prior to an application of anti-icing fluid. RDF can degrade both the effectiveness of the anti-ice fluid and the airworthiness of an aircraft if not removed.

2.5 Hold over time (HOT)

The exposition/operations manual must provide guidance to flight crew on the process for managing the HOT of an anti-icing fluid type. To be suitable, the exposition/operations manual should include the factors that affect the HOT, such as:

- precipitation type and rate
- ambient humidity
- relative humidity
- wind direction and velocity
- aircraft surface (skin) temperature
- de-icing/anti-icing fluid type, including the water fluid ratio.

The exposition/operations manual must include instruction on when the HOT time commences, typically at the beginning of the final fluid application, and how this is communicated to the PIC. The instructions should also include a process for recording the HOT commencement in the maintenance log or other document.

The exposition/operations manual should include the holdover times in the form of a table or diagram to account for the various types of ground icing conditions that may be encountered, and the different fluid types and concentrations used. A range of holdover times for a particular condition is recommended to account for the variation in the existing local meteorological conditions, particularly the aircraft skin temperature and the rate of precipitation being encountered. Typically, the operator will provide the HOT tables produced by a recognised source, such as Transport Canada, EASA or FAA, which are published annually.

HOT tables should be available to all staff involved with ground de-icing/anti-icing operation. The exposition must detail the process for ensuring up-to-date HOT tables are provided for each winter season.

The exposition/operations manual must provide instructions to the PIC on what action to take if the HOT expires before take-off.

2.6 Communications

The exposition/operations manual must include procedures for communication between ground crew and flight crew during the ground de-icing/anti-icing process. The procedures will depend on whether the operator conducts ground de-icing/anti-icing operations on the ramp prior to engine start or at a remote location. Some ground de-icing/anti-icing operations occur at a remote facility, which are provided by a third-party contractor. It is important that the exposition/operations manual considers each location where ground de-icing/anti-icing operations will occur and the specific local procedures.

To be suitable, communications should include the following:

- fluid type (e.g. Type I, II, III or IV)
- fluid name (manufacturer and brand/industry name)

- concentration of fluid (not required for Type I fluid)
- local time (start of final treatment or start of second step)
- date (DDMMMYY)
- the statement 'Post de-icing/anti-icing check completed'.

Note: This can be done via a technical log entry or, in the case of remote de-icing/anti-icing, relayed to technical crew via interphone.

2.7 Ground de-icing/anti-icing processes

2.7.1 Roles and responsibilities

The exposition/operations manual must clearly define the roles and responsibilities of all personnel involved in the ground de-icing/anti-icing operation. If the operator utilises a third party to conduct ground de-icing/anti-icing operations, then the exposition/operations manual will describe the division of responsibilities. Operators who conduct ground de-icing/anti-icing operations at multiple locations may develop a local manual which outlines the local procedures.

2.7.2 Aircraft ground de-icing/anti-icing alternatives

The exposition/operations manual may contain alternative ground de-icing procedures that do not involve the use of a de-icing fluid, such as:

- forced air
- mechanical techniques (e.g. sweeping the aircraft)
- heated hangars.

The inspector should confirm that the procedures proposed are supported by the original equipment manufacturer (OEM) or listed in the aircraft maintenance manual (AMM).

2.7.3 Ground de-icing/anti-icing facilities

Depending on the ground de-icing/anti-icing operations conducted, the exposition/operations manual may need to describe the facilities used at different locations. Ground de-icing/anti-icing operations may be conducted at either the gate using a tanker, or at a remote location where the aircraft passes through a gantry system.

To be suitable, the inspector will confirm the facilities used for the conduct of de-icing/anti-icing operations. This may be done though a local area manual at each location.

2.7.4 De-icing/anti-icing check procedures

The exposition/operations manual must detail the following checks during a ground de-icing/anti-icing operation:

- Prior to application check – determine extent of aircraft contamination by ice, snow, slush or frost.
- Post application check – must be carried out by a qualified person in accordance with the operator's procedures. The inspection should include any part of the aircraft that has been treated by fluid identified during the contamination check. This step is the responsibility of the PIC.
- Special check – to inspect for clear ice which may have formed due to cold-soaked wings where conditions such as rain and high humidity exist.

2.7.5 De-icing/anti-icing fluid application procedures

The ground de-icing/anti-icing program should provide guidelines on the application of anti-icing fluids.

The application of de-icing/ anti-icing fluids is dispensed from spray nozzles mounted on specifically designed ground de-icing/anti-icing trucks or similar equipment (e.g. a small trailer). Numerous procedures must be followed to ensure the fluid is applied correctly, such as:

- the aircraft manufacturer's recommendations regarding where and where not to spray (e.g. cockpit windows, engine and APU inlets, wheels and brakes, pitot tubes, static ports)
- applying fluid as close as possible to the aircraft's departure time
- observing application and aircraft-related limits (such as fluid mixtures, fluid temperature, pressure at the nozzle, application procedure and spraying techniques)
- applying at a 45-degree angle and avoid direct spraying (the introduction of carbon fibre fuselages has also changed the way fluid is applied)
- applying fluid symmetrically to the aircraft.

2.8 Ground de-icing/anti-icing equipment

De-icing/anti-icing equipment, that has been stored and not used over the warmer months, must be tested and verified as operational. The ground de-icing/anti-icing program should include a schedule and process for carrying out annual maintenance of equipment, to ensure correct calibration, performance and functionality. This maintenance may include, but is not limited to, inspecting and/or testing of:

- fluid mixing systems
- fluid mix accuracy at the nozzle
- components (e.g. pumps, nozzles and pipes)
- heating systems
- refractometer.

To be suitable, the de-icing/anti-icing service provider should keep detailed maintenance records, including calibration records which the operator should confirm prior to the start of the winter season.

2.9 Training and quality assurance

2.9.1 Training and assessment of personnel conducting de-icing/anti-icing operations

All personnel involved in ground de-icing/anti-icing operations must be trained and assessed as competent. The operator's training and competency program should include initial and recurrent training processes for both flight crew and ground crew. An operator that uses a third-party ground de-icing/anti-icing specialist contractor should include a competency verification process for the contractor's personnel. These processes will satisfy the requirement to assess contracting personnel in relation to competency of de-icing/anti-icing operations.

For flight crew, the training syllabus should include both theory and practical training in :

- types of ground icing conditions and precipitation
- weather conditions (effects of frost, ice, snow and slush on aircraft performance)
- the clean aircraft concept
- fluid types and characteristics
- use of HOT tables
- de-icing/anti-icing communications, including records
- aircraft configuration requirements for de-icing/anti-icing operations.

For ground crew, the training syllabus should include both theory and practical training in:

- types of ground icing conditions and precipitation

- weather conditions (effects of frost, ice, snow and slush on aircraft performance)
- the clean aircraft concept
- fluid types and characteristics
- de-icing/anti-icing communications, including records
- aircraft configuration requirements for de-icing/anti-icing operations
- fluid application methods
- pre-operation equipment checks
- post de-icing/anti-icing inspection.

Refer to *SAE AS6286—Aircraft Ground Deicing/Anti-Icing Training and Qualification Program* for further information.

2.9.2 Quality assurance (QA) program

The operator must establish a quality assurance (QA) program that, prior to each winter season, requires an audit of the de-icing/anti-icing program. The audit can be conducted via the maintenance organisation quality assurance system or the operator's safety management system. Some specialist de-icing/anti-icing service providers are members of the International Air Transport Association (IATA) de-icing/anti-icing quality control pool (DAQCP). If an operator, who has contracted a third party provider with IATA DAQCP membership, has access to the IATA audit report and the operator monitors their required corrective actions, the inspector can accept this as the operator meeting their audit requirements.

A suitable scope for an audit of a de-icing/anti-icing program includes review of:

- de-icing/anti-icing policies and procedures
- training, assessment and personnel records
- pre-season equipment maintenance requirements
- equipment defect and rectification maintenance records
- storage, handling and verification of anti-icing fluids
- calibration records.

3. Revision history

Amendments/revisions for this principle are recorded below in order of the most recent first.

Table 3. Revision history table

Version No.	Date	Parts / Sections	Details
1.1	June 2024	All	Reformat to latest template
1.0	November 2022	All	First issue