NoRRA
Nordic Regional Airlines

Winter Operations Manual

Revision 23

Effective date 24.09.2024

Vantaa, 23.09.2024

Janne Rostén

Head of Ground Operations

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RECORD OF REVISIONS

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0	9.5.2014
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2	8.10.2015
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HIGHLIGHTS OF CHANGES

Chapter/Section	Change
0.1.5	“Avidocs” replaced with “Company extranet”, updated address for the extranet
0.3.2	Updated “Organisational Structure”
1.1	“follow” changed to “following”, “ensure” changed to “ensuring”
1.3	Updated process to define safety objective, the name and signature of the Accountable Manager changed from Janne Tarvainen to Juha Ojala
2.3	Deleted “ARP6257 Aircraft Ground De/Anti-Icing Communication Phraseology for Flight and Ground Crews” from the SAE Standards listing
2.8	Updated validity for “FAA Holdover Time Guidelines Winter 2024-2025”
3.1.6.7.2	Deleted WOM reference
3.1.6.7.3	Deleted WOM reference from the subsection title and text
3.1.6.8.2	Deleted “(see application tables)”
3.2.1	All instances of ““Clean Aircraft” concept” changed to small caps throughout the manual, excluding section headings, “and “Annex 14, Vol” deleted
3.2.3.2	Updated “SAE Publications” listing
3.2.3.3	Updated “Other Applicable Documents” listing
3.2.3.5.1	“POSTHOLDER TRAINING” changed to “FLIGHT CREW TRAINING”, “CONTAMINATION CHECK” changed to “PREFLIGHT CONTAMINATION CHECK”
3.2.3.5.2	All abbreviations listed changed into small caps and written in small caps in the subsequent sections
3.2.4.1	“OAT” changed to “outside air temperature (OAT)”, NOTES numbered, with updated contents on NOTE one, “period” changed to “range”, “short” changed to “limited”
3.2.4.2	Updated bullet points after note
3.2.4.3.1	“their” changed to “its”
3.2.5.2.1	Deleted “and ;”
3.2.5.2.2	“his/her” changed to “their”, deleted “and ;”
3.2.5.6	“Contamination Check” changed to “preflight contamination check”
3.2.5.11	“fluid-specific” changed to “fluid brand”, “DI-L10” changed to “DI-L20”, info changed to NOTE
3.2.5.13	“the Postholder Trainer” changed to “The Flight Crew Trainer”
3.2.6.2	“shall” changed to “will”
3.2.7.1	Updated contents, deleted contents about QMS and training success proof, “air carrier” changed to “air operator”, “shall” deleted
3.2.8	Updated Tables 2 and 3
3.2.8.1	“these” changed to “the following”
3.2.8.2	Editorial changes to Tables 4 and 5
3.2.8.4.2	Deleted “(oral and practical)”, updated contents about records
3.2.10.3	“he/she does” changed to “they do”
3.2.10.4	“towards” changed to “toward”

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Chapter/Section	Change
3.2 Appendix 1	p. 1 Updated other key aircraft ground deicing standards listing, “As this” deleted, editorial change p. 2 “upwards” changed to “upward” p. 3 “upwards” changed to “upward”, “downwards” changed to “downward”, “see A3” changed to “see Figure A3” p. 4-5 Editorial change p. 6 “Clean Aircraft Concept” changed to small caps p.7 Editorial change, deleted “is not effective for removing and” p. 8 Editorial change p. 9 Updated document reference p. 10 Updated information on regulators, updated picture in Figure A9, updated “SAE Global Aircraft Ground Deicing Standards”, editorial change, deleted “and one minor”, added “and” p. 11-12 “Holdover Time Guidelines” changed to small caps, “Company” changed to “air operator” p. 13 Added definitions for “DEWPOINT” and “FROST POINT” p. 15 “Well” deleted from “well below”, holdover table numbering changed from “TE 13” to “TE 11”, and form “TE10” to “TE 8”, updated content, “upwards” changed to “upward”, updated temperatures p. 16 Editorial change p. 17 “mixtures” changed to “concentration”, “airline” changed to “air operator” p. 18 “”have no ice ridges” deleted p. 19 Editorial change, “aircraft operators” changed to “air operators” p. 20 Updated information on SAE Types II, III and IV, “outside air temperature” changed to “OAT”, last paragraph of 8.3.3 made into NOTE 1, former NOTE made NOTE 2 p. 21 Updated content in 9.2, editorial change, added new subsection 9.3.1 “Cold Dry Snow or Ice Crystals” p. 22 Added “; the choice of”, added “an additional” p. 23 Updated “Definitions of Freezing Weather Conditions” listing, “outside air temperature” changed to “OAT”, editorial change p. 24 “yellow and IV” changed to “yellow, and Type IV fluids”, updated picture in Figure A3 with the number of fluids changed from three to four, holdover table numbering changed from “TE 13” to “TE 11, editorial changes, “airplane” changed to “aircraft” p. 26 Updated “Step 1”, updated “The Simple Concepts” section, deleted “[at least 60 °C (140 °F)”, “outside air temperature” changed to “OAT (or below)” p. 27 “most paints” changed to “certain paints”, editorial changes p. 28 Heading “TE11: Types of Fluid Tests and Checks Required and the Equipment for Doing This” changed to “TE11: Types of Fluid Checks Required and the Equipment for Doing This”, “tested” deleted also from the text, “conformity” changed to “analysis”, updated fluid certificate letters, updated “General Fluid Handling and Storage Notes”, deleted subsections 11.2.1 and 11.2.3, “cold” changed to “unheated”, editorial changes p. 29 Added “drums” p.30 “two-man” changed to “two-person” p. 31 Deleted contents about minimum temperature for undiluted Types II, III, and IV, “cold” changed to “unheated” p. 32 “to” changed to “and”, “further” changed to “farther”, “would” changed to “will”, “operators and airlines” changed to “ground operators/service providers and air operators”, updated contents in “Equipment Communication Requirements” p. 33 Editorial changes, “one-man” changed to “one-person” p. 34 Subsection heading 12.9 changed from “Typical De/Anti-Icing Vehicle Layout” to “Typical Deicing/ Anti-Icing Vehicle Layout” p. 36 “upwards” changed to “upward”, “downwards” changed to “downward”, “fluid-specific” changed to “fluid brand”, updated information about Type I heating for deicing, editorial changes p. 37 Added “Wing tip devices”, “cockpit” changed to “flight deck” p. 39 “airline operator” changed to “air operator”, added “provided” p. 39 Editorial changes, updated content in 13.2.1 considering holdover times (examples deleted), added information on “Precipitation Intensity”, updated content in 13.2.2 considering Holdover Times, with last paragraphs deleted (Holdover Time information), subsection heading “Type I Fluid Generic HOT Table Example (Table A2)” changed to “Type I Fluid HOT Table Example (Table A2)”, all instances of “generic” deleted, “outside air temperature” changed to “OAT”, updated fluid temperature information p. 40 Subsection heading changed from 13.2.4 “Type II/III/IV Fluid Generic Holdover Time Table Example (Table A3)” to “Type II/III/IV Fluid Generic Holdover Time Table Example (Table A3 and A3.2)” with updated temperatures and times for fluids, all instances of “generic” deleted p. 41 Editorial changes, updated HOT table A3, added another HOT table (A3.2) with note

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Chapter/Section	Change
3.2 Appendix 1	p. 42 Updated Table A4, deleted “with anti-icing fluid”, table title changed from “Frost protection holdover times for thickened fluids” to “Generic frost protection holdover times for all fluid types” p. 44 Added “format”, updated listing of trainee skills, updated listing of phraseology situations, updated information about communication with the flight crew, deleted “(e.g., at night)“ and “The normal anti-icing code shall be provided for preventive anti-icing treatment. “, “final step of the fluid deicing/anti-icing treatment procedure” replaced with “anti-icing treatment”, updated notes in subsection 14.1.4 “The Anti-Icing Code, “neat” changed to “undiluted”, added new subsection 14.1.5 “The Post Deicing Report”, editorial change p. 45 Updated flight crew information, updated SAE documentation reference, updated communication instructions, editorial change p. 45-46 Updated “Radio Telephony Phraseology” instructions, editorial change p. 48 Updated contents for “Check of Critical Surfaces” p. 49 Updated information on checking critical surfaces p. 50 Added information about melting snow and ice, deleted reporting listing and added WOM reference p. 51 Updated temperatures, “safety data sheet (SDS) or product information bulletin (PIB).” changed to “SDS or PIB.”, editorial changes p.52 Updated reference page number, “towards” changed to “toward”, editorial change p. 53 Editorial changes, updated glycol percentages and instruction p. 56 “QMS” changed to “quality management system (QMS)” p. 57 “organizations Quality Management System (QMS)” changed to “organisation’s (QMS)”, editorial changes p. 58 Updated “Local Rules and Procedures Confirming to the SAE Global Deicing Standards” listing
3.2 Appendix 3	p. 1 Training duration table updated (headings) p. 2-3 Updated tables C1
6.2	Updated: FAA Holdover Guidelines table
6.3	Updated: FAA Holdover Guidelines table
6.4	Updated: FAA Holdover Guidelines table
6.5	Updated: FAA Holdover Guidelines table
6.6	Updated: FAA Holdover Guidelines table
6.7	Updated: FAA Holdover Guidelines table
6.8	Updated: FAA Holdover Guidelines table, former subsection and table “Holdover Times for Snow Mixed With Freezing Fog” deleted leading to numbering changes in the subsequent subsections
6.9	Updated: FAA Holdover Guidelines table
6.10	Updated: FAA Holdover Guidelines table
8	“heater” changed to “electrical heater”, deleted information about Norra heater responsibilities

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0 ORGANISATION AND OPERATIONS

0.1 GENERAL

0.1.1 Purpose

The main purpose of this manual is to ensure safe and smooth handling of Nordic Regional Airlines Oy (Norra) aircraft and passengers at all stations operated by Nordic Regional Airlines.

This manual is meant as a a general guideline and source of information for procedures, practices and Company policies for all personnel who are engaged in aircraft and passenger handling duties.

This Winter Operations Manual is the property of Nordic Regional Airlines. It shall not be given or loaned, or its content disclosed, to persons or companies not associated with Nordic Regional Airlines. The Head of Ground Operations of Nordic Regional Airlines, who is in charge of this manual, is the only one who can give permission to exemptions from this rule.

0.1.2 Scope

Winter operations and de-/anti-icing instructions are included in the Winter Operations Manual (WOM).

Winter Operations Manual contains procedures, regulations and information about winter operations for Nordic Regional Airlines aircraft.

The content is based on Nordic Regional Airlines policies, international and national aviation regulations and requirements, such as EASA OPS, together with standards and recommended practices published by IATA and ICAO.

0.1.3 Introduction for Usage

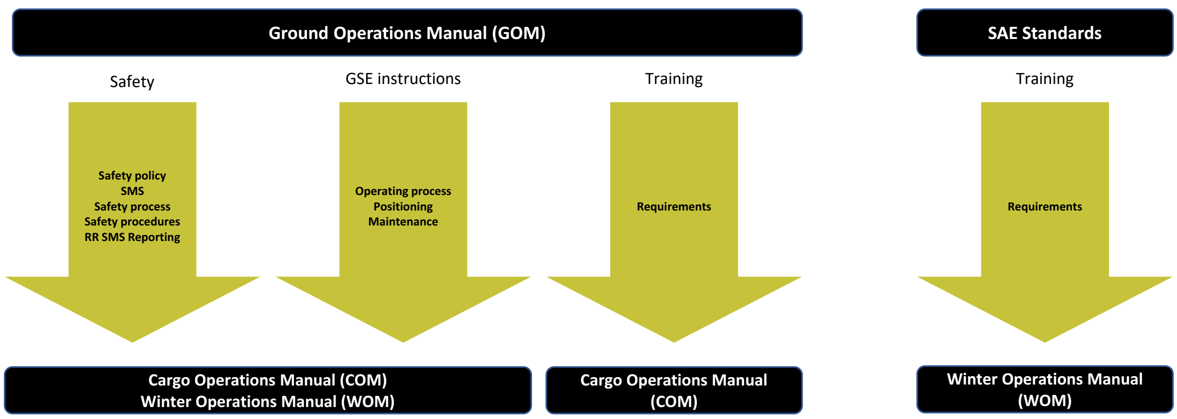
This Winter Operations Manual in English is the only official version. There is a list of effective pages at the beginning of this manual. Everyone using this manual shall make sure that he/she has the latest updated version by contacting Nordic Regional Airlines, Head of Ground Operations, if necessary.

Cargo acceptance and handling instructions are included in the Cargo Operations Manual (COM). The Cargo Operations Manual contains acceptance and handling procedures, regulations and information about aircraft cargo handling for Nordic Regional Airlines aircraft.

The safety policy, safety process and procedures are included in the Winter Operations Manual, and these also apply to all Norra operations and manuals (GOM, COM, WOM).

Ground Support Equipment (GSE) instructions are included in the Ground Operation Manual (GOM). These instructions also apply to Norra's cargo and winter operations (COM, WOM).

Training requirements are included in the Ground Operations Manual. These requirements also apply to Norra's cargo operations. The training requirements for Norra de/anti-icing operations are described in WOM.



0.1.4 Notation in This Manual

A vertical line adjacent to the paragraph in question is used to indicate the latest changed, new or deleted information.

The header on each page indicates the section, page number and date as well as the revision number of the page.

0.1.5 Maintaining and Revision

The exact description of the distribution methods and channels for Company manuals is published in the Nordic Regional Airlines Document Management Manual.

The Company extranet is used for distributing the latest revision of the Winter Operations Manual, Ground Operation Bulletins (GOB) and Safety Alert Bulletins (SAB) for subcontractors and other relevant parties. The Head of Ground Operations is responsible for sending revision notifications to all relevant persons according to the valid distribution list. The Head of Ground Operations is responsible for maintaining the manual distribution list to ensure its correctness.

Passenger handling duties and service products are described in the Finnair Ground Operations Manual (AY GOM).

The main purpose of the Finnair Ground Operations Manual (AY GOM) is to ensure the safe and smooth handling of Finnair passengers at all stations operated by Finnair or Norra.

This manual defines the guidelines, procedures, practices and company policies for all personnel engaged in aircraft and customer handling duties. The contents is based on Finnair policies, international and national aviation regulations and requirements such as EASA-OPS together with standards and recommended practices published by IATA and ICAO. Any processes and procedures described in this manual are as minimum equivalent to the processes and procedures contained in the IATA Ground Operations Manual (IGOM).

The official version of the AY GOM is published in English language and only in electronic format. The official version of the manual can be found in Finnair Partner HUB portal.

All Finnair staff and related partners shall acquaint themselves with the Finnair Partner HUB which acts as the main source for all required documentation and information for external partners. Partner HUB presents all relevant manuals, documents and bulletins related to ground operations. Moreover, all relevant station contacts and other organizational information can be retrieved through the Partner HUB.

Finnair Partner HUB can be accessed by using the following URL link: partnerhub.finnair.com

Finnair shall ensure that the Finnair Ground Operations Manual (AY GOM) is available to all personnel engaged in passenger handling duties.

An example of a revision notification:

Dear Madame/Sir,

For your information, Nordic Regional Airlines (Norra) has published a new revision of the Ground Operations Manual (revision xx).

You can find the manual at:

https://kompassi.flynorra.com/

Login name: ground
Password: operations

In case you have any problems opening the PDF file, please make sure that you have the latest version of Adobe Reader.

It is the Holder's responsibility to bring to the attention of his/her personnel concerned the necessary information found in the revisions. Any discrepancies and errors found in this manual should be brought to the attention of the Head of Ground Operations by sending email to **janne.rosten@flynorra.com**.

The Head of Ground Operations will ensure that the documentation used directly in the conduct or support of the ground handling operations is:

- Locked to avoid tampering.
- Identifiable as to the version number and document creator.

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- In a clear, legible, usable format.
- Accurately represented.
- In compliance with current applicable regulations, laws, rules or standards.
- Acceptable by any interested departments, authority or body.
- Annually reviewed and checked for validity.

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0.2 GENERAL AIRLINE INFORMATION

0.2.1 General

Nordic Regional Airlines has its home base in Vantaa, is engaged in commercial aviation business, and is authorised to carry passengers, mail and/or cargo for remuneration and/or hire in non-scheduled as well as scheduled air transport. The geographical area of operations is within the area that in ICAO Document no 7754 is referred to as the "European (EUR) Region" and nations bordering the Mediterranean and the Canaries. Nordic Regional Airlines Oy do not operate ULD aircraft.

The airplanes used for operations are:

- E-Jet 190 with a maximum certified take-off mass of 47 790 kg.
- ATR 72-500 with a maximum certified take-off mass of 23 000 kg.

E-Jet 190 and ATR 72 airplanes operated by Nordic Regional Airlines operate in performance class A. Flights are conducted in accordance with the Instrument Flight Rules (IFR).

0.3 ORGANISATION

0.3.1 Responsibilities, Authorisation and Duties of Post Holders

0.3.1.1 Head of Ground Operations

The Head of Ground Operations is accountable to the Accountable Manager for ensuring the safety and security of ground handling operations.

The responsibilities of the Head of Ground Operations are:

- Ensuring that the instructions in the Ground Operation Manual (GOM) are in accordance with EASA-OPS.
- Ensuring that the Cargo Operations Manual (COM) and Winter Operations Manual (WOM) are up to date.
- Ensuring that the Company has a valid Ground Handling Agreement (GHA) in all regularly (route) operated airports.
- Continuous evaluation and quality control of ground operations.
- Ensuring that audit findings including the follow-up actions, if any, are closed and performed on time.
- Ensuring that Ground Handling Agreements include all services and facilities required for safe operation.
- Ensuring that all companies that have a GHA with Nordic Regional Airlines have access to up-to-date Nordic Regional Airlines Manuals and bulletins.
- Ensuring that all dangerous goods allowed to be carried on board, other than those carried on a person according to OM-A 9, fulfils all EASA-OPS requirements.
- Ensuring Commanders of the Company's airplanes are aware of suitability of ground operations facilities on the aerodrome.
- Acting as deputy for the Operations Manager during his/her absence.

The Head of Ground Operations is authorised to:

- Identify and manage safety risks in field of ground operations through operator Safety Management System / with authority to make decisions that affect safety of ground operations.
- Purchase all equipment and services required for safe ground operations after consulting with the Accountable Manager.

The Head of Ground Operations shall oversee that all GHA partners:

- Have adequate management, number of staff, facilities and equipment for the intended operation.
- Control the condition of their equipment in an adequate and regular manner.

- Give their employees all initial and recurrent training required by Norra/EASA-OPS/GHA companies themselves.
- Meet the requirements of Norra/EASA-OPS/GHA companies themselves.

Qualification requirements for the Head of Ground Operations are:

- Acceptable to the Authority.
- Completion of a Nominated Person Ground Operations training course.
- Successful completion of a Nominated Person Ground Operations Examination.
- Initial SMS training.
- Successful completion of IATA SGHA-SLA training course.
- Successful completion of IATA Ground Operation Diploma.
- Successful completion of IATA Quality Management (QMS) training course.
- Successful completion of IATA Human Factors in Ground Operations training course.
- Comprehensive knowledge of IATA Operational Safety Audit (IOSA) program.
- Comprehensive knowledge of EASA-OPS and any associated requirements and procedures.
- A minimum of 10 years of experience in ground operations management.

0.3.1.2 Operations Manager

The Operations Manager is the person responsible for Norra Ground Handling operations at Helsinki-Vantaa airport. The Operations Manager reports to the Head of Ground Operations.

The principal responsibility of the Operations Manager is to oversee that the Norra Ground Operations Department Ground Handling operations at Helsinki-Vantaa airport are routinely conducted with high professionalism at a level acceptable to the Competent Authority and the Company.

To achieve this he or she shall pay close attention to operative procedures.

The Operations Manager also acts as the Company Head of Deicing Training, DI-L70 and Winter Programme Manager.

The responsibilities and authorities of the Operations Manager are:

- Acting as deputy for the Head of Ground Operations in his absence.
- Keeping up with the global development of operative and deicing procedures and developing the procedures and contents of the Winter Operation Manual (WOM) and Ground Control Manual (GCM).
- The Head of Ground Operations acts deputy for the Operations Manager in his/her absence.

Qualification requirements for the Operations Manager are:

- Practical experience of ground operations.
- Appropriate management experience.
- Ability to act as supervisor.

0.3.1.3 Delegation of duties

Ground Handling company shall have a process for the delegation of duties within the management system for ground handling operations that ensures managerial continuity is maintained when operational managers are absent from the workplace.

Each Norra manager or “head of” who is responsible for operational control and/or has responsibility within the management system for liaison with regulatory authorities, original equipment manufacturers and other operationally relevant external entities must be appointed a deputy, who will ensure managerial continuity, when the responsible managers are absent.

The Operations Manager acts as deputy for the Head of Ground Operations in his absence. The Head of Ground Operations announces his absences by using the “out of office” tool, which sends an automatic reply to all incoming emails.

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An example of an automatic email reply:

Dear Sender,

Thank You for your email. I'm currently out of the office and will be back in the office on xx.xx.xxxx. I have limited access to my email during my absence. Please note that emails are NOT forwarded.

Due to my absence, please accept my apologies for a late reply.

The Operations Manager, Mr. Jussi Olkinuora, acts as my deputy, and here is his contact information:

jussi.olkinuora@flynorra.com / +358 50 591 3541

In urgent operative issues please contact NORRA OPS Control at:

NORRA OPS +358 10 249 4001 / ops@flynorra.com

(In very urgent matters please call my mobile phone +358 50 4425 111)

0.3.1.4 Responsibilities of Security Manager

The Security Manager is responsible for ensuring that:

- Security instructions in the Winter Operation Manual are in accordance with EU commission regulations, NCASP, EASA AMC and IOSA requirements.

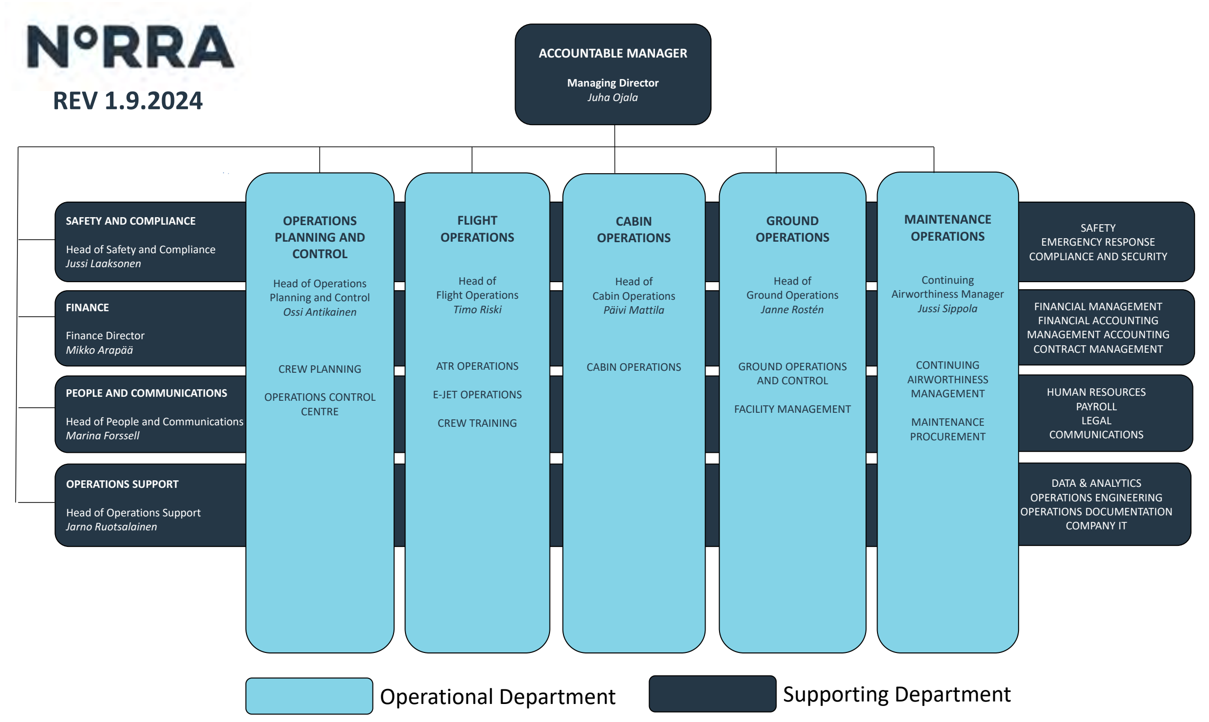
0.3.1.5 Emergency Response Manager

The Emergency Response Manager is responsible for ensuring that required Company Emergency Response information is available in the WOM.

0.3.1.6 Responsibilities of Safety Office Manager

The Safety Office Manager is responsible for ensuring that the instructions in the Winter Operations Manual for reporting accidents, incidents and occurrences are in accordance with EASA-OPS.

0.3.2 Organisational Structure



0.3.3 Scope of Ground Operations

Ground operations cover the following functions:

- Definition of requirements for ground handling services.
- Procedures, instructions and documentation for ground services.
- Procurement of the following services:
  - Passenger and baggage handling.
  - Cargo/Mail loading and unloading, transportation of passengers and baggage on the apron and allocation and operation of required Ground Support Equipment.
  - Aircraft mass & balance calculation and documentation and other airplane handling services, e.g. cabin cleaning, toilet and water service, aircraft heating and cooling, ground power.
  - Cargo and mail acceptance and handling.
  - Catering loading.
  - De/Anti-icing.
- Continuous evaluation and safety/quality control of ground operations.
- Inspection and reporting of ground operations.

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0.3.4 Management Process of Ground Operations

0.3.4.1 Agreement

In all cases where ground handling is outsourced or a service is provided a contract or an agreement must be in place, clearly defining the safety and/or security related services and standards expected.

A relevant part of an agreement or Standard Level Agreement (SLA) must include measurable specifications of what is expected from the service provider, as these must be monitored and recorded as being delivered in a meeting with service provider.

Ground handling for Nordic Regional Airlines flights is arranged through procuring the services from local ground handling service providers. The procured services shall be established and arranged in such a manner that all required safety and security aspects are observed. The services shall be economical and are to be performed in line with Nordic Regional Airlines standards as well as the rules and regulations of all the relevant authorities.

The relation between Nordic Regional Airlines and the service providers is established in writing in the form of a ground handling agreement which shall be accepted and signed by both parties. This agreement specifies the legal and administrative elements of the relation as well as the many practical details, e.g. list of the handling services included in the agreement, the locations and the charges for the services to be provided. Ground handling for Nordic Regional Airlines flights is usually based on the IATA Standard Ground Handling Agreement format.

0.3.4.2 Service Delivery Standards

Service Delivery Standards (GOM section 3) provide the basis for the qualitative, safety, security and training requirements and standards, which are to be followed by the service provider and are the subject of monitoring and reviewing on a regular basis by the Head of Ground Operations.

In addition to being familiar with the instructions of the Nordic Regional Airlines Manuals, every employee of the handling company must be well acquainted with these standards when performing duties for Nordic Regional Airlines operation.

The standards and targets provide the minimum requirements and standards for the delivery of services to Nordic Regional Airlines.

0.3.4.3 Communication

he operations at each destination airport are under the responsibility of the Head of Ground Operations. The Head of Ground Operations shall see to it that all ground operations functions are performed in accordance with the ground handling agreement signed between the parties as well as with all Company and authority safety rules and regulations. He or she shall conduct meetings with the service providers at their airports, if necessary, as well as with the airport authorities and/or other authorities. The main communication channels are email and meetings.

The meeting minutes with the handling companies and other parties concerning Norra operations are to be documented and archived. Bulletins are used for exchanging additional information.

The main channel for feedback from the ground handling company to the operator is Norra’s reporting tool (Rolls-Royce SMS).

The Ground Handling company shall have a communication system that enables an effective exchange of information relevant to the conduct of ground handling operations throughout the management system for ground handling operations and in areas where ground handling operations are conducted.

0.3.4.4 Safety and Security Aspects

0.3.4.4.1 General

Safety and security are integral parts of the responsibilities of all employees of the service providers performing handling services for Nordic Regional Airlines. The key principles in the Nordic Regional Airlines safety policy are Just Culture and non-punitive reporting of safety related events and observations, as laid down in the Aviation Regulations and Company instructions. SMS related requirements obligatory to the handling companies include Finnish Aviation Act 864/2014 and EU Regulation 376/2014. Security related requirements are written in the Security Manual for Handling Agents. All events, observations and incidents with a potential effect on flight safety and any errors or omissions found in the material or information provided by Nordic Regional Airlines that become known to

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the handling company shall be immediately reported to Nordic Regional Airlines. Reports are to be made using the Company Rolls-Royce SMS portal. More detailed information on the reporting procedure can be found in GOM section 3.

The Nordic Regional Airlines Safety and Compliance Department maintains SMS and analysis of Safety Occurrence Reports, stored in the Rolls-Royce SMS.

0.3.4.4.2 Safety Review Board (SRB)

Safety Review Board will consider strategic safety functions.

The board is chaired by Accountable Manager and is composed of heads of departments and key person of ATO and Part-M organizations. Head of Safety and Compliance shall facilitate board meeting. SRB shall have a meeting quarterly or, if considered necessary by the chair or the board, more often. Safety Office Manager shall act as secretary in this meeting and maintain yearly scheduling of SRB.

The SRB should monitor:

- Safety performance against the safety policy and objectives
- The effectiveness of the SMS implementation plan/function
- The effectiveness of the safety supervision of contracted operations
- The SRB shall ensure that appropriate resources are allocated to achieve the established safety performance
- The SRB shall give strategic direction to the safety action group

Head of Safety & Compliance shall present a safety review during this meeting. Safety review includes the risk status of the operation and presenting of flight and alertness data and reporting statistics.

0.3.4.4.3 Safety Action Group (SAG)

There are five SAGs:

- Flight Operations SAG (FOSAG),
- Continuing Airworthiness SAG (CASAG),
- Cabin Operations SAG (CSAG),
- Ground Operations SAG (GSAG), and
- Fatigue SAG (FSAG).

SAG meetings are held monthly and at least 10 times per year.

The purpose of the Safety Action Groups is to share safety related information and safety concerns with the top management and shareholders. SAGs will take strategic direction from the SRB. Minutes of the meetings shall be recorded in the dedicated Norra SharePoint folder administered by the Safety & Compliance Department for monitoring. The SAG chairperson will summarise the minutes to be reviewed in the SRB meetings quarterly.

The Safety Office produces a monthly safety follow-up to be reviewed in SAG meetings. The follow-up includes e.g. occurrence statistics, the operational risk profile, FDM status and analysis (not relevant for each SAG), assessment and investigation follow-up, analysis of predicted crew member alertness and planned versus actual time worked (not relevant to each SAG) and Safety Performance Indicators relevant for each group.

The SAG shall:

- Oversee operational safety.
- Resolve identified hazards.
- Assess the impact on safety of operational changes.
- Implement corrective action plans and oversee effectiveness of corrective actions in order to maintain the acceptable level of safety.
- Monitor actions taken as a result of a Rolls-Royce SMS assessment (safety related assessments assigned to responsible managers).

The first SAG meeting of each year shall be an extended meeting in which, the hazard register (available on company's network drive) shall be reviewed. Before that mentioned meeting, SAG's chairman shall re-asses the hazards relating to the scope of each SAG. New hazards and updated ones shall be reviewed in the mentioned SAG meeting and required safety assessments shall be carried out by the next SAG meeting.

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0.4 AIR TRANSPORT CONDITIONS AND AGREEMENTS

0.4.1 International Air Transport Association (IATA)

The International Air Transport Association (IATA) is a world organisation of scheduled airlines. IATA is in a way the world parliament of airlines and their representatives in international organisations. IATA was founded in 1945, and its headquarters are in Geneva and Montreal.

The major purpose of the IATA activities and aims is to ensure that all airline traffic anywhere in the world operates with the greatest possible rapidity, safety, convenience, efficiency and the utmost economy. IATA is particularly concerned with facilitating interline arrangements and standardisation of forms, procedures, handling agreements, etc.

Information on the International Air Transport Association (IATA) is included in most initial staff training programs and is contained in various publications and manuals available at airports.

0.4.2 International Civil Aviation Organisation (ICAO)

The International Civil Aviation Organisation (ICAO) was founded in 1944 as an intergovernmental organisation to serve as a medium through international understandings and agreements so that problems related to civil aviation could be solved. In 1947 ICAO became an agency with a close relationship with the United Nations (UN). ICAO's headquarters is in Montreal with regional offices in Bangkok, Cairo, Lima, Mexico City, and Paris.

The major aims and purposes of ICAO are to develop the principles and techniques of international air navigation and also to prevent unreasonable competition and discrimination between contracting states.

One of ICAO's major objectives is to establish international standards, recommended practices and procedures covering the technical fields of aviation, such as licensing the personnel, rules of the air, aeronautical meteorology, airworthiness, air traffic services, aircraft accident inquiry, aircraft noise regulations, etc.

There is close cooperation between ICAO and IATA.

0.4.3 European Aviation Safety Agency (EASA)

EASA is an Agency of the European Union. As a Community Agency, EASA is a body governed by European public law; it is distinct from the Community Institutions (Council, Parliament, Commission, etc.) and has its own legal personality. EASA was set up by a Council and Parliament regulation (Regulation (EC) 1592/2002 repealed by Regulation (EC) No 216/ 2008) and was given specific regulatory and executive tasks in the field of civil aviation safety and environmental protection. The European Aviation Safety Agency is the centrepiece of the European Union's strategy for aviation safety. Its mission is to promote the highest common standards of safety and environmental protection in civil aviation. The Agency develops common safety and environmental rules at the European level. It monitors the implementation of standards through inspections in the Member States and provides the necessary technical expertise, training and research. The Agency works hand in hand with the national authorities which continue to carry out many operational tasks, such as certification of individual aircraft or licensing of pilots.

The main tasks of the Agency currently include:

- Rulemaking: drafting aviation safety legislation and providing technical advice to the European Commission and to the Member States
- Inspections, training and standardisation programmes to ensure uniform implementation of European aviation safety legislation in all Member States
- Safety and environmental type certification of aircraft, engines and parts
- Approval of aircraft design organisations worldwide as and of production and maintenance organisations outside the EU
- Authorisation of third-country (non EU) operators
- Coordination of the European Community programme SAFA (Safety Assessment of Foreign Aircraft) regarding the safety of foreign aircraft using Community airports
- Data collection, analysis and research to improve aviation safety. In a few years, the Agency will also be responsible for safety regulations regarding airports and air traffic management systems.

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0.4.4 Commercial Traffic Agreements

All Norra operated flights are Finnair purchase traffic flights and are operated under AY flight numbers.

0.4.5 Traffic Restrictions

In order to protect the interests of national carriers the governments of certain countries may sometimes impose various restrictions on foreign carriers operating to/from or via their country. Such restrictions may affect the possibilities to carry passengers, cargo and/or mail in different ways.

0.5 ADMINISTRATIVE MATTERS

0.5.1 Responsibility

Matters of an administrative nature are in principle handled centrally at stations either by:

1) The Station Manager or equivalent
2) A staff member designated by him/her, or
3) A special function.

0.5.2 Company Materials

It is essential that when procuring materials, equipment or other products which the Company relies upon or needs as part of its daily business, such items meet, where appropriate, conform to any required standard or specification. In the area of ground operations any such items may need to conform to regulatory standards and as such must meet any technical standards.

Orders to be made:

Passenger service:	Finnair, according to Finnair instructions
Ramp service:	Norra, janne.rosten@flynorra.com
ATR LIR forms:	os.doc@flynorra.com

0.5.3 Reports

The following reports and report tasks are the responsibility of the person handling administrative matters:

- Reports to local management and Head Office functions.
- Replies to reports.

0.5.4 Deicing/Anti-icing Program

0.5.4.1 General

Operating procedures and trainings must always comply with the latest SAE Standards and NORRA own special requirements that are specified in this manual.

No Commander shall commence take-off unless the external surfaces are clear of any deposit which might adversely affect the performance and/or controllability of the airplane except as permitted in respective OM-B.

Everybody concerned should have a clear realization of the POTENTIALLY CATASTROPHIC EFFECT even the thinnest layer of snow, frost and ice can have on the performance of an aircraft when it is in a critical situation, e g during take-off. Numerous take-off accidents serve as a warning not to neglect this fact.

The procedures stated herein establish the minimum requirements for the anti- and deicing of airplanes on the ground to provide an aerodynamically clean airplane for take-off.

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1 NORDIC REGIONAL AIRLINES COMPANY SAFETY CULTURE COMMITMENT

1.1 OUR COMMITMENT

Our commitment and the purpose of the Company is to:

- Produce reliable and safe air travel to our customers at a competitive price, and
- Ensure the highest level of service and satisfaction to our customers to meet or exceed their expectation.

These goals shall be achieved by an excellent working efficiency throughout the Company. We shall develop and adhere to safe operational practices, by continuously operating at the highest level of safety that meets or exceeds the standards and requirements of the Authorities or the requirements agreed with our customers.

The Company is committed to complying with the requirements of the European Aviation Safety Agency (EASA), International Air Transport Association (IATA) operational safety audit (IOSA) requirements and the relevant EC Regulations and Finnish Laws.

The Company is also committed to following good corporate governance and to ensuring sustainable environmental practices, which especially focus on fuel efficiency, aircraft noise, efficient flight planning and execution and energy conservation. The environmental practices shall comply with applicable regulations and legislation.

1.2 OUR POLICIES

1) To develop and embed a safety culture in all our aviation activities that recognises the importance and the value of an effective management system and acknowledges, at all times, that safety is paramount.

2) To control the safety risks associated with aircraft operations to a point that is as low as reasonably practicable.

3) To clearly define to all personnel and to subcontractors their accountabilities and responsibilities for them to perform and develop all aviation safety related duties in line with the Company policies and processes.

4) To ensure that all personnel are provided with adequate and appropriate aviation safety information and training, as well as to ensure that they are competent in safety matters. Personnel should only be given safety related tasks in which they are competent.

5) To require that personnel who perform operationally critical functions are physically and medically fit for duty.

6) To ensure that sufficient skilled and trained resources and the existence of the necessary facilities, workspace, supporting services, as well as suitable work environment are available to implement the safety management systems.

7) To ensure that third party supplied systems and services, which impact the safety of our operations, meet all appropriate requirements and standards.

8) To constantly review, and whenever possible, improve our management system, operating procedures, policies, and the level of safety, quality and cost effectiveness of the services and operations.

9) To establish realistic objectives and/or targets for our safety performance and measure our performance against these.

10) To conduct surveys as well as safety management reviews to ensure that relevant and effective actions are taken.

11) To ensure that the application of our safety management systems is integral to all our aviation activities, with the objective of achieving the highest levels of safety standards and performance.

12) To promote safety awareness.

13) To offer a communication processes that ensures a free flow of information throughout the organisation.

14) The common languages of the Company are English and Finnish.

15) All Company operational personnel shall comply with the applicable laws, regulations and procedures in all locations where operations are conducted.

16) To create an environment that promotes open and honest reporting of hazards and incidents, and

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17) To ensure that no action will be taken against any employee who discloses a safety concern through the hazard reporting system, unless such disclosure indicates, beyond any reasonable doubt, gross negligence or a deliberate or wilful disregard of regulations or procedures. If there is need to launch a disciplinary action against someone due to inappropriate behaviour, Company event review group (ERG) will investigate said action and it will produce a written document which states opinion of ERG. This opinion shall be taken into consideration when responsible nominated person defines level of action.

18) The Company is committed to promoting the development of cyber security processes and practices throughout the Company and reserving sufficient resources for them.

1.3 COMPANY SAFETY OBJECTIVES

1) To maintain an acceptable level of safety (SMM 3.2 SPI 1).

2) An adequate level of senior management man-hours is utilised to Safety Management (SMM 3.2 SPIs 4, 5, 6, and 7).

3) Staff consciousness concerning Safety Management is monitored (Safety Survey).

4) Staff reporting level is maintained at a high level, thus indicating a healthy safety culture (SMM 3.2 SPIs 2 and 3).

5) Flight data monitoring covers an adequate number of flights (SMM 3.2 SPI 9).

The process to define safety objective

Annually in the first SRB meetings company safety objectives are reviewed and updated. The achievement of safety objectives shall be monitored and verified by Safety Review Board meetings, indicators listed in SMM 3.2 shall be utilised. Current company safety objectives are presented in SMM and communicated through the organisation in annual SMS recurrent training.

The procedures described in our manuals are mandatory and must be adhered to by all Company employees. Any deviation from the policies or procedures must be agreed upon by the Accountable Manager or by the Nominated Person, as appropriate.

These procedures do not override the necessity of complying with any new or amended regulations adopted by the Competent Authority, where such regulations conflict with these procedures. Every employee is responsible for making a report, if he/she observes a hazard in the operating environment or finds out that the requirements or Company procedures are not complied with or if customer service quality is compromised.

By the Management System, we ensure that the Company operations comply with the commitment and policies as described herein.

Juha Ojala,
Accountable Manager

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2 REFERENCES

2.1 GENERAL

Wherever in this Winter Operations Manual these references are indicated, this always refers to the latest version of the applicable references.

2.2 EASA- AIR OPERATIONS / AMC GM1- GM3 CAT.OP.MPA.250 - ICE AND OTHER CONTAMINANTS - GROUND PROCEDURES

2.3 SAE STANDARDS, LATEST EDITION OF

http://www.sae.org

AIR6284, Forced Air or Forced Air/Fluid Equipment for Removal of Frozen Contaminants

AMS1424, /1, /2 Deicing/Anti-Icing Fluid, Aircraft, SAE Type 1

AMS1428, /1, /2 Fluid, Aircraft Deicing/Anti-Icing, Non-Newtonian (Pseudoplastic), SAE Types II, III, and IV

AS6285 Aircraft Ground Deicing/Anti-Icing Processes

AS6286 Aircraft Ground Deicing/Anti-Icing Training and Qualification Program

AS6332 Aircraft Ground Deicing/Anti-icing Quality Management

2.4 ISO PUBLICATIONS:

ISO 9000 Quality Management Systems -- Fundamentals and Vocabulary

ISO 9001 Quality Management Systems - Requirements

2.5 IOSA STANDARDS MANUAL

http://www.iata.org/whatwedo/safety/audit/iosa/Pages/index.aspx

2.6 IATA AHM

http://www.iata.org/publications/Pages/ahm.aspx

2.7 COMPANY MANUALS

- SMS MANUAL
- OM-A
- OM-B ATR
- OM-B E-JET
- SEM

2.8 FAA HOLDOVER TIME GUIDELINES WINTER 2024-2025

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3 AIRCRAFT DEICING/ANTI-ICING PROGRAMME

3.1 AIRCRAFT GROUND DEICING/ANTI-ICING PROCESSES

3.1.1 Rationale

The purpose of this document is to provide industry standards for the methods and procedures used in performing the treatments necessary for the proper deicing and anti-icing of aircraft on the ground using AMS1424 and AMS1428 qualified fluids (Type I, II, III, and IV) and non-fluid methods.

Exposure to weather conditions on the ground that are conducive to ice formation can cause the accumulation of frost, snow, slush, or ice on aircraft surfaces and components. These contaminants can adversely affect aircraft performance, stability, control, and operation of mechanical devices such as control surfaces, sensors, flaps, and landing gear. If frozen deposits are present, other than those considered in the aircraft certification process, the performance of the aircraft may be compromised.

Regulations governing aircraft operations in icing conditions shall be followed. Specific rules for aircraft are set forth in the United States Code of Federal Aviation Regulations (FAR), EASA OPS, Canadian Aviation Regulations (CAR), and others. Paraphrased, these rules specify that no one may dispatch or takeoff an aircraft with frozen deposits on components of the aircraft that are critical to safe flight. A critical surface or component is one which could adversely affect the mechanical or aerodynamic function of an aircraft. In the event of differences or discrepancies in the requirements set out in this standard and any requirements set out in the domestic regulations applicable to the end user, the domestic regulation requirements shall supersede those set out in this standard.

As individual icing situations or aircraft types and models may require special procedures, this document can never replace the aircraft operator's judgment. The responsibility for the correct deicing and anti-icing procedures for aircraft always rests with the operator of the aircraft.

The ultimate responsibility for the determination that the aircraft is clean and meets airworthiness requirements rests with the Pilot In Command in command of the aircraft.

This revision includes:

- Reorganised sections and edited titles.
- Added definitions.
- Reorganised aircraft components.
- Added information on daily concentration tests.
- Added information on glycol delivery methods.
- Amended of post-deicing check after infrared deicing.
- Edited caution statement about surface coatings and their effects on de/anti-icing fluids.
- Reviewed and updated communication section.
- Introduced recommended phraseology and references from ARP6257A.

3.1.2 Scope

3.1.2.1 Field of Application

The SAE Aerospace Standard (AS) establishes the minimum requirements for ground-based aircraft deicing/anti-icing methods and procedures to ensure the safe operation of aircraft during icing conditions on the ground.

The application of the procedures specified in this document are intended to effectively remove and/or prevent the accumulation of frost, snow, slush, or ice contamination which can seriously affect the aerodynamic performance and/or the controllability of an aircraft. The principal method of treatment employed is the use of fluids qualified to AMS1424 (Type I fluid) and AMS1428 (Type II, III, and IV fluids).

All guidelines referred to herein are applicable only in conjunction with the applicable documents. Due to aerodynamic and other concerns, the application of deicing/anti-icing fluids shall be carried out in compliance with engine and aircraft manufacturer's recommendations.

3.1.2.2 Agreements and Contracts

This information is mandatory as a basis for operations and service support agreements.

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3.1.2.3 Hazardous Materials

While the materials, methods, applications, and processes referenced to, or described in, this specification may involve the use of hazardous materials, this standard does not address the hazards which may be involved in their use. It is the sole responsibility of the user to ensure their familiarity with the safe and proper use of any hazardous materials and processes and to take necessary precautionary measures to ensure the health and safety of all personnel involved.

3.1.3 Abbreviations and Definitions

3.1.3.1 Abbreviations

ACARS	aircraft communications addressing and reporting system
APU	auxiliary power unit
CDF	central deicing facility
DDF	designated deicing facility
DIS	deicing/anti-icing supervisor
°C	degrees Celsius
CoA	certificate of analysis
CoC	certificate of conformance
°F	degrees Fahrenheit
EASA	European Aviation Safety Agency
EFB	electronic flight bag
FAA	Federal Aviation Administration
°F	degrees Fahrenheit
FOD	foreign object debris or foreign object damage
FP	Freezing Point
h	hours
HOWV	highest on-wing viscosity
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
LOUT	lowest operational use temperature
LOWV	lowest on-wing viscosity
MB	message board
OAT	outside air temperature
QA	quality assurance
QC	quality control
SDS	safety data sheet
TC	Transport Canada

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3.1.3.2 Definitions

For the purposes of this document, the following definitions apply.

3.1.3.3 Advisory Word Definitions

The following advisory words are to be used as defined.

MAY: This means the practice is encouraged and/or optional.

SHALL: This means the practice is mandatory. A synonym for must.

SHOULD: This means that the practice is recommended or strongly encouraged.

MUST: This means the practice is mandatory. A synonym for shall.

3.1.3.4 Definitions

The following words and phrases are to be used as defined:

ACTIVE FROST: Active frost is a condition when frost is forming. Active frost occurs when (1) the aircraft surface temperature is at or below the frost point, or (2) there is water in liquid form (e.g., dew) on the aircraft surface and the surface falls to/or below 0°C (frozen dew).

ANTI-ICING: Procedure by which fluid is applied to provide protection against the formation of frost or ice or the accumulation of snow or slush on treated surfaces of an aircraft for a limited period of time (holdover time).

ANTI-ICING FLUID:

1) Mixture of water and Type I fluid.
2) Premix Type I fluid.
3) Type II, III, or IV fluids.
4) Mixture of water and Type II, III, or IV fluids.

NOTE: For deicing/anti-icing purposes in a one-step procedure, fluids in 1, 2, and 4 shall be heated to ensure a temperature of 60°C (140°F) minimum at the nozzle.

ANTI-ICING CODE: Report is given to the flight crew that deicing/anti-icing has been carried out and the details of the anti-icing treatment that was applied.

BRIX (DEGREES BRIX or °BRIX”): Unit of measurement of refraction. See also refraction and refractometer.

CERTIFICATE OF ANALYSIS: A document, issued by a manufacturer, attesting that a lot or batch of a product fulfills the manufacturer's sales specification requirements, listing the tests, the test requirements, the test results on that lot or batch, the lot or batch number and a date.

CERTIFICATE OF CONFORMANCE: A document declaring that a product fulfills the requirements of a standard. Also known as certificate of conformity.

CHECK: Examination against a relevant standard by a trained and qualified person to ascertain satisfactory condition.

COLD SOAKING: Ice can form even when the outside air temperature (OAT) is well above 0 °C (32 °F). An aircraft equipped with wing fuel tanks may have fuel that is at a sufficiently low temperature such that it lowers the wing skin temperature to below the freezing point of water. If an aircraft has been at a high altitude, where cold temperature prevails, for a period of time the aircraft’s major structural components such as the wing, tail, and fuselage will assume the lower temperature, which will often be below the freezing point. This phenomenon is known as cold soaking. While on the ground, the cold-soaked aircraft will cause ice to form when liquid water, either as condensation from the atmosphere or as rain, comes in contact with cold-soaked surfaces.

CHEMICAL CONTAMINATION: Condition when substances (chemicals) are present where they should not be or are at concentrations higher than they should be.

CLEAR ICE: Ice difficult to detect visually. It is normally formed in the area of the wing fuel tanks, caused by cold-soaking. Clear ice may break loose during or after takeoff, and poses a hazard particularly to aircraft with rear mounted engines.

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CONTAMINATION: All forms of frozen or semi-frozen deposits on an aircraft, such as frost, snow, slush, or ice (also known as frozen contamination).

CONTAMINATION CHECK: A check of aircraft surfaces and components for contamination to establish the need for deicing.

DEICING: Procedure by which frost, snow, slush, or ice is removed from an aircraft in order to provide clean surfaces and components.

DEICING/ANTI-ICING: Combination of or referring to both of the procedures for “deicing” and “anti-icing”. It may be performed in one or two steps.

DEICING FLUID:

1) Heated water.
2) Heated mixture of water and Type I fluid.
3) Heated premix Type I fluid.
4) Heated Type II, III, or IV fluids.
5) Heated mixture of water and Type II, III, or IV fluids.

NOTE: Unheated fluids are ineffective to deice.

DEICING SERVICE PROVIDER: The company responsible for the aircraft deicing/anti-icing operations on an airfield.

DEICING PERSONNEL: Groundcrew personnel with roles and responsibilities associated with aircraft ground icing operations.

DEWPOINT: temperature at which unsaturated air must be cooled to cause saturation with respect to liquid water. The moisture condenses to liquid water either on surfaces as dew or as tiny liquid droplets suspended in air.

FREEZING DRIZZLE: Fairly uniform precipitation composed exclusively of fine drops [diameter less than 0.5 mm (0.02 inch)] very close together which freeze upon impact with the ground or other exposed objects.

FREEZING FOG: A suspension of numerous very small water droplets which freeze upon impact with the ground or other exposed objects; generally reduces the horizontal visibility at the earth’s surface to less than 1 km (5/8 mile).

FREEZING POINT: Temperature at which a liquid starts to become a solid.

FREEZING POINT BUFFER: The difference between the outside air temperature (OAT) and the freezing point of the fluid used.

FREEZING POINT BUFFER, NEGATIVE: Condition when the freezing point of a deicing/anti-icing fluid is above the OAT.

FREEZING RAIN, LIGHT: Precipitation of liquid water particles which freezes upon impact with the ground or other exposed objects, either in the form of drops of more than 0.5 mm (0.02 inch) or smaller drops which, in contrast to drizzle, are widely separated. Measured intensity of liquid water particles is up to 2.5 mm/h (0.10 in/h) or 25 g/dm2/h with a maximum of 0.25 mm (0.01 inch) in 6 minutes.

FREEZING RAIN, MODERATE: Precipitation of liquid water particles which freezes upon impact with the ground or other exposed objects. Moderate freezing rain may appear in the form of large drops or can appear to fall in sheets where individual drops are not identifiable. Moderate freezing rain has a measured intensity of between 0.10 to 0.30 in/h.

FREEZING RAIN, HEAVY: Precipitation of liquid water particles which freezes upon impact with the ground or other exposed objects. Heavy freezing rain can seem to fall in sheets and individual drops may not be identifiable. Heavy freezing rain has a measured intensity of more than 0.30 in/h.

FROST/HOARFROST: Tiny ice crystal formed on a surface at or below the frost point. Frost generally occurs with clear skies at temperatures below freezing point. Frost can also occur from the freezing of dew.

FROST, LOCAL: The limited formation of frost in localised wing areas cooled by cold fuel or large masses of cold metal in the wing structure; this type of frost does not cover the entire wing.

FROST POINT: temperature, at or below 0 °C, at which air undersaturated with moisture must be cooled (at constant pressure) to cause saturation with respect to ice. The moisture directly deposits, without going through the liquid phase, as frost on exposed surfaces providing nucleation sites. The frost point is higher (warmer) than the dewpoint

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by about 10% at a given humidity level in air. Air temperature readings given by a thermometer are applicable to the height above ground of the thermometer itself. Because cool air sinks and the ground often cools very quickly, especially on clear nights, the ground temperature on clear, still nights is invariably lower than the temperature only a few feet higher. Thus, frost can form even when a thermometer gives a reading above freezing. The same happens with aircraft-frost can form on aircraft when the thermometer air temperature reading is above 0 °C.

FUEL FROST: Frost, normally in the area of the wing fuel tanks, caused by the cold-soaking. Also known as non-environmental frost or cold-soaked fuel frost.

GROUNDCREW: Personnel with responsibilities for the handling, maintenance and servicing of an aircraft while on the ground, as well as the coordination of these activities.

HAIL: Precipitation of small balls or pieces of ice with a diameter ranging from 5 to 50 mm (0.2 to >2.0 inches) falling either separately or agglomerated.

HIGHEST ON-WING VISCOSITY (HOWV): Highest viscosity of a deicing/anti-icing fluid which is still aerodynamically acceptable.

HOARFROST: A synonym for frost. See frost/hoarfrost.

HOLDOVER TIME: Estimated time for which an anti-icing fluid will prevent the formation of frost or ice and the accumulation of snow on the treated surfaces of an aircraft.

ICE PELLETS: Precipitation of transparent (grains of ice), or translucent (small hail) pellets of ice, which are spherical or irregular, and have a diameter of 5 mm (0.2 inch) or less. Ice pellets usually bounce when hitting hard ground.

LOWEST ON-WING VISCOSITY (LOWV): Lowest viscosity of a deicing/anti-icing fluid for which the applicable holdover timetable can still be used.

LOWEST OPERATIONAL USE TEMPERATURE (LOUT):

The LOUT is the higher (warmer) of:

- The lowest temperature at which the fluid meets the aerodynamic acceptance test (according to AS5900) for a given type (high speed or low speed) of aircraft, or
- The freezing point of the fluid plus the buffer of 10 °C (18 °F) for Type I fluid and 7 °C (13 °F) for Type II, III, or IV fluids.

POST-DEICING CHECK: A check by qualified ground personnel to ensure that all critical surfaces are free of adhering contamination after the deicing procedure has been completed.

POST-DEICING/ANTI-ICING CHECK: A check by qualified ground personnel to ensure that all critical surfaces are free of adhering contamination after the deicing/anti-icing has been completed.

POST-DEICING/ANTI-ICING REPORT: Report given to the flight crew confirming that deicing/anti-icing has been carried out and the details of the deicing/anti-icing procedure that was applied.

PRE-DEICING PROCESS: A process to remove large quantities of frozen contamination prior to the regular deicing/ anti-icing process with the objective of reducing the quantity of deicing fluid to be used.

PRE-FLIGHT CONTAMINATION CHECK: A check performed by the flight crew or ground crew (if ordered by the flight crew) prior to departure to verify the presence of adhering contamination to establish the need for deicing/anti-icing. It may be part of the flight crew walk around before the flight.

PRE-TAKEOFF CHECK: A check by the flight crew prior to takeoff and within holdover time. This test is normally conducted from inside the cockpit. It is normally accomplished by a continuous assessment of the conditions that affect holdover time and includes an assessment and adjustment of holdover time.

PRE-TAKEOFF CONTAMINATION CHECK: A check of the critical surfaces for adhering contamination. This check is accomplished after the holdover time has been exceeded and must be completed within 5 minutes prior to the beginning of takeoff.

PROXIMITY SENSOR: A proximity sensor is a safety feature on some models of deicing equipment, that upon activation, disengages relevant systems, preventing equipment movement and damage from occurring due to physical contact between equipment components (e.g., spray nozzle, forced air nozzle, operator basket, etc.) and aircraft surfaces. As a safety mechanism, the proximity sensor is designed to prevent damage from occurring to aircraft surfaces, normally while the equipment chassis is in a stationary position (not maneuvering). Where

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equipped, the type of sensor used may vary by design, and may activate either by physical contact (e.g., a proximity switch with contact mechanism), or by non-physical activation (e.g., infrared, radar, etc.).

REFRACTIVE INDEX: Refractive index, for any substance, is the ratio of the velocity of light in a vacuum to its velocity in the substance. For solutions, the refractive index will vary upon the concentration of the solute in the solvent. Using a calibration curve, it is possible to determine the concentration of the solute in the solvent. For example, for aqueous glycol solutions, it is possible to determine the concentration of the glycol in water by measuring the refractive index and comparing the result to the calibration curve.

QUALIFIED STAFF: Trained staff who have passed theoretical and practical training tests and have been certified for performing this type of job; refer to WOM 3.2 "Aircraft Ground Deicing/Anti-icing Training and Qualification Programme".

QUALITY ASSURANCE: Is process-oriented, and it focuses on preventing quality issues. It is a proactive approach. An audit is done to validate QA processes, the quality procedures to be followed (e.g., "documented")

QUALITY CONTROL: Is product-oriented and focused on identifying quality issues in manufactured products and performance of service. It is a reactive approach. Inspections/checks/tests are done as part of the QC procedure, to verify the quality of the available procedures and operations. (e.g., "implemented").

REFRACTION: The bending of light as it passes from one transparent substance into another. For solutions, the refraction will vary upon the concentration of the solute in the solvent. Using a calibration curve, it is possible to determine the concentration of the solute in the solvent. For example, for aqueous glycol solutions, it is possible to determine the concentration of the glycol in water by measuring refraction with a refractometer and comparing the result to the calibration curve. Refraction can be expressed as a dimensionless number (index of refraction) or as a scale of concentration, e.g., degrees Brix (°Brix), or freezing point (°C or °F). See also refractometer.

REFRACTIVE INDEX: Unit of measurement of refraction expressed in the form of a dimensionless number. See also refraction and refractometer.

REFRACTOMETER: An optical instrument designed to measure the refractive index of water soluble fluids.

RESIDUE/GEL: A buildup of dried out thickened fluids typically found in aerodynamically quiet areas of the aircraft.

RIME ICE: Small, frozen, spherical water droplets, opaque/milky and granular in appearance, which looks similar to frost in a freezer, typically, rime ice has low adhesion to the surface and its surrounding rime ice particles.

SLUSH: Slush is snow or ice that has been combined with water.

SNOW: Snow is a precipitation of ice crystals, most of which are branched, star-shaped or mixed with unbranched crystals. At temperatures higher than -5 °C (23 °F), the crystals are generally agglomerated into snowflakes.

SNOW GRAINS: Precipitation of very small white and opaque particles of ice that are fairly flat or elongated with a diameter of less than 1 mm (0.04 inch); when snow grains hit hard ground, they do not bounce or shatter.

SNOW PELLETS: Precipitation of white, opaque particles of ice. The particles are round or sometimes conical, their diameters range from approximately 2 to 5 mm (0.08 to 0.2 inch), they are brittle and easily crushed, and they do bounce and may break upon contact with hard ground.

STORAGE TANK: A vessel for holding fluid that can be fixed, or mobile; includes rolling tanks (ISO tanks), totes, trailers, or drums.

TACTILE CHECK: Process by which a person touches specific aircraft surfaces. Tactile checks, under certain circumstances, may be the only way of confirming the critical surfaces of an aircraft are not contaminated. For some aircraft, tactile checks are mandatory as part of the deicing/anti-icing check process to ensure the critical surfaces are free of frozen contaminants.

THICKENED FLUID. A fluid that contains polymeric thickeners. AMS1428 Type II, III, and IV fluids are thickened fluids; AMS1424 Type I fluids are not thickened.

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3.1.4 Roles and Responsibilities

3.1.4.1 Pilot In Command

The Pilot In Command has the ultimate responsibility for the aircraft and shall not commence take-off unless the external surfaces are clear of any deposit which might adversely affect performance and/or controllability except as permitted in the aircraft operators manual.

3.1.4.2 Aircraft Operator

Shall have responsibility for:

- Aircraft ground deicing programs.
- The Pilot In Command.
- Management responsibilities.

3.1.4.3 Deicing Service Provider

Shall have the responsibility for:

- The safety and operability of the designated deicing facilities.
- Aircraft ground deicing/anti-icing procedures.

A deicing service provider shall have aircraft deicing/anti-icing procedures, including a quality control (QC) program. These procedures, which ensure compliance with the relevant regulations and global aircraft deicing standards such as AS6285, AS6286, and AS6332, shall cover all aspects of the aircraft ground deicing/anti-icing process, including (but not limited to) instructions, tasks, responsibilities, authorizations, and infrastructure for the deicing/anti-icing process as follows:

- Use of suitable deicing/anti-icing treatment method according to this standard.
- Remote deicing/anti-icing instructions (when applicable).
- Sufficient number of trained and qualified deicing/anti-icing personnel.
- Qualified staff to co-ordinate and supervise the deicing/anti-icing treatments.
- Use of suitable deicing/anti-icing equipment.
- Special handling procedures for Type II, III, and IV deicing/anti-icing fluids to maintain quality.
- Post-deicing/anti-icing check (when applicable).
- Protocol for communications with flight crew for both gate and remote locations (when applicable).
- Communicating the post-deicing/anti-icing report to the flight crew.
- Documentation of all deicing/anti-icing treatments.
- Personnel safety arrangements.
- Provisions for tools and clothing for deicing/anti-icing personnel.
- Environmental arrangements.
- A quality control program.

3.1.4.4 Airports

Shall have the responsibility for:

- Following local environmental regulations.
- The logistics of bringing fluid onto a field.
- The operability of the dedicated deicing facilities.
- Message boards.
- Weather support.
- Health and safety.

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3.1.4.5 Regulatory Authority

Has the responsibility for:

- Regulatory and guidance material, plus the advocacy of the clean aircraft concept.
- The policies and standards that support the operability of the clean aircraft concept.
- Review and approval of airline operator ground deicing programs (as applicable).

3.1.4.6 Air Traffic Control

Has the responsibility for:

- The flow of aircraft through the regional system.

3.1.5 Quality Management

3.1.5.1 General

All companies providing deicing/anti-icing services shall have a quality program. The purpose of the program is to ensure that deicing/anti-icing of aircraft on the ground is accomplished in accordance with regulatory requirements and guidance, industry standards, and the operator's program. To verify effectiveness of the deicing/anti-icing of aircraft on the ground, the quality program should include both quality assurance (QA) and quality control (QC) processes and procedures.

3.1.5.2 Quality Assurance

To meet quality assurance (QA) requirements, a company must provide proof it follows the rules and instructions in any specific field correctly, and that it has a proper and efficient quality assurance and quality control programs. Quality assurance is confirmed by auditing. Sometimes audit pools are formed so that companies are not audited several times on the same process by different entities; for example, IATA's Deicing/Anti-icing Quality Control Pool (DAQCP). All companies should have a QA program in place. QA programs shall follow the standards published in WOM 3.4.

3.1.5.3 Station Quality Control Program

A QC program shall cover all aspects of aircraft ground deicing/anti-icing and shall include, but is not limited to, the following checks:

- Procedures and instructions are up to date.
- Responsibilities and tasks clearly defined and are up to date.
- Communication procedures/protocols are up to date.
- All personnel are trained and qualified.
- The quality of deicing/anti-icing fluid from all storage tanks, all equipment tanks, and all spray nozzles are within limits.
- Correct and safe functioning of deicing/anti-icing spray equipment.
- Correct and safe functioning of (remote/centralised) deicing/anti-icing facility (if applicable).
- Reporting methods and reports are up to date.

NOTE 1: Prior to the start of each winter, perform all above listed checks.

NOTE 2: During each winter season perform QC checks on deicing/anti-icing fluids from all spray nozzles at operational settings on a regular basis and file test results until the start of the next winter period.

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3.1.5.4 Fluid Quality Control

3.1.5.4.1 General

To ensure the necessary safety margins are maintained in the deicing/anti-icing operation, the fluid used to both deice and anti-ice aircraft surfaces must meet specification and be at the correct concentration. Factors like pumping, storing, heating, and spraying may cause degradation/contamination of deicing/anti-icing fluids. To assure the correct quality of these fluids, follow fluid manufacturer's recommendations and perform the following checks and tests. Results of all testing shall be recorded.

3.1.5.5 Fluid Delivery and Acceptance

3.1.5.5.1 Fluid Delivery Methods

Some of the most common delivery methods and their precautions are the following:

3.1.5.5.1.1 Bulk Shipments (e.g., Tank Trucks and Rail Cars)

This delivery method consists of the usage of reusable vessels which can hold a larger fluid quantity. After performing the proper fluid quality controls, it is then transferred into the receiver's storage.

The fluid supplier shall provide an assurance that one of the following has been met prior to loading the bulk shipping container for delivery to the customer:

a) The shipping container and included delivery hoses were cleaned.

b) The previous load consisted of fluid identical to the delivered fluid.

3.1.5.5.1.2 Packaged Goods (i.e., Totes, Pails, or Drums)

When de/anti-icing fluid are delivered in a single or multiple containers (i.e., totes, pails, or drums) all sealed and shipped by the fluid manufacturer (or authorized company), fluid supplier shall provide all pertinent documentation as required in 3.1.5.5.1.3.

3.1.5.5.1.3 Fluid Delivery Acceptance

Fluid acceptance consists of delivery documentation checks, seal checks and fluid tests. Fluid acceptance check shall be performed for each delivery of aircraft deicing and anti-icing fluids before the first use of the delivered fluid for filling a storage tank or deicing vehicle tank.

3.1.5.5.1.4 Fluid Delivery Documentation

A. The delivery shall be accompanied by a certificate of analysis.

   1) For Type I, II, III, and IV fluids, the certificate shall include delivery specification limits and test results of the following:
      a) Appearance.
      b) Refraction.
      c) pH.
   2) For deliveries of Type II, III, and IV fluids, the certificate shall also include (delivery) viscosity specification limits and test results for laboratory viscosity testing.

B. The documentation and paperwork accompanying the delivery shall be checked to verify the following:

   1) The delivered fluid name corresponds to the fluid ordered.
   2) The delivered fluid brand name corresponds to product identification labels or tags for each delivery vessel.
   3) The delivered fluid concentration corresponds to product identification labels or tags for each delivery vessel.
   4) The lot or batch number on delivery documents correlate with other shipping documents provided.
   5) The test results noted on the certificate of analysis meet the applicable fluid manufacturer's specification limits.

3.1.5.5.1.5 Shipment Seal Checks

A. Shipment seals shall be checked to ensure:

   1) The product has not been tampered with

2) Identification numbers align with those noted on delivery documentation (where applicable).

B. If seals contain identification numbers, the numbers should be noted on acceptance documentation.

3.1.5.5.2 Fluid Samples

A fluid sample shall be taken from the delivery vessel during bulk shipping prior to fluid transfer. A sample from each separate compartment is required, when applicable.

For packaged goods deliveries (i.e., sealed totes, pails, or drums), fluid testing can be postponed until the container is opened (unsealed) prior to be used or transferred. After opened and sampled, if delivery includes multiple containers, it is considered acceptable if only one sample from each production lot or batch is taken.

NOTE: Deicing/anti-icing fluids may degrade even when stored under appropriate conditions. Fluid manufacturers may assign a shelf life which is the time for which a product is expected to be useable or saleable when stored under appropriate conditions. For a deicing/anti-icing fluid, shelf life sets the time after which a fluid, under appropriate storage conditions, should be retested to verify that it still meets specification requirements. Consult the fluid manufacturer for further information.

3.1.5.5.2.1 Sample Tests

A. The following tests shall be performed on each sample taken at delivery:

1) Appearance (visual examination):
   a) Color.
   b) Foreign body contamination (e.g., rust particles, debris, etc.).
2) Refraction Check (refractive index or freezing point) to verify fluid concentration.

B. The following tests are optional for each sample. These checks can be helpful if fluid degradation is suspected:

1) pH.
2) Field viscosity check or laboratory viscosity test for Type II, III or IV fluids.

C. All test results shall be within the fluid manufacturer’s specification limit.

3.1.5.5.2.2 Nonconformities or Discrepancies

A. Users and service providers shall have a documented procedure in place on the appropriate action to be taken when irregularities or discrepancies are identified during the fluid delivery documentation checks and fluid sample tests.

B. Fluid manufacturers should have information contained within their documentation outlining specific procedures and/or contact information to assist and provide support to service providers in such occurrences.

3.1.5.5.3 Fluid Preseason and Within-Season Tests

Fluids that are applied to the aircraft shall meet the fluid manufacturer’s specification or in-service limitations, as applicable. A program shall be in place that assures the safe use, handling and performance parameters of fluids are always followed and met.

One way of complying with this requirement is to carry out a preseason quality test and within-season tests as described below.

3.1.5.5.4 Type I Fluid

3.1.5.5.4.1 Test Frequency

These tests shall be performed:

A. At the start of the deicing season.

B. On any vehicle or storage tank when fluid contamination or degradation is suspected.

Fluid samples shall be taken from all deicing/anti-icing fluid spray nozzles of all deicing/anti-icing spraying equipment in the most common concentrations used for deicing/anti-icing, and from all storage tanks in use. For vehicles without a mixing system, the sample may be taken directly from the vehicle pre-mix tank after ensuring that the fluid is at a uniform mixture. Perform the following tests on the fluid samples:

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- Appearance (visual examination).
  - Color.
  - Foreign body contamination (e.g., rust particles, debris, etc.).
- Refraction.
- pH*.

*Perform this test if fluid degradation or contamination is suspected.

3.1.5.5.5 Type II, III, and IV Fluids

3.1.5.5.5.1 Test frequency. These tests shall be performed:

a) At the start of the deicing season.

b) On any vehicle or storage tank when fluid contamination or degradation is suspected.

c) After equipment maintenance on the fluid pump and spray system that have the potential to affect the quality of the fluid (e.g., pumps, nozzles, etc.).

3.1.5.5.5.2 Fluid Samples

Fluid samples shall be taken from all deicing/anti-icing fluid spray nozzles of all deicing/anti-icing spraying equipment for all of the concentrations used for anti-icing and from all storage tanks in use. Perform the following tests:

a) Appearance (visual examination).

   1) Color.
   2) Foreign body contamination (e.g., rust particles, debris, etc.).

b) Refraction.

c) pH*.

   1) Perform this test if fluid degradation or contamination is suspected.

d) Laboratory viscosity.

3.1.5.5.5.3 Sample Test Requirements

- Results of the appearance, refraction and pH tests shall be within the limits set by the applicable fluid manufacturer specification or in-service limits.
- Results of the Type II, III, and IV viscosity tests on samples from spray nozzles shall be no lower than the lowest on-wing viscosity (LOWV) and no higher than the highest on-wing viscosity (HOWV). Fluids with a viscosity less than the LOWV shall not be used with holdover time guidelines.
- Results of the viscosity tests on samples from storage tanks shall be within the limits needed to ensure the viscosity of fluid when applied to aircraft will remain within the LOWV and the HOWV. Any expected degradation during fluid storage and handling and during the use of fluid application equipment must be considered.

NOTE: The LOWV for specific fluids are listed in Transport Canada and FAA Holdover Time Guidelines. The HOWV for specific fluids are provided by the applicable fluid manufacturer. The LOWV and HOWV are unique for each specific fluid and fluid concentration (i.e., 50%, 75%, and 100%).

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3.1.5.5.6 Daily Concentration Tests

3.1.5.5.6.1 General

Fluids or fluid/water mixture samples shall be taken from the deicing/anti-icing equipment nozzles or manufacturer's authorized sample ports on a daily basis when the equipment is in use. Perform a refraction test on the samples taken. The sample shall be protected against precipitation. Combustion heaters and trucks shall not be operated in confined or poorly ventilated areas to prevent asphyxiation. Requirements for suitable equipment are described in ARP1971.

NOTE 1: Equipment without a mixing system: samples may be taken from the mix tank instead of the nozzle. Ensure the fluid is at a uniform mix.

NOTE 2: Equipment with proportional mixing systems: the operational setting for the flow and pressure shall be used. Allow the selected fluid concentration to stabilise before taking a sample.

NOTE 3: Equipment with an in-line sampling system: a sample for Type I may be taken by following the truck manufacturer's method.

3.1.5.5.6.2 Type I Fluid from Nozzles

- Maximum permitted concentration shall not be exceeded.
- For use in a one-step method and in the second step of a two-step method, the concentration shall be such that the freezing point is at least 10 °C (18 °F) below the OAT.
- For use in the first step of a two-step method, the concentration shall be such that the freezing point of the fluid is at the OAT or below.

3.1.5.5.6.3 Type I Fluid in Tanks

The concentration shall be within the "in-service" limits published by the manufacturer for fluid at the applicable concentration.

3.1.5.5.6.4 Type II, III, and IV Fluids

For fluids from nozzles or in tanks, the concentration shall be within the "in-service" limits published by the manufacturer for fluid at the applicable concentration.

For Type II, III, and IV fluid/water mixtures (50/50 or 75/25), a tolerance range of 0 to +7% from the setting may apply, depending on the product.

3.1.5.5.7 Check on Directly or Indirectly Heated Type I, II, III, or IV Fluids

SAE Type I, II, III, and IV deicing/anti-icing fluids, if heated (directly or indirectly), shall be heated in a manner to preclude fluid degradation in storage or application. The integrity of the fluid following heating shall be checked periodically. Factors like heating rate and heating time cycles should be considered in determining the frequency of fluid inspections. Refer to the fluid manufacturer's recommendations.

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3.1.5.5.8 Fluid Test Methods

The following tests may be performed by any appropriate equivalent method.

A. Appearance:

1) Put fluid from the sample into a clean transparent bottle.
2) Check visually for color.
3) Check visually for any kind of contamination (e.g., rust particles, debris, rubber, or discoloration, etc.).

B. Refraction:

1) Ensure a functionality check was performed in accordance with manufacturer’s instructions.
2) Put a fluid drop taken from the sample onto the test screen of the refractometer and close the cover plate.
3) Read the value (usually expressed as refractive index, degrees Brix or freezing point) and use the correction factor given by the manufacturer of the fluid in case the temperature of the refractometer is not 20°C (68°F).
4) Compare the refraction result to the specification limit or in-use limit, as appropriate.
5) Clean the refractometer by wiping with a water-wet cloth, wipe dry, and return it to the protective cover.

C. pH:

This test may be performed either with pH indicator paper (litmus paper) or with a calibrated or functionally tested pH meter. Read the value and compare with the limits for the fluid.

NOTE: In the laboratory this pH check shall be performed with a calibrated or functionally tested pH meter.

D. Field viscosity test

This test may be performed using the fluid manufacturer’s recommended method, like a falling ball or the Stony Brook device. Read the value and compare with the limits for the fluid.

E. Laboratory viscosity test

Perform the viscosity test using the fluid manufacturer's method or AS9968. Compare the viscosity values with the applicable limits.

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3.1.5.5.9 Nozzle Fluid Sampling Procedure for Type II, III, or IV Fluids

To ensure that the necessary safety margins are maintained between the start of the deicing/anti-icing operation and takeoff, the fluid used to both deice and anti-ice aircraft surfaces must meet specification and be at the correct concentration. Due to the possible effect of vehicle/equipment heating and/or delivery system components on fluid condition, it is necessary for the sampling method to simulate typical aircraft application. This section describes some methods for collecting samples of Type II, III, and IV fluids, sprayed from operational aircraft deicing/anti-icing vehicles and equipment, prior to the necessary QC checks being carried out.

A. Method using a purpose-built stand

Spray the fluid onto a purpose-built stand, consisting of a suitable plate (for application) and an associated fluid collection system. In the absence of such a stand, a suitable apparatus can be used. The distance between the spray nozzle and the surface shall be approximately 1 to 3 m (3 to 10 feet), and the fluid shall be sprayed perpendicular to the surface. By following this simple procedure, a representative nozzle sample can be obtained. If there are any questions about the deicing fluid, contact and consult the fluid manufacturer. If there are any questions about the deicing vehicle or unit, pump, pump pressure, etc., consult the ground service equipment shop or the vehicle manufacturer.

1) Select the required flow rate/spray pattern for the fluid to be sampled simulating routine operations.
2) Spray the fluid to purge the lines and check the concentration of a sample, taken from the gun/nozzle after purging.
3) Should the refraction indicate that the lines have not been adequately purged, repeat the previous step until the concentration is correct for the fluid to be sampled (on certain vehicles it may be necessary to spray more than 50 L of fluid, before the lines are completely purged).
4) Direct the fluid onto the sampling surface and spray an adequate amount of fluid to allow for a 1 L sample to be taken.

B. Trashcan method
items required:

1) Large garbage cans, buckets, or 55-gallon drums.
2) Large trash can liners.
3) Sample bottle that is clean and dry.

Procedure for Nozzle Sample:

1) Set trash cans out and put two liners in each trash can.
2) Weigh the trash can down with sand or blocks.
3) Stand about +1 to 3 meters (or 4 to 10 feet) away from the cans.
4) Open the nozzle and spray into 1 of the trash cans so that the lines are purged of any old fluid.
5) When the line has been purged, move the nozzle to the next trash can, keeping the nozzle open.
6) Do not close the nozzle and restart as that will shear the fluid.
7) Spray 2 to 3 gallons (8 to 12 litres) into the second trash can.
8) Pull the liner out and put a small hole in bottom of bag to fill the sam.ple bottle.

C. Sample identification

Attach a label to each sample bottle providing the following data:

1) Manufacturer's brand name and full name and type of the fluid (e.g., Kilfrost ABC-3/Type II).
2) Identification of deicing/anti-icing equipment (e.g., Elephant Beta DT04, Fixed Rig R001, etc.).
3) Detail where the sample was taken from (e.g., nozzle, storage tank, or equipment tank).
4) Mixture strength (e.g., 100/0, 75/25, etc.).
5) Station (e.g., BAK, etc.).
6) Date sample was taken.

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3.1.6 Aircraft Ground Deicing/Anti-icing Methods

3.1.6.1 Aircraft Ground Deicing/Anti-Icing Methods General Comments

These procedures specify the methods for deicing and anti-icing of aircraft on the ground to provide safe takeoff. When aircraft surfaces are contaminated by frozen moisture, they shall be deiced prior to dispatch with fluids, mechanical methods, alternative technologies, or combinations thereof. When freezing precipitation exists and the precipitation is adhering to the surfaces at the time of dispatch, aircraft surfaces shall be deiced/anti-iced with fluids. If both deicing and anti-icing are required, the procedure may be performed in one or two steps. The selection of a one- or two-step procedure depends upon weather conditions, available equipment, available methods (generally the use of deicing and anti-icing fluids), and the holdover time needed. If a one-step procedure is used, then both WOM 3.1.14.4 and WOM 3.1.14.5 apply for guidance regarding fluid limitations.

CAUTION

Slippery conditions can exist on the ground or equipment following the deicing/anti-icing treatment.

3.1.6.2 Predeicing Procedure to Be Done Prior to Deicing/Anti-Icing

Companies may employ a pre-deicing procedure prior to the main deicing procedure, in order to remove large amounts of frozen contamination (e.g., snow, slush, or ice), in order to reduce the quantity of glycol-based deicing fluid that is needed. This pre-deicing procedure may be performed with various means (e.g., infrared technology, brooms, forced air, fluid injected into forced air, heat, heated water, heated fluids with negative buffer). If the pre-deicing procedure is used, make sure that the subsequent deicing procedure removes all frozen contamination including the contamination that may have formed on surfaces and/or in cavities due to the pre-deicing procedure.

3.1.6.3 Infrared Deicing

This subsection establishes the procedures for the removal of frozen precipitation by using infrared deicing technology. Specific information on facility requirements, as well as their inclusion in aircraft ground deicing programs, can be found in publications listed in WOM 2.

A. General requirements: Frost, snow, slush, or ice shall be removed from aircraft surfaces prior to dispatch from the facility or prior to anti-icing.

B. Deicing: Deicing using infrared energy is accomplished through heat that breaks the bond of adhering frozen contamination. The application of infrared energy may be continued to melt and evaporate frozen contaminant. Wet surfaces require an application of heated deicing fluids to preclude refreezing after removal of the infrared energy source. When required, for operations other than frost or leading-edge ice removal, and when OAT is at or below 0°C (32°F), an additional treatment with hot deicing fluid shall be performed within the facility to prevent refreezing of water which may remain in hidden areas.

CAUTION

If the aircraft requires retreatment and deicing/anti-icing fluids had been applied before flight, conventional deicing/anti-icing with fluids shall be performed.

C. Post-deicing check: The aircraft shall be checked in accordance with the requirements of WOM 3.1.12.

D. Anti-icing: If anti-icing is required, it shall be accomplished in accordance with WOM 3.1.14.7.2. If anti-icing is performed inside the facility, infrared power levels must be adjusted as required during the anti-icing procedure to prevent the re-accumulation of frozen contamination because of snow blowing through the facility and to maintain fluid integrity for the time the aircraft is in the facility. Dehydration of the fluid can negatively impact the fluid performance.

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3.1.6.4 Deicing by Fluids

Frost, snow, slush, or ice may be removed from aircraft surfaces by the use of deicing fluids. It is the responsibility of the deicing service provider to ensure that all frozen deposits (with the possible exception of frost, which may be allowed as described in WOM 3.1.12) are removed from the specified surfaces during the deicing procedure.

CAUTION

Consult aircraft maintenance manuals for limitations for the maximum application pressure, temperature, and the use of glycol (AMS1424/1 and AMS1428/1) versus non-glycol (AMS1424/2 and AMS 1428/2) fluids.

3.1.6.4.1 Removal of Contaminants

For maximum effect, fluids shall be applied close to the surface to minimise heat loss. Fluid temperature and pressure should not exceed aircraft maintenance manual requirements. The heat in the fluid effectively melts any frost, as well as light deposits of snow, slush, and ice. Heavier accumulations require the heat to break the bond between the frozen deposits and the structure; the hydraulic force of the fluid spray is then used to flush off the contamination. The deicing fluid will prevent refreezing for a period of time, depending on aircraft skin and OAT, the fluid used, the mixture strength, and the weather.

3.1.6.4.2 Removal of Frost and Light Ice

A general procedure consisting of a nozzle setting that gives a solid cone (fan) spray should be used. This ensures the largest droplet pattern available, thus retaining the maximum heat in the fluid. Providing the hot fluid is applied close to the aircraft skin, a minimal amount of fluid will be required to melt the deposit.

3.1.6.4.3 Removal of Snow

A nozzle setting sufficient to flush off deposits and minimize foam production is recommended. Foam could be confused as snow. The method adopted will depend on the equipment available and the depth and type of snow; i.e., light and dry or wet and heavy. In general, the heavier the deposits of snow or ice, the heavier the fluid flow that will be required to remove it effectively and efficiently from the aircraft surfaces. For light deposits of both wet and dry snow, similar procedures as for frost removal may be adopted.

Wet snow is more difficult to remove than dry snow, and unless deposits are relatively light, the selection of a high fluid flow will be found to be more effective. Under certain conditions, it will be possible to use the heat, combined with the hydraulic force of the fluid spray, to melt and subsequently flush off frozen deposits. However, where snow has bonded to the aircraft skin, the procedures detailed in WOM 3.1.14.4.5 should be utilized. Heavy accumulation of snow will always be difficult to remove from aircraft surfaces and vast quantities of fluid will invariably be consumed in the attempt. Under these conditions, serious consideration should be given to removing the majority of the snow using a pre-deicing procedure before attempting a normal deicing procedure.

3.1.6.4.4 Removal of Ice

Heated fluid shall be used to break the ice bond. The high thermal conductivity of metal skin is utilized when a stream of hot fluid is directed at close range onto one spot, until the surface is just exposed. This will then transmit the heat laterally in all directions raising the temperature above the freezing point and thereby breaking the adhesion of the frozen mass with the aircraft surface.

Non-metallic surfaces (e.g., composites) have a lower heat transfer than metallic surfaces. Deicing may take longer, and more fluid may be needed. By repeating this procedure a number of times, the adhesion of a large area of frozen snow or glazed ice can be broken. The deposits can then be flushed off with either a low or high flow, depending on the amount of the deposit.

3.1.6.4.5 Cold Dry Snow or Ice Crystals

Cold dry snow or ice crystals, in very cold conditions [generally below -10 °C (14°F)], may not adhere to a cold dry aircraft nor its critical surfaces. Under these conditions, it may swirl as it blows across the surfaces, making it evident it is not adhering. Therefore, the critical surfaces remain free of adhering contaminants.

However, if frozen contamination has accumulated on critical surfaces, it must be adequately removed. It cannot be assumed that these accumulations will blow off during takeoff.

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During cold dry conditions, the air operators will need take into consideration the following elements:

1) Refueling with fuel warmer than the wing skin temperature may create a condition whereby previously non-adhering precipitation may adhere to the wing surfaces.

2) The use of heated deicing fluids may increase the risk of cold dry snow or ice crystals to adhere to critical surfaces post application. Under such operational conditions, an anti-icing treatment might need to be considered.

CAUTION

A close monitoring of de/anti-icing fluid's LOUT is required to ensure a safe operation.

3) Monitor the location of heat-releasing equipment such as ground power units or bridges that may create conditions for non-adhering precipitation to start adhering to aircraft surfaces.

4) The location where the aircraft is parked might increase the risk for non-adhering precipitation to start adhering (e.g., one wing in the sun, a building obstructing the wind, etc.).

5) Operations in close proximity to other aircraft may cause snow, ice particles, or moisture to be blown onto critical aircraft components; or can cause dry snow/ice crystals to melt and refreeze on aircraft critical surfaces.

If it cannot be adequately demonstrated that cold dry snow or ice crystals is not adhering or accumulating, then it must be removed before takeoff.

CAUTION

Aircraft with rear mounted engines are more susceptible to ingest frozen accumulation that might cause damage or engine failure.

3.1.6.4.6 General Deicing Fluid Application Strategy

For effective removal of snow and ice, the following techniques should be adopted. Aircraft may require unique procedures to accommodate design differences, and aircraft manufacturer's instructions should be consulted. Ice, snow, or frost dilutes the fluid. Apply enough hot deicing fluid to ensure that refreezing does not occur and all contaminated fluid is driven off. The application of deicing fluid must be done in a pattern that ensures all contaminants on the aircraft are removed. The preferred method is to spray the aircraft from top to bottom.

3.1.6.4.6.1 Wings, Horizontal Stabilizers, and Elevators

The direction of the spray shall be from the leading-edge to the trailing edge in the vicinity of any control surfaces (i.e., the rudder). Caution must be used to ensure fluid is not sprayed directly into any vertical tail or control surface openings.

NOTE: There is an exception: On aircraft with no leading edge devices (i.e., hard wing and/or propeller driven), deicing/anti-icing fluid may be sprayed from highest point of the wing surface camber to the lowest, flowing forward over the leading edge of the wing ensuring sufficient rollover, and over the trailing edge. Caution must be used to ensure fluid is not sprayed directly into any wing openings.

CAUTION

Wing surface temperatures can be considerably below ambient temperature due to contact with cold fuel and/ or proximity to large masses of cold-soaked metal. Use a fluid/water mixture with a higher concentration of glycol than is usually required by the OAT to prevent refreezing.

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3.1.6.4.6.2 Lower Wing Surface (Underside of Wing) Deicing Procedures

Treatments must be symmetrical and may include flaps and lower surfaces. Spray the affected areas with a heated fluid/water mixture suitable for a one-step procedure as required (see caution below), and then spray the same areas under the other wing. Both wings must be treated identically (same areas, same amount and type of fluid, same mixture strength), even if the frozen contamination is only present under one wing. Holdover times do not apply to underwing treatments.

It is the responsibility of the deicing service provider to ensure that the treatment is performed symmetrically, and that on completion, all frozen deposits (with the possible exception of frost, which may be allowed) have been removed. When it is confirmed that the treated areas are clean, the following statement shall be given to the flight crew: "Underwing deicing only, holdover times do not apply."

CAUTION

Underwing frost and ice are usually caused by very cold fuel in the wing tanks. Use a fluid/water mixture with a higher concentration of glycol than is usually required by the OAT to prevent refreezing.

3.1.6.4.6.3 Vertical Surfaces

Start at the top and work down to the base of any vertical surface, spraying from forward to aft in the vicinity of control surfaces.

3.1.6.4.6.4 Fuselage

Spray the fluid along the top centerline and then towards the outboard of the fuselage. Ensure that it is clear of ice, snow, and slush in accordance with the aircraft manufacturer's manuals. Hoarfrost may be allowed in accordance with the aircraft manufacturer's manuals.

3.1.6.4.6.5 Nose/Radome Area and Flight Deck Windows

Type I fluid/water mixture or manual methods of removal (such as squeegees or brushes) are recommended.

When thickened fluids are used, avoid spraying near the flight deck windows, as fluid can cause a severe loss of visibility. Any thickened fluid remaining on the nose areas where it could blow back onto the flight deck windows should be removed prior to departure, using a diluted Type I fluid, squeegees, or equivalent. If flight deck windows are contaminated with thickened fluids, use water or an approved windshield cleaner (use of a low freezing point windshield washing fluid is recommended when OAT is at or below 0 °C [32 °F]).

CAUTION

Prior to cleaning of the flight deck windows, ensure that the window heating system is switched off.

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3.1.6.4.6.6 Landing Gear and Wheel Bays

Do not spray deicing fluid directly onto wheels and brakes. Remove all ice and snow from the landing gear, paying particular attention to uplocks, downlocks, sensors, door mechanisms, gravel deflectors, and steering systems.

NOTE: It may be possible to mechanically remove accumulations such as blown snow; however, where deposits have bonded to surfaces, they can be removed by the application of hot air.

3.1.6.4.6.7 Engines

Deposits of snow should be mechanically removed from engines prior to departure. Any frozen deposits that may have bonded to either the lower surface of the intake or the fan blades including the rear side, or propellers, may be removed by hot air or other means recommended by the engine manufacturer. If use of deicing fluid is permitted, do not spray directly into the engine core.

3.1.6.4.7 Removal of Local Area Contamination

When no precipitation is falling or expected, and when there is no active frost, a "local area" deicing may be carried out under the below mentioned or similar conditions. In some cases, a full or complete deicing is not necessary. When the presence of frost and/or ice is limited to localised areas on the surfaces of the aircraft and no holdover time is applicable, only the contaminated areas will require treatment.

This type of contamination will generally be found on the wing and/or stabilizer leading edges, or in patches on the wing and/or stabilizer upper surfaces. Spray the affected area(s) with a heated fluid/water mixture suitable for a one-step procedure. Both sides of the wing and/or stabilizer upper surfaces shall receive the same type of fluid; the same area in the same location on each wing/stabilizer shall be sprayed, including when conditions would not indicate the need for treatment of both wings/stabilizers.

It is the responsibility of the deicing service provider to ensure that the treatment is performed symmetrically and that upon completion, all frozen deposits have been removed. After this check has confirmed that the areas are clean, the following statement shall be given to the flight crew: "Local area deicing only. Holdover times do not apply."

3.1.6.5 Anti-Icing by Fluids

Frost, snow, slush, or ice will, for a period of time, be prevented from adhering to or accumulating on aircraft surfaces by the application of anti-icing fluids. This section provides procedures for the use of anti-icing fluids.

A. Required usage: Anti-icing fluid shall be applied to the aircraft surfaces when freezing rain, snow, or other freezing precipitation may adhere to the aircraft at the time of dispatch.

B. Optional usage: Anti-icing fluid may be applied to clean aircraft surfaces at the time of arrival (preferably before unloading begins) on short turnarounds during freezing precipitation, and on overnight aircraft. This will minimise ice accumulation prior to departure and often makes subsequent deicing easier.

CAUTION

This practice has the potential to build up dried residues. An appropriate inspection and cleaning program shall be established.

In anticipation of weather conditions that require deicing, anti-icing fluid may be applied to clean aircraft surfaces prior to the aircraft being exposed to the freezing precipitation. This will minimise the possibility of snow and ice bonding or reduce the accumulation of frozen precipitation on aircraft surfaces and facilitate subsequent deicing.

Prior to flight, the aircraft must be deiced, unless the integrity of the fluid can be ensured. Deice in accordance with WOM 3.1.14.8, Table 1, whenever possible, to reduce the potential for dried residue build up.

NOTE: Dehydration (water evaporation) of Type II, III, and IV fluids can negatively impact the fluid performance.

For effective anti-icing, an even layer of sufficient thickness of fluid is required over the prescribed aircraft surfaces which are free of frozen deposits. For maximum anti-icing protection, undiluted Type II, III, or IV fluid should be used.

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The high fluid flow pressure and flow rates normally associated with deicing are not required. When possible, pump speeds and nozzle spray patterns should be adjusted accordingly.

NOTE: Type I fluids provide limited holdover effectiveness when used for anti-icing purposes.

CAUTION

AMS1424/2 and AMS1428/2 acetate- or formate-based fluids when used for deicing:

- May significantly shorten the holdover times of Type II, III, and IV fluids when used in combination with these fluids.
- May cause corrosion on aircraft materials.

Refer to aircraft manufacturers documentation, fluid manufacturer recommendations and AMS1424/1, AMS1424/2, AMS1428/1, and AMS1428/2 for more information.

3.1.6.5.1 Anti-Icing Fluid Application Strategy

The spraying procedure should be continuous and as short as possible. Anti-icing should be carried out as near to the departure time as possible in order to utilise available holdover time. The anti-icing fluid shall be distributed uniformly and with sufficient thickness over all surfaces to which it is applied. In order to control the uniformity, all aircraft surfaces shall be visually checked during application of the fluid. Spray from the leading edge to the trailing edge on wings, horizontal, and vertical stabilizers.

To use Type I holdover times guidelines in all conditions, including active frost, an additional minimum of 1 L/m2 (~2 gallons/100 ft2) of heated Type I fluid/water mixture must be applied to the surfaces after all frozen contamination is removed. This application is necessary to heat the surfaces, as heat contributes significantly to the Type I fluid holdover times. The Type I/water mixture used for anti-icing must be selected so that the freezing point of the mixture is at least 10 °C below the OAT and heated so the nozzle temperature is at least 60 °C (140 °F).

For Type II, III, or IV fluids (non-Newtonian fluids), a sufficient amount is indicated by fluid just beginning to run off the leading and trailing edges of horizontal surfaces. Apply sufficient fluid to achieve an even, uniform layer, typically achieved by using 1 to 3 L/m2 (~2 to 6 gallons/100 ft2), depending on the type of non-Newtonian anti-icing fluid used.

Consult the fluid manufacturer for any applicable fluid specific application guidance.

Refer to local regulatory documents, such as the FAA Holdover Time Guidelines: Winter 20xx-20yy (annual publication) or to Transport Canada Holdover Time Guidelines: Winter 20xx-20yy (annual publication).

The following surfaces shall be treated as specified by the aircraft manufacturer's documentation:

- Wing upper surfaces including leading edges and upper control surfaces.
- Wing tip devices.
- Both sides of vertical stabilizer and rudder to receive anti-ice protection when freezing precipitation conditions exist. See 5.5.2 for more information about holdover time limitations when anti-icing with non-Newtonian fluids on vertical surfaces.
- Horizontal stabilizer upper surfaces including leading edges and elevator upper surfaces.
- When necessary, fuselage upper surfaces, dependent upon the amount and type of freezing precipitation (this is especially important on centre-line engine aircraft).

CAUTION

Anti-icing fluids may not flow evenly over wing leading edges, horizontal, and vertical stabilizers. These surfaces should be checked to ensure that they are properly coated with fluid.

It is the responsibility of the deicing service provider to ensure that the surfaces mentioned above are free of frost, snow, slush, or ice prior to the start of the anti-icing treatment, and that on completion of the treatment, these surfaces are fully covered with an adequate layer of anti-icing fluid.

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NOTE: SAE Type II, III, and IV fluids used for anti-icing purposes are normally applied unheated on clean aircraft surfaces, but they may be applied heated and diluted for a one-step procedure. Refer to the fluid manufacturer's recommendation.

3.1.6.6 Holdover Time

Holdover time is obtained by anti-icing fluids remaining on the aircraft surfaces. With a one-step procedure, the holdover time begins at the start of the treatment; with a two-step procedure, it begins at the start of the second step (anti-icing). Holdover time will have effectively run out when frozen deposits start to form/accumulate on treated aircraft surfaces. Due to their properties, Type I heat transfer and the thin liquid wetting film, provides limited holdover time, especially in conditions of freezing precipitation. With this type of fluid, no additional holdover time would be provided by increasing the concentration of the fluid in the fluid/water mixture. Type II, III, and IV fluids contain a thickening agent, which enables the fluid to form a thicker liquid wetting film on external aircraft surfaces. This film provides a longer holdover time especially in conditions of freezing precipitation. With this type of fluid, additional holdover time will be provided by increasing the concentration of the fluid/water mixture, with a maximum holdover time available typically from undiluted fluid.

Holdover time guidelines give an indication as to the time frame of protection that could reasonably be expected under conditions of precipitation. However, due to the many variables that can influence holdover time, these times should not be considered as minima or maxima, as the actual time of protection may be extended or reduced, depending upon the particular conditions existing at the time, such as strong winds, jet blast, etc. Aircraft surfaces with steeper angles (e.g., vertical stabilizer, deployed flaps, etc.) might also have an effect on holdover times that needs to be considered.

Holdover time guidelines are established and published by the FAA and TC. The responsibility for the application of this data remains with the user.

CAUTION

Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may also be reduced when aircraft skin temperature is lower than OAT. Therefore, the indicated times should be used only in conjunction with a pre-takeoff check.

CAUTION

Surface coatings, including but not limited to waxes, are currently available that may be identified as ice phobic or hydrophobic, enhance the appearance of aircraft external surfaces, and/or lead to fuel savings. Since these coatings may affect the fluid wetting capability and the resulting fluid thickness of deicing/anti-icing fluids, they have the potential to affect holdover time and aerodynamics. Test all surface coatings against AIR6232 to ensure they do not interfere with the performance of deicing/anti-icing fluids. For more information, consult the fluid and aircraft manufacturers.

3.1.6.6.1 Local Frost Prevention in Cold-Soaked Wing Areas

Wing surface temperatures can be considerably below OAT due to contact with cold fuel and/or close proximity to large masses of cold-soaked metal in the wing structure. In these areas, frost can build up on wing surfaces and may result in the entire wing needing to be deiced and anti-iced prior to the subsequent departure. This section provides standards for the prevention of local frost formation in cold-soaked wing tank areas during transit stops in order to make deicing and anti-icing of the entire wing unnecessary under such circumstances. This procedure does not, however, supersede standard deicing and anti-icing procedures in accordance with WOM 3.1.14.4 and WOM 3.1.14.5, and it shall be applied in coordination with these subsections. This procedure also does not relieve the user from any requirements for treatment and checks in accordance with aircraft manufacturer manuals.

NOTE: This section is also applicable to other surfaces of the aircraft (e.g., stabilizers).

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3.1.6.6.1.1 Procedure

Using suitable spray equipment, apply a proper coating of undiluted Type II, III, or IV fluid to the wings in the limited cold-soaked areas where the formation of frost may be expected, due to contact of the wing with cold fuel or masses of cold metal.

NOTE: A proper coating completely covers the treated area with visible fluid.

3.1.6.6.1.2 Limits/Precautions for Local Frost Prevention

Procedure limitation: This local frost prevention procedure is neither a substitute for standard deicing and anti-icing procedures in accordance with sections WOM 3.1.14.4.2 and WOM 3.1.14.5.1, clear ice checks or any other aircraft manufacturer requirement, nor a substitute for the requirement that aircraft surfaces shall be clear of frost, snow, slush, or ice accumulations.

a) Operator approval: This procedure shall only be carried out if approved by the operator of the aircraft to be treated.

b) Training: This procedure shall only be carried out by trained and qualified personnel (see WOM 3.2).

3.1.6.6.1.3 Application Limits

This local frost prevention procedure shall be applied to clean wings immediately following arrival of the aircraft. Application is acceptable at the latest when frost just starts to form, but in this case the fluid shall be applied at a minimum temperature of 50°C (122°F). If precipitation occurred between application of the fluid and dispatch of the aircraft, and/or if precipitation is expected before takeoff, a two-step deicing/anti-icing procedure shall be performed (refer to WOM 3.1.14.4 and WOM 3.1.14.5).

3.1.6.6.1.4 Symmetrical Treatment Requirement

Wings shall receive the same and symmetrical treatment; the same area in the same location on each wing shall be sprayed, including when conditions would not indicate the need for treatment of both wings.

CAUTION

Aerodynamic problems could result if this requirement is not met.

3.1.6.6.1.5 Holdover Time

A holdover time shall not be assigned to local frost prevention since this treatment does not cover the entire aircraft or wing surface, respectively.

3.1.6.6.1.6 Final Check - Local Frost Prevention

A tactile (by touch) check of treated areas and a visual check of untreated areas of both wings shall be performed immediately before the aircraft leaves the parking position. These checks are conducted to ensure that both wings are clean and free of frost. The applied anti-icing fluid shall remain in a liquid state and shall show no indication of failure (e.g., color change to white, a loss of gloss, or the presence of ice crystals in the fluid film).

3.1.6.6.1.7 Flight crew Information - Local Frost Prevention

Where this procedure was performed, flight crew shall be advised of the treatment and that holdover times do not apply. This may be communicated through flight release or other documentation, or verbally when the flight crew is onboard. See XX (first note) and XX for more information.

3.1.6.7 Limits

3.1.6.7.1 Fluid Related Limits

Applied fluids: The freezing point depressant concentration of the applied fluid must not exceed the highest freezing point depressant concentration (as measured by refraction) at which the fluid met the aerodynamic acceptance test. For applicable values, refer to the fluid manufacturer's documentation.

Frost, snow, slush, or ice dilutes the fluid. Apply enough hot deicing fluid to ensure that refreezing does not occur, and all contaminated fluid is driven off.

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Temperature limits (see XX for information on application tables): When performing two-step deicing/anti-icing, the freezing point of the fluid used for the first step shall be at or below the OAT.

Type I fluids: The freezing point of the Type I fluid mixture used for either one-step procedure or as a second step in the two-step procedure, shall be at least 10 °C (18 °F) below the OAT. In no case shall this temperature be lower than the LOUT.

3.1.6.7.2 Fluid Related Limits

Applied fluids: The freezing point depressant concentration of the applied fluid must not exceed the highest freezing point depressant concentration (as measured by refraction) at which the fluid met the aerodynamic acceptance test. For applicable values, refer to the fluid manufacturer's documentation.

Temperature limits: When performing two-step deicing/anti-icing, the freeze point (FP) of the fluid used for the first step shall be at or below the OAT.

Type I fluids: The freezing point of the Type I fluid mixture used for either one-step procedure or as a second step in the two-step procedure shall be at least 10 °C (18 °F) below the OAT. In no case shall this temperature be lower than the LOUT.

CAUTION

All Type I fluids supplied as concentrates for dilution with water prior to use shall not be used undiluted. For exceptions, refer to fluid manufacturer's documentation.

CAUTION

All Type I fluids have a maximum concentration mix related to the aerodynamic acceptability. Refer to fluid manufacturer's documentation.

Type II, III, and IV fluids: The freezing point of Type II, III, IV fluids used for either one-step deicing/anti-icing or as the second step in a two-step procedure shall be at least 7°C (13°F) below OAT, and not lower than the aerodynamic acceptability lower limit of the fluid.

NOTE: Type II, III, and IV fluids do not have a published holdover times below -25 °C (-13 °F) in active frost conditions. Refer to local regulatory documents, such as the FAA Holdover Time Guidelines: Winter 20xx-20yy (annual publication) or to Transport Canada Holdover Time Guidelines: Winter 20xx-20yy (annual publication) for more information.

Frost, snow, slush, or ice dilutes the fluid. Apply enough hot deicing fluid to ensure that refreezing does not occur and all contaminated fluid is driven off.

3.1.6.7.3 Fluid Application Limits

Under no circumstances shall an aircraft that has been anti-iced receive a further coating of anti-icing fluid directly on top of the contaminated film. If an additional treatment is required before flight, a complete deicing/anti-icing shall be performed. Ensure that any remaining fluid from any previous treatment is flushed off. Anti-icing only is not permitted.

CAUTION

The application of Type II, III, and IV fluids, especially when used in a one-step procedure or in the first step of a two-step procedure, may cause fluids to collect in aerodynamically quiet areas, cavities, and gaps which can dry out and leave dried residues. Dried residues may rehydrate and freeze following a period of high humidity, and/or rain conditions. This may cause flight control problems. These dried residues may require removal.

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Consult the aircraft manufacturer with regard to inspection methods and frequency, related maintenance requirements, and aircraft washing recommendations.

CAUTION

The application of hot water or heated Type I fluid in the first step of a two-step procedure will minimise the formation of residues. Dried residues may rehydrate and freeze under certain temperature, high humidity, and/or rain conditions and may block or impede critical flight control systems. If a Type II, III, or IV fluid is used in a one-step procedure or in the first step of a two-step procedure, then an appropriate inspection and cleaning program shall be established dependent on the operator's experience and fleet type. Whenever suitable, deice and anti-ice with only Type I to help avoid these residue issues.

Flight control problems associated with frozen or unfrozen residues have been observed to be particularly prevalent when thickened fluids are used to remove frost during a period of dry weather followed by hydration of the dried residues by water from rain, condensation, cleaning, or wet snow in flight.

NOTE 1: In order to detect dried residues, it may help to spray a water mist onto the affected surfaces. This causes the dried residues to rehydrate and swell into a gel.

NOTE 2: If removal of contamination is required on the lower side of the wings and the horizontal stabilizer and elevator, deicing fluid shall be applied sparingly to minimise fluid flow into drain holes. Whenever possible, use Type I only. Consult the aircraft manufacturer's documentation.

3.1.6.7.4 Aircraft Related Limits

The application of deicing/anti-icing fluid shall be in accordance with the requirements of the airframe/engine manufacturers and local procedures.

3.1.6.8 Procedure Precautions

3.1.6.8.1 One-Step Procedure

This is performed using heated deicing/anti-icing fluids (see WOM 3.1.14.4.2). The correct fluid concentration is chosen with regard to desired holdover time, dictated by OAT and weather conditions (see WOM 3.1.14.8). The fluid used to deice the aircraft remains on the aircraft surfaces to provide limited anti-ice capability.

CAUTION

Wing skin temperature may differ and, in some cases, may be lower than OAT. A mix with higher glycol concentration can be used under the latter condition to ensure a sufficient buffer.

CAUTION

The application of Type II, III, or IV fluids, especially when used in a one-step procedure, may cause fluids to collect in aerodynamically quiet areas, cavities, and gaps which can dry out and leave dried residues. Dried residues may rehydrate and freeze following a period of high humidity and/or rain conditions. This may impede flight control systems. These dried residues may require removal. Consult the aircraft manufacturer with regard to inspection methods and frequency, related maintenance requirements, and aircraft washing recommendations.

NOTE 1: If a Type II, III, or IV fluid is used in a one-step procedure, then an appropriate inspection and cleaning program shall be established. Whenever suitable, deice and anti-ice with only Type I.

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NOTE 2: In order to detect dried residues, it may help to spray a water mist onto the affected surfaces. This causes the dried residues to rehydrate and swell into a gel.

NOTE 3: If removal of contamination is required on the lower side of the wings and the horizontal stabilizer and elevator, deicing/anti-icing fluid shall be applied sparingly to minimise fluid flow into drain holes. Whenever possible, use Type I only. Consult the aircraft manufacturer's documentation.

3.1.6.8.2 Two-Step Procedure when the First Step is Performed with Deicing Fluid (see WOM 3.1.14.5.1)

The correct fluid(s) shall be chosen with regard to OAT (see WOM 3.1.14.8). The second step is performed with anti-icing fluid to protect the surfaces. This fluid and its concentration are chosen with regard to desired holdover time, which is dictated by OAT and weather conditions. The second step shall be performed before the first step fluid freezes, if necessary, area by area. Service providers shall ensure the first step fluid and the second step fluid used on aircraft are compatible. This can be accomplished by contacting the respective fluid manufacturer(s).

Use a second step spraying technique to cover completely the first step fluid (for example, using the method described in WOM 3.1.14.5.1) with a sufficient amount of second step fluid. For guidance on the amount of fluid, refer to WOM 3.2, AS6286 and/or the fluid manufacturer's documentation.

Where refreezing occurs following the initial treatment, both the first and second step must be repeated.

CAUTION

Wing skin temperature may differ and, in some cases, may be lower than OAT. A mix with higher glycol concentration can be used under these conditions to ensure a sufficient buffer.

CAUTION

The application of Type II, III, or IV fluids, especially when used in a one-step procedure or in the first step of a two-step procedure, may cause fluids to collect in aerodynamically quiet areas, cavities, and gaps, which can dry out and leave dried residues. Dried residues may rehydrate and freeze following a period of high humidity and/or rain conditions. This may impede flight control systems. These dried residues may require removal. Consult the aircraft manufacturer with regard to inspection methods and frequency, related maintenance requirements, and aircraft washing recommendations. The use of hot water or heated mixture of Type I fluid/ water for the first step of a two-step deicing/anti-icing procedure will minimise the formation of dried residues.

NOTE 1: If a Type II, III, or IV fluid is used in the first step of a two-step procedure, then an appropriate inspection and cleaning program shall be established. Whenever suitable, deice and anti-ice with only Type I.

NOTE 2: In order to detect dried residues, it may help to spray a water mist onto the affected surfaces. This causes the dried residues to rehydrate and swell into a gel.

NOTE 3: Anti-icing of the lower side of the wings and/or horizontal stabilizer and elevator is normally not foreseen. However, if these surfaces must be deiced, the deicing fluid freezing point must be low enough to prevent refreezing.

3.1.6.8.3 Holdover Time of Applied Fluid

With regard to holdover time provided by the applied fluid, the objective is that it is equal to or greater than the estimated time from the start of anti-icing to the start of takeoff based on existing weather conditions.

3.1.6.8.4 Symmetrical Treatment

Aircraft shall be treated symmetrically, that is, left-hand and right-hand side shall receive the same and complete treatment, even when only one side of the aircraft needs treatment. Procedures in WOM 3.1.14.5.1 shall be followed if an anti-icing treatment is to be performed on the aircraft.

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CAUTION

The aircraft is considered UNSAFE if this requirement is not met.

3.1.6.8.5 Aircraft Configuration

During anti-icing and deicing, the moveable surfaces shall be in a position as specified by the aircraft manufacturer.

3.1.6.8.6 Air Conditioning and Bleed Air

Engines shall remain running at idle or can be shut down during deicing/anti-icing operations. Air conditioning and/or auxiliary power unit (APU) bleed air shall be selected OFF, or as recommended by the airframe and engine manufacturer. Avoid spraying deicing/anti-icing fluid directly into the engine inlet core.

3.1.6.8.7 Spray Precautions and Sensitive Areas

Do not spray deicing/anti-icing fluids directly onto wiring harnesses and electrical components (receptacles, junction boxes, etc.), brakes, wheels, exhausts, thrust reversers, cavities, or other sensitive devices.

3.1.6.8.8 Sensors

Deicing/anti-icing fluid spray shall not be directed into the orifices of pitot tubes (heads), static ports/vents, or directly onto air stream direction detectors probes/angle of attack airflow sensors. This includes all openings.

3.1.6.8.9 Engines

All reasonable precautions shall be taken to minimise fluid entry into engines, APU, other intakes/outlets, and control surface cavities. Refer to manufacturer documentation. Deicing/anti-icing fluid spray shall not be directed into engine core or directly onto engine probes/sensors.

3.1.6.8.10 Windows, Doors, and Emergency Exits

Do not direct fluid spray onto the flight deck or cabin windows, as this can cause crazing of the acrylic or penetration of the window seals. Fluid spray may be directed above these surfaces and allowed to flow over.

Do not spray deicing/anti-icing fluids directly onto windows, doors, and emergency exits/hatches to prevent any fluid infiltration.

3.1.6.8.11 Fluid Removal from Flight Deck Windows

If Type II, III, or IV fluids are used, all traces of the fluid on flight deck windows shall be removed prior to departure, with particular attention being paid to windows fitted with wipers. Any forward area from which fluid may blow back onto flight deck windows during taxi or subsequent takeoff shall be free of fluid prior to departure. Failure to do so may result in obscured visibility.

NOTE: Deicing/anti-icing fluid can be removed by rinsing with an approved cleaner and a soft cloth or flushing with Type I fluid.

3.1.6.8.12 Folding Wings

Do not direct high pressure fluid spray onto the hinge recesses or bushings on the lower extended lugs of folding wing devices, as this can cause lubricants to be washed away. Fan spray or overspray are allowed.

3.1.6.8.13 Landing Gear and Gravel Deflectors

Landing gear (including the gravel deflector and spray/foreign object debris (FOD) deflectors on certain types of aircraft) and wheel bays shall be kept free from the buildup of slush, ice, or accumulations of blown snow.

3.1.6.8.14 Balance Bays, Gaps, and Hinges

When removing ice, snow, or slush from aircraft surfaces care shall be taken to prevent it entering and accumulating in auxiliary intakes and control surface balance bays, gaps, or hinge areas.

3.1.6.8.15 In-Flight Ice Accretion and Splash Up

Contamination buildup on and within aircraft lift devices and other critical surfaces can form in flight or when on the ground. During icing conditions, when flaps and slats are retracted, contamination may not be visible. Conditions

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where this can occur may include, but are not limited to, the accumulation of ice in flight, the splash up of slush onto the underwing and flaps during ground maneuvering, and flap track contamination where snow and/or other contaminants may blow and compact within these openings. As the possibility exists that this could remain undetected, it is important that when these conditions are present or suspected, these areas shall be inspected, and any frozen deposits removed prior to departure.

3.1.6.8.16 Engine Ice

Under the conditions of freezing fog, or other freezing precipitation conditions, it is necessary for the front and rear side on the fan blades to be checked for ice buildup prior to start-up. Any deposits discovered are to be removed by directing air from a low flow hot air source, such as a cabin heater, onto the affected areas or other means recommended by the aircraft operator based on information from the aircraft and engine manufacturers.

3.1.6.8.17 Fluid Residues

After frequent applications of deicing/anti-icing fluids, it is advisable to inspect aerodynamically quiet areas and cavities for dried residues of thickened deicing/anti-icing fluid. For these inspections, it may be necessary to open access panels. Consult airframe manufacturers for inspection and cleaning details and procedures.

3.1.6.8.18 Treatment Interruption

If a treatment is interrupted (for example, a truck running out of fluid), the flight crew shall be immediately informed, stating:

- The reason for the interruption.
- Actions to be taken (in consultation with the flight crew).
- Expected time of delay.

Before continuing the treatment:

- Inform the flight crew.
- Establish in consultation with the flight crew, the further treatment to be carried out, including any surfaces requiring re-treatment in relation to holdover time.

Carry out the treatment as agreed.

3.1.6.8.19 Clear Ice Precautions

Clear ice can form on aircraft surfaces below a layer of snow or slush. Therefore, it is important that surfaces are closely examined following each deicing procedure, in order to ensure that all deposits have been removed. Significant deposits of clear ice can form in the vicinity of the fuel tanks, on wing upper surfaces, as well as underwing. Aircraft are most vulnerable with regard to this type of buildup when one or more of the following conditions exist:

- Wing temperatures remain well below 0°C (32°F) during the turnaround/transit.
- Ambient humidity is high and/or precipitation occurs while the aircraft is on the ground.
- Frost or ice is present on lower surface of either wing.
- Ambient temperatures between -2°C (28°F) and +15°C (59°F) are experienced, although clear ice may form at other temperatures if the other three conditions listed above exist.

Clear ice is extremely difficult to detect. Therefore, when the above conditions prevail, or when there is otherwise any doubt that clear ice may have formed, a close examination shall be made visually and/or physically prior to departure, in order to ensure that surfaces are free of clear ice. If clear ice is believed to be present, deicing is required.

NOTE: Low wing temperatures associated with this type of buildup normally occur when large quantities of cold fuel remain in wing tanks during the turnaround/transit and any subsequent refueling is insufficient to cause a significant increase in fuel temperature.

3.1.6.8.20 Proximity Sensor Activation Reporting Procedures

An operational procedure shall be in place in circumstances where a proximity sensor on the deicing equipment is activated and/or comes into contact with an aircraft surface. For equipment types furnished with a proximity sensor requiring physical contact in order to activate, in the event of sensor contact, the pilot-in-command shall be informed immediately and be provided with specific information pertaining to the location on the aircraft where

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contact was made. The equipment involved shall remain in position until investigation can occur to inspect the affected area for damage.

A third party shall visually inspect the affected area for any signs of visual damage. If no visible damage is observed, the de/anti-icing procedure may continue at the discretion of the pilot-in-command. If damage is suspected or detected, the pilot-in-command shall be notified and the de/anti-icing procedure shall cease. Further inspection of the affected area should be performed by an individual deemed qualified under the air operators' program to determine the aircraft airworthiness.

NOTE: By design, this type of proximity sensor normally will not cause damage to an aircraft surface if contact is made to a fixed aircraft surface while the equipment chassis is stationary. In certain circumstances, however, damage may occur outside of the sensors design limitations. This includes, but is not limited to:

- Contact with an aircraft surface while the equipment chassis is maneuvering;
- Contact with an aircraft surface while the aircraft is maneuvering;
- Contact with a moving/rotating aircraft surface (i.e., propeller, engine fan blade, etc.); and/or
- Contact is made or suspected to have been made between a component of the deicing vehicle and aircraft.

In these circumstances, the procedures mentioned above this note shall apply. Should a proximity sensor be activated, all pertinent and relevant details shall be documented, including (at a minimum):

- Date.
- Time.
- Vehicle operator name(s).
- Vehicle identification (e.g., number).
- Flight number.
- Aircraft registration and/or air operator fleet identification (e.g., fin/tail/ship number, etc.).
- Deicing location (e.g., bay or gate number).
- Location on the aircraft where the contact was made, including specifics (e.g., side, aircraft part, etc.)
- Proximity sensor location on the vehicle and point where the contact was made (e.g., nozzle, left side of sensor, etc.).
- Name and job title of the third-party individual that performed inspection.
- Third-party company name (not required if third party is from the deicing/anti-icing company).
- Result of the third party inspection (e.g., no visual damage detected or damage suspected/present).

Groundcrew involved in the de/anti-icing procedure shall be trained on the operation of the proximity sensor (including equipment reactivation) and procedures in the event of contact. In addition, for those personnel deemed qualified to perform the third-party inspection, they shall also be trained on visual inspection requirements and procedures. Flight crew should be trained on the purpose and functionality of a proximity sensor, and the specific company procedures and requirements in the event of contact.

3.1.6.9 Fluid Application Guidelines

The fluid application guidelines are part of local regulatory documents, such as the FAA Holdover Time Guidelines: Winter 20xx-20yy (annual publication) or to Transport Canada Holdover Time Guidelines: Winter 20xx-20yy (annual publication).

CAUTION

Failure to follow proper fluid application guidance may result in reduced protection of uncertain duration.

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3.1.7 Checks

The decision whether deicing/anti-icing is required shall be determined when one or more of the following circumstances is applicable:

- An aircraft is parked overnight and subjected to ice or snow conditions.
- When ice has accumulated in flight (in-flight ice accretion).
- During taxi to the gate occurring in icing and/or snow conditions.
- Following an inspection or check by the flight crew at a gate.
- As indicated by a check by a qualified deicing/anti-icing person.
- Active frozen or freezing falling precipitation is occurring.
- When cold-soaked fuel has created ice or frost on critical surfaces or components.
- When aircraft has been deiced/anti-iced some time prior to flight crew arrival.

3.1.7.1 Contamination Check to Establish the Need for Deicing

A contamination check shall include all areas mentioned in WOM 3.1.8.2 through WOM 3.1.8.2, and any other surfaces and components of the aircraft as indicated by the aircraft manufacturer and shall be performed from points offering sufficient visibility of these parts (e.g., from the deicing/anti-icing vehicle, a ladder, or any other suitable means of access as necessary). Any contamination found on the surfaces or components of the aircraft that are critical to safe flight shall be removed by a deicing procedure; this shall be followed by anti-icing treatment when required.

Where an aircraft has been deiced and/or anti-iced some time prior to the arrival of the flight crew, an additional contamination check shall be carried out prior to departure, in order to establish whether further treatment is required. Requests for deicing/anti-icing shall specify the parts of the aircraft requiring treatment.

NOTE: For specific aircraft types, additional requirements exist; e.g., special clear ice checks, such as tactile checks on wings. These special checks are not covered by the contamination check. Aircraft operators shall make arrangements for suitably qualified personnel to meet these requirements.

3.1.7.2 Tactile Check

The need for a specific tactile check shall be determined by the aircraft manufacturer, air operator and/or local regulator.

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3.1.7.3 Post-Deicing/Anti-Icing Check

An aircraft shall not be dispatched after a deicing/anti-icing procedure until the aircraft has received the following visual check by qualified staff. This check shall include wings, horizontal stabilizers (both lower and upper surfaces), vertical stabilizer, and fuselage, including pitot heads, static ports temperature sensors, and angle of attack sensors. This check shall also include any other parts of the aircraft on which a deicing/anti-icing procedure was performed according to the requirements identified during the contamination check.

The post-deicing/anti-icing check shall be performed from points offering sufficient visibility of all treated surfaces (e.g., from a deicing/anti-icing vehicle, ladder, or other suitable means of access). Any contamination found shall be removed by further deicing/anti-icing treatment, and the post-deicing/anti-icing check shall be repeated. Before takeoff, the flight crew must ensure that they have received confirmation that this post-deicing/anti-icing check has been accomplished.

NOTE 1: For specific aircraft types, additional requirements exist; e.g., special clear-ice checks, such as tactile checks on wings. These special checks are not covered by the post-deicing/anti-icing check. Aircraft operators shall make arrangements for suitably qualified staff to meet any special check requirements.

NOTE 2: During engine(s)-on deicing operations, the access/view to certain aircraft components is restricted and cannot be checked (e.g., Inboard underwings between the running wing mounted engines and the fuselage). These areas should be inspected during the pre-flight contamination check and if treatment is required, advise the deicing personnel for further coordination and removal.

When the deicing/anti-icing service provider performs the deicing/anti-icing treatment as well as the postdeicing/ anti-icing check, it may either be performed as a separate check or incorporated into the deicing/anti-icing operation as specified below. The deicing/anti-icing service provider shall specify the method used in his winter procedures, by customer where necessary:

As the deicing/anti-icing treatment progresses, the deicing/anti-icing sprayer will closely monitor the surfaces receiving treatment in order to ensure that all forms of frost, snow, slush, or ice (with the exception of cold-soaked fuel frost on the lower surface of wings and light frost on the fuselage, which may be allowed per the aircraft manufacturer and state regulatory authority) are removed, and that upon completion of anti-icing treatment, these surfaces are fully covered with an adequate layer of anti-icing fluid.

When the request for deicing/anti-icing did not specify the fuselage, a visual check of the fuselage shall be performed at this time, in order to confirm that it has remained free of contamination (with the possible exception of light frost, which may be allowed as per the aircraft manufacturer and state regulatory authority). If contaminated, advise flight crew to consider its removal.

Any evidence of contamination that is outside the defined limits shall be reported to the flight crew immediately and be removed by further deicing/anti-icing treatment. Then the post-deicing/anti-icing check shall be repeated.

Once the treatment has been completed, the deicing operator will conduct a close visual check of the surface where the treatment commenced, to ensure that it has remained free of contamination.

3.1.7.4 Pre-Takeoff Check

The flight crew shall continually monitor the weather conditions after the deicing/anti-icing treatment. Prior to takeoff, a flight crew member shall assess whether the applied holdover time is still appropriate and/or if untreated surfaces may have become contaminated. This check is normally performed from **inside** the flight deck.

3.1.7.5 Pre-Takeoff Contamination Check

This is a check of the critical surfaces for contamination. This check shall be performed when the condition of the critical surfaces of the aircraft cannot be effectively assessed by a pre-takeoff check or when the holdover time has been exceeded. This check is normally performed **outside** of the aircraft. The alternate means of compliance for a pre-takeoff contamination check is to perform a complete deicing/anti-icing re-treatment of the aircraft.

3.1.7.6 Flight Control Check

A functional flight control check using an external observer may be required after deicing/anti-icing, depending upon aircraft type (refer to relevant manuals). This is particularly important in the case of an aircraft that has been subjected to an extreme ice or snow covering.

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3.1.8 Aircraft Requirements After Deicing/Anti-icing

3.1.8.1 General

Following the deicing/anti-icing procedures and prior to take-off, the critical aircraft surfaces shall be free of all frost, snow, slush, or ice accumulations in accordance with the following requirements.

3.1.8.2 Wings, Tails, and Control Surfaces

Wings, tails, and control surfaces shall be free of frost, snow, slush, or ice unless the aircraft manufacturer and regulatory authority permits that a coating of frost may be present on wing lower surfaces in areas cold-soaked by fuel between forward and aft spars; and/or on upper wing surfaces within defined areas, in accordance with the aircraft manufacturer's published documentation.

NOTE: Except for frost due to cold-soaked fuel as mentioned above, and unless otherwise specified in the Aircraft Flight Manual or other aircraft manufacturer's documentation, contamination is not acceptable on the upper or lower surfaces of the horizontal stabilizer and elevator/tab; strakes; inboard, outboard, upper, and lower surfaces of the wing and wing tip devices; and either side of the vertical stabilizer and rudder.

3.1.8.3 Pitot Tubes, Static Ports, and All Other Air Data Sensing Devices

Pitot tubes, static ports, angle of attack sensors, and other air data sensing devices shall be free of frost, snow, slush, ice, and fluid.

NOTE: Ice ridges can form on different areas of the aircraft, especially on the nose of the fuselage while on the ground. These ridges will disrupt air flow into the air data sensing devices, which can result in false measurements. All contamination shall be removed from these areas.

3.1.8.4 Engines

Engine inlets (including the leading edge), exhaust, thrust reversers, cooling intakes, control system probes, vortex dissipators, and ports shall be free of frost, snow, slush, or ice. Engine fan blades, propellers (as appropriate), and spinner cones shall be free of frost, snow, slush, or ice, and shall be free to rotate.

3.1.8.5 Air Conditioning Inlets and Outlets

Air inlets, outlets, pressure-release valves, and outflow valves shall be free of frost, snow, slush, or ice, and shall be unobstructed.

3.1.8.6 Landing Gear and Landing Gear Doors

Landing gear and landing gear doors shall be unobstructed and free of frost, snow, slush, or ice. Do not spray deicing/ anti-icing fluids directly onto wiring harnesses and electrical components (receptacles, junction boxes, etc.) brakes and wheel components.

3.1.8.7 Fuel Tank Vents

Fuel tank vents shall be free of frost, snow, slush, or ice.

3.1.8.8 Fuselage

The fuselage shall be free of ice, slush, and snow. In accordance with the aircraft manufacturer's documentation, frost may be present on the fuselage for take-off within specified amounts provided that no other forms of contamination are present, and inlets, outlets, and other devices (as identified by the aircraft manufacturer) are free of contamination.

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3.1.8.9 Flight Deck Windows and Nose or Radome Area

Any significant deposits of frost, snow, slush, or ice on the flight deck windows or on areas forward of the flight deck windows shall be removed prior to departure. Heated flight deck windows will not normally require deicing. Any forward area from which fluid may flow back onto flight deck windows during taxi or subsequent takeoff shall be free of fluid prior to departure.

If SAE Type II, III, or IV fluids have been used, all traces of the fluid on flight deck windows shall be removed prior to departure, with particular attention paid to windows fitted with wipers. Thickened fluid (SAE Types II, III, or IV) can be removed by using a diluted Type I mixture, water (where it has been determined that refreezing will not occur), a manual method (ensuring that windscreen heat is turned off), or another cleaner as approved by the aircraft manufacturer.

NOTE: During falling precipitation, heated windows may cause liquid effluent to freeze near sensors, requiring deicing.

3.1.8.10 Dried Thickened Fluid Residues When the Aircraft Has Not Been Flown after Anti-Icing

Dried thickened-fluid (SAE Types II, III, or IV) residues can occur when surfaces have been deiced/anti-iced but the aircraft has not been flown and has not been subject to precipitation. The fluid may then have dried on the surfaces. In such situations, the aircraft must be checked for dried residues from thickened fluids and cleaned as necessary.

3.1.8.11 Special Maintenance Considerations

Proper account should be taken of the possible side-effects of fluid use. Such effects may include, but are not necessarily limited to, dried and/or rehydrated residues and the removal of lubricants.

3.1.9 Communications

3.1.9.1 Communication Procedures

Persons communicating with the flight crew shall have a basic knowledge of the English language (operational level or equivalent according to the current version of the training document WOM 3.2). For local flights involving local flight and ground crew, local language may be used (refer to the current version of training document WOM 3.2).

Communication between the flight crew and the ground crew will usually be achieved using a combination of documentation, visual and/or verbal communication. For treatments carried out with flight crew onboard, the use of flight interphone (headset) or VHF radio will usually be required. Message boards (electronic/written) may also be used at designated deicing facilities (DDF) and other deicing locations to enhance communications. Use of hand signals is not recommended except for the final “all clear” signal.

NOTE: In circumstances where an aircraft is deiced or anti-iced overnight and/or where flight crew members are not onboard, the subsequent flight crew communication procedures do not apply. In these circumstances, the air operator should be advised the treatment details, and where applicable, the anti-icing code elements where anti-icing was performed.

3.1.10 Communication Prior to Starting Deicing/Anti-Icing Treatment

A. Before starting deicing/anti-icing, the flight crew shall be requested to confirm the treatment required (i.e., surfaces and components to be deiced, anti-icing requirements, plus any special deicing procedures).

B. Before fluid treatment starts, the flight crew shall be requested to configure the aircraft for deicing/anti-icing (surfaces, controls, and systems as per aircraft type requirements or recommended procedures). The deicing crew shall wait for confirmation that this has been completed before commencing the treatment.

C. For treatments conducted without the flight crew present, suitably qualified staff member shall be nominated by the aircraft operator to confirm the treatment required (when applicable) and to confirm the correct configuration of the aircraft.

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3.1.11 Abnormal Communication

3.1.11.1 Communication for Proximity Sensor Activation by Physical Contact

For equipment types furnished with a proximity sensor requiring physical contact in order to activate (see 5.7.13 for further information) and, in the event of sensor contact, the flight crew shall be informed using the suggested phraseology in Table 3.

3.1.11.2 Interrupted Operations

A deicing/anti-icing treatment should be continuous and as short as possible. If a treatment is interrupted (for example, a truck runs out of fluid or flight crew troubleshooting, etc.), parties involved in the operations shall be immediately informed stating:

a) The reason for interruption.

b) The actions to be taken (in consultation with other party flight crew/ ground crew).

c) The expected time of delay.

d) Statement that deicing/anti-icing is incomplete and to standby.

Follow the suggested phraseology in table 4.

3.1.12 Communication Post-Deicing/Anti-Icing Procedures

An aircraft shall not be dispatched for departure after treatment until the flight crew has been notified of the type of treatment performed and all the relevant information. The post-deicing/anti-icing communication (see WOM 3.1.12.1) shall be provided by qualified staff upon completion of the treatment, indicating that the checked surfaces (see WOM 3.1.7.3**)** are free of frost, snow, slush, or ice; that deicing/anti-icing is complete, that equipment is cleared from the area; and in addition, providing the necessary information for the flight crew to estimate the appropriate holdover time for the prevailing weather conditions when anti-icing fluid has been used.

3.1.12.1 The Anti-Icing Code

The following elements comprising the anti-icing code shall be recorded and be communicated to the flight crew by referring to the anti-icing treatment. The elements below shall be provided:

NOTE: This information shall not be communicated in circumstances where anti-icing holdover times do not apply, e.g., local frost prevention in cold-soaked wing areas, symmetrical local area deicing, or deicing of specific surfaces only (such as leading edges for removal of impact ice), etc. See 8.4.1.2 and 8.6.1.1 for more information.

A. The fluid type (i.e., Types I, II, III, or IV)

B. The fluid name (manufacturer and brand/trade name) of the Types II, III, or IV anti-icing fluid.

NOTE: Communication of this element is not required for Type I fluid.

C. The concentration of fluid (dilution) within the undiluted fluid/water mixture, expressed as a percentage by volume for Types II, III, or IV (i.e., 100% (“undiluted”) = 100% fluid, 75% = 75% fluid and 25% water, 50% = 50% fluid and 50% water).

NOTE: Communication of this element is not required for Type I fluid.

D. The local time (hours and minutes -hh:mm), either:

1) For a one-step deicing/anti-icing operation: at the start of the final treatment, or
2) For a two-step deicing/anti-icing operation: at the start of the second step (anti-icing).

E. The date in the following format: day, month, year (DDMMMYY (e.g., 28JAN15 = January 28, 2015))

NOTE: This element is required for record keeping and is optional for flight crew notification.

F. The statement, “Postdeicing/anti-icing check completed.”

NOTE 1: For specific aircraft types, additional requirements exist, e.g., tactile checks for clear ice on wing surfaces. Additional confirmation for these checks may be required.

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NOTE 2: An alternative means of visual communication of the anti-icing code to the flightcrew can be used (e.g., written on paper, MBs, ACARS, EFBs, etc.).

NOTE 3: Aircraft onboard systems, available to assist flightcrew to determine holdover time, require a good coordination between service providers and aircraft operators to provide fluid information in advance or to inform the customers of any change of fluids prior the de/anti-icing operation.

Follow the suggested phraseology in Table 2.

3.1.13 Off-Gate Communications

During deicing/anti-icing, a two-way communication between the flight crew and the deicing/anti-icing operator/ supervisor must be established prior to the deicing/anti-icing procedure. This may be done either by interphone or by VHF radio. Alternate means of communication may be the use of ACARS, EFBs, and MBs. In the event of conflict, verbal communication shall take precedence.

During treatment, all necessary information must be transmitted to the flight crew, including the beginning of treatment, treatment of the sections requiring de-activation of aircraft systems, etc. (using standardized deicing/ anti-icing phraseology). Communication contact with the flight crew may be concluded after transmission of the post-deicing/anti-icing communication and readiness for taxi-out has been announced. During deicing/anti-icing operations with engines on, both verbal and visual communications shall be utilised and positive control maintained during the deicing/anti-icing operation in accordance with ARP5660.

A. General instructions: The deicing/anti-icing operator and/or airport authority must ensure that all necessary information regarding operation of the off-gate/CDF/DDF site is published and available to flight crews. This information shall be included within the deicing/anti-icing operator’s and/or airport authority’s local procedures documentation and be made available to air operators and flight crews (e.g., it can be included as part of flight release documentation, etc.). This information should also be published in applicable state aeronautical navigation documents/publications. This information shall include, at a minimum:
   1) The location of and standard taxi routing to, within, and from the deicing/anti-icing site;
   2) How to coordinate the deicing/anti-icing operation;
   3) How to communicate before, during, and after the deicing/anti-icing operation;
   4) How taxi-and-stop guidance is provided to the flight crew (e.g., VHF, MBs, etc.); and,
   5) Any unique requirements or procedural differences affecting the flight crew and/or flight crew/ground crew interface.

B. Responsibilities: The responsibility to conduct a contamination check before dispatch rests with trained and qualified personnel. If the contamination check was performed by a person different that the flight crew, the results of the contamination check must be provided to the flight crew via verbal or visual (written or electronic) means. Subsequently, the flight crew is responsible for acquiring the proper treatment. After treatment, the treated surfaces and components must be checked by a trained and qualified staff (see WOM 3.1.16) and the post-deicing/anti-icing report must be given to the flight crew (see WOM 3.1.12.1). Subsequently, the flight crew is responsible for the airworthiness of the aircraft.

C. Emergency procedures: Whether conducting deicing/anti-icing operations at a remote location or at a centralised deicing/anti-icing facility, local procedures shall be established to ensure that both aircraft and ground emergencies are handled safely, expeditiously, and are coordinated with the local emergency plan.

3.1.13.1 Phraseology

Use of the following phraseology is recommended during deicing/anti-icing operations and are intended as guidelines for establishing clear, concise standardized communication and phraseology between flight crew and ground crew during an aircraft deicing/anti-icing operation. It is very important that both parties understand fully about communication requirements, aircraft configuration, de/anti-icing treatment needed, and post-deicing reporting requirements.

In locations/operations with unique or specific operating requirements and/or technologies, supplemental phraseology or modifications to the phraseology in this document may be required. This may include but is not limited to specific aircraft configuration requirements or specialized checks (i.e., tactile check), locations/operations where approved alternate means of communications are utilized (i.e., MBs, EFB applications, etc.), or other

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regulatory or air operator requirements exist. This is permitted, pending the required communication elements (i.e., anti-icing code or post-deicing report) are maintained and provided to the flight crew in the respective circumstance.

3.1.13.1.1 Ground Crew and Flight Crew Phraseologies for Deicing/Anti-Icing Operations

Words italicized in parentheses—(xxxx)—indicate that specific information, such as a level, a place, or a time, etc., must be inserted to complete the phrase, or, alternatively, that optional phrases may be used. Words in square brackets—[xxxx]— indicate optional additional words or information that may be necessary in specific instances. Within the phraseologies, where the term "NOTE" is followed by a numeral, a superscript numeral—#—has been placed within the phraseology to indicate the specific element where the note is applicable.

3.1.14 Ground Equipment

3.1.14.1 Deicing Units

Combustion heaters and trucks shall not be operated in confined or poorly ventilated areas to prevent asphyxiation.

- Motorised/trucks (refer to ARP1971).
- Non-motorised (tower/gantry/carts).
- Forced air or forced air/fluid equipment for the removal of frozen contaminants (refer to AIR6284).

3.1.14.2 Ice Detention Equipment

Refer to AS5681.

3.1.15 Deicing and Anti-Icing Fluids

3.1.15.1 Fluid Storage and Handling

Deicing/anti-icing fluid is a chemical product with an environmental impact. During fluid handling, avoid any unnecessary spillage, comply with local environmental and health laws, and follow the manufacturer's safety data sheet (SDS). Different products shall not be commingled (blended) without additional qualification testing. Consult with the fluid manufacturers. Slippery conditions may exist on the ground or equipment following the deicing/anti-icing procedure. Caution should be exercised, particularly under low humidity or non-precipitation weather conditions.

Tanks shall be dedicated to the storage of the deicing and/or anti-icing fluid to avoid contamination with other fluids. Storage tanks shall be constructed of materials compatible with the deicing/anti-icing fluid, as specified by the fluid manufacturer. Care should be taken to avoid using dissimilar metals in contact with each other, as galvanic corrosion may form and degrade thickened fluids. Tanks shall be conspicuously labeled to avoid contamination. As a minimum, the following information must be identified:

- Type of fluid (SAE Types I, II, III, or IV).
- Fluid product name.
- Fluid concentration or mixture.
- Examples:
  - SAE Type I Fluid Manufacturer, Product Name, Concentrate Aircraft Deicing Fluid.
  - SAE Type I Fluid Manufacturer, Product Name, Dilute Aircraft Deicing Fluid.
  - SAE Type IV Fluid Manufacturer, Product Name, "undiluted," 75/25 or 50/50.

The condition of the tanks shall be examined annually for corrosion, contamination, and/or leaks. If corrosion or contamination is evident, tanks shall be repaired or replaced. Corrosion in tanks most often occurs in the vapor space of partially empty tanks by evaporation and subsequent condensation of water from the deicing fluid. To reduce corrosion, keep tanks containing aircraft deicing fluid full during summer or periods of low use.

NOTE 1: If the quality of the fluids is checked in accordance with WOM 3.1.5.5.3, the tank inspection interval may be longer than one year.

NOTE 2: Although deicing/anti-icing fluids are generally noncorrosive, the water vapor in the head space above the fluids can accelerate corrosion. To reduce head space corrosion, keep the tanks full.

Storage temperature limits for the fluid shall comply with the manufacturer's requirements.

3.1.15.2 Fluid Transfer Systems

The performance characteristics of Type II, III, and IV deicing/anti-icing fluids may be degraded by excessive mechanical shearing or chemical contamination. Therefore, only compatible pumps, control valves, piping, hoses, and application devices (nozzles) shall be used. The design of fluid transfer systems shall be in accordance with the fluid manufacturer's recommendations. Fluid transfer systems shall be dedicated to the specific fluid being handled to prevent inadvertently mixing fluids of different Types or manufacturers. All fill ports and discharge points shall be clearly labeled to prevent inadvertent product mixing. All fill ports must be protected to prevent foreign contamination.

3.1.15.3 Heating

Deicing/anti-icing fluids shall be heated according to the fluid manufacturer's guidelines, and the heated fluids shall be checked periodically.

- For Type I fluids, water loss may cause undesirable aerodynamic effects.
- For Type II, III, and IV fluids, thermal exposure and/or water loss may cause degradation making them not usable.

CAUTION

Avoid unnecessary heating of fluid in vehicle tanks. Prolonged or repeated heating of fluids (directly or indirectly) may result in loss of water or oxidation, which can lead to the performance degradation of the fluid, and may cause viscosity degradation in Type II, III, and IV fluids leading to shorter holdover times. Any of the following situations or a combination of them can accelerate the fluid performance degradation:

- Low fluid usage (turnover).
- Trucks being in standby mode with heating system on for extended periods of time.
- High temperatures in the fluid tanks.
- High temperatures in water tanks which are in direct contact with the fluid tanks (no insulation between tanks).

The integrity of the fluid following heating shall be checked periodically. Factors like heating rate, time, and temperature cycling should be considered in determining the frequency of fluid inspections. Refer to the fluid manufacturers' recommendations.

3.1.15.4 Application Equipment

Check with the fluid manufacturer's recommendations for filling and fluid transitions in order to prevent fluid contamination and degradation. Requirements for suitable equipment are described in ARP1971. Application equipment shall be clean before being initially filled with deicing/anti-icing fluid in order to prevent fluid contamination.

3.1.16 Staff Training and Qualification

Deicing/anti-icing procedures must be carried out exclusively by personnel trained and qualified on this subject. Companies providing deicing/anti-icing services shall have both a qualification program and a QC program to monitor and maintain an acceptable level of competence.

Training programs shall follow the guidelines and recommendations published in WOM 3.2.

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3.2 AIRCRAFT GROUND DEICING/ANTI-ICING TRAINING AND QUALIFICATION PROGRAMME

3.2.1 Rationale

This document provides the industry standards and guidance for the training and qualifying of staff, plus the expected contents of this training for effective deicing and anti-icing of aircraft on the ground. It forms one part of three related SAE Aerospace Standards (AS) and should be read in conjunction with WOM 3.1 and WOM 3.4. Collectively, WOM 3.1, WOM 3.2, and WOM 3.4 are known to the international community as “the Globalized Aircraft Deicing Standards.”

Exposure to weather conditions conducive to ice formation can cause the accumulation of frost, snow, slush, and ice on aircraft surfaces and components. These contaminants can adversely affect aircraft performance and controllability. In addition, they can adversely affect the operation of mechanical devices such as control surfaces, sensors, flaps, and landing gear. If frozen deposits are present other than those accounted for in the aircraft certification process, then the performance and safety of the aircraft will be compromised.

Regulations governing aircraft operations in ground icing conditions shall be followed. The International Civil Aviation Organization ICAO “Annex 6, Part I” mandates specific rules for the safe operation of aircraft during ground icing conditions, and all member states subsequently are required to have regulations in place to ensure conformance with these. Paraphrased, these rules specify that no one may dispatch or take off an aircraft with frozen deposits on components of the aircraft that are critical to safe flight. A critical surface or component is one which could adversely affect the mechanical or aerodynamic function of an aircraft. The intent of these rules is to ensure that no one attempts to dispatch or operate an aircraft with frozen deposits adhering to any aircraft component critical to safe flight. This is known as the “clean aircraft” concept.

This document specifies the standards for training and qualifying staff, plus the expected contents of their training. It provides guidance for the setting up of a proper training and qualification programme for the deicing and anti-icing of aircraft on the ground. Although references are made to the other two global standards, some background information to support a training programme is provided to make the material a better tool for the preparation and execution of the training and qualification process. Standard teaching plans and a practical assessment method are included. This material was compiled using various international documents, with support from SAE standards and individually contributed editorial comments. Its purpose is to serve as a “globalized deicing training manual.” In addition, each organisation involved in aircraft ground deicing and anti-icing is responsible for complying with local regulations and requirements imposed by manufacturers of aircraft, equipment, and fluids, in addition to regulatory and environmental authorities.

This revision represents a completion of the work performed in the previous WOM 3.2 revision. Some work was undefined or under discussion so for the sake of clarity, the previous WOM 3.2 revision was completed with some items outstanding with the intention of following up quickly with a new revision.

3.2.2 Scope

3.2.2.1 Field of Application

This document establishes the minimum training and qualification requirements for ground-based aircraft deicing/ anti-icing methods and procedures. All guidelines referred to herein are applicable only in conjunction with the applicable documents. Due to aerodynamic and other concerns, the application of deicing/anti-icing fluids shall be carried out in compliance with engine and aircraft manufacturers’ recommendations. The scope of training should be adjusted according to local demands. There are a wide variety of winter seasons and differences of the involvement between deicing operators, and therefore the level and length of training should be adjusted accordingly. However, the minimum level of training shall be covered in all cases. As a rule of thumb, the amount of time spent in practical training should equal or exceed the amount of time spent in classroom training.

3.2.2.2 Agreements and Contracts

This information is recommended as a basis for operations and service support agreements.

3.2.2.3 Hazardous Materials

While the materials, methods, applications, and processes referenced to or described in this specification may involve the use of hazardous materials, this standard does not address the hazards which may be involved in their use. It is the sole responsibility of the user to ensure their familiarity with the safe and proper use of any hazardous

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

3.2.3 References

3.2.3.1 Applicable Documents

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document shall take precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3.2.3.2 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

AMS1424	Fluid, Aircraft Deicing/Anti-Icing, SAE Type I
AMS1424/1	Deicing/Anti-Icing Fluid, Aircraft SAE Type I Glycol (Conventional and Non-Conventional) Based
AMS1424/2	Deicing/Anti-Icing Fluid, Aircraft SAE Type I Non-Glycol Based
AMS1428	Fluid, Aircraft Deicing/Anti-Icing, Non-Newtonian (Pseudoplastic), SAE Types II, III, and IV
AMS1428/1	Fluid, Aircraft Deicing/Anti-Icing, Non-Newtonian (Pseudoplastic), SAE Types II, III, and IV Glycol (Conventional and Non-Conventional) Based
AMS1428/2	Fluid, Aircraft Deicing/Anti-Icing, Non-Newtonian (Pseudoplastic), SAE Types II, III, and IV Non-Glycol Based
ARP1971	Aircraft Deicing Vehicle - Self-Propelled
ARP5660	Deicing Facility Operational Procedures
AS5900	Standard Test Method for Aerodynamic Acceptance of AMS1424 and AMS1428 Aircraft Deicing/ Anti-Icing Fluids
AS6285	Aircraft Ground Deicing/Anti-Icing Processes
AS6286B	Aircraft Ground Deicing/Anti-Icing Training and Qualification Program
AS6332	Aircraft Ground Deicing/Anti-Icing Quality Management
AS9100	Quality Management Systems - Requirements for Aviation, Space, and Defense Organizations

3.2.3.3 Other Applicable Documents

ICAO DOC 9640 AN/940 Manual of Ground Deicing/Anti-Icing Operations

ICAO DOC 9835 AN/453 Manual on the implementation of ICAO Language Proficiency Requirements

ICAO Annex 6, Operation of Aircraft, Part 1 – International Commercial Air Transport – Aeroplanes

ICAO Doc 4444 ATM/501 – Procedures for Air Navigation Services – Air Traffic Management

ISO 9001 Quality management systems - Requirements

FAA, Holdover Time Guidelines (current issue – annual publication)

FAA, Notice N 8900.ZZZ, “Revised FAA–Approved Deicing Program Updates” (current issue – annual publication)

FAA, Ground Deicing Program - Summary of Changes to FAA Holdover Time Guidelines and Associated Documents for Winter 20xx-20yy (current issue - annual publication)

FAA, Ground Deicing Program - General Information (current issue - annual publication)

Transport Canada, Holdover Time (HOT) Guidelines Regression Information (current issue – annual publication)

Transport Canada Holdover Time Guidelines: Winter 20xx-20yy (current issue - annual publication)

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Transport Canada, TP 14052E, "Guidelines for Aircraft Ground Icing Operations" (current issue – annual publication)

3.2.3.4 Related Publications

The following publications are provided for information purposes only and are not a required part of this SAE Technical Report.

Aircraft Manufacturer and Operator Manuals.

3.2.3.5 Definitions and Abbreviations

3.2.3.5.1 Definitions

HEAD OF DEICING TRAINING: The person responsible for ensuring the effective delivery of the deicing/anti-icing training of personnel for the whole organisation. This person must have a complete understanding of the subject matter herein and a documented competence level. By agreement of the senior management team, this may also be the Programme Manager/Responsible Person/Accountable Executive.

FLIGHT CREW TRAINING: The person responsible for deicing/anti-icing training for flight crews.

QUALITY MANAGEMENT SYSTEM: The ability to demonstrate both management commitment to and the organisational ability to deliver the required level of product or service.

SENIOR MANAGEMENT TEAM: A team of individuals at the highest level of management of an organisation who are responsible for ensuring the proper delegation and delivery of performance for the day-to-day tasks of managing winter operations.

WINTER PROGRAMME MANAGER/RESPONSIBLE PERSON/ACCOUNTABLE EXECUTIVE/ACCOUNTABLE PERSON: The person responsible for ensuring that the processes needed to maintain the quality of systems to comply with the clean aircraft concept.

PREFLIGHT CONTAMINATION CHECK: A check of aircraft surfaces and components for contamination to establish the need for deicing.

3.2.3.5.2 Abbreviations

ATC	air traffic control
ATCT	air traffic control tower
CBDS	computer-based deicing simulator
CBT	computer-based training
QMS	quality management system

Refer to WOM 3.1 for other definitions and abbreviations that are not listed within this section.

3.2.4 The Requirements for Clean Aircraft in Winter - Organisation and Training

3.2.4.1 The Requirement for Clean Aircraft in Winter Operations

The smooth flow of air over the wings of an aircraft provides the lift necessary for flight. The continued optimisation of aerodynamic surfaces over time has led to increasing efficiency gains and safety improvements. However, exposure to weather conditions on the ground that are conducive to ice formation can cause the accumulation of frost, snow, slush, or ice on aircraft critical surfaces and components that will adversely affect aircraft performance and control. The operation of mechanical devices, such as control surfaces, sensors, flaps, and landing gear, will also be affected. If frozen contamination is present, other than that approved via the aircraft certification process, the ability for the aircraft to fly safely may be greatly reduced and will cause potentially dangerous conditions. An aircraft ready for departure must be a clean aircraft that has no frozen contaminants adhering to any critical surface. Regulations governing aircraft operations in icing conditions shall be followed. The International Civil Aviation

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Organization ICAO "Annex 6, Part I" mandates specific rules for the safe operation of aircraft during ground icing conditions, and all member states are required to have regulations in place to ensure this:

> *4.3.5.6: A flight to be planned or expected to operate in suspected or known ground icing conditions shall not take off unless the aircraft has been inspected for icing and, if necessary, has been given appropriate deicing/anti-icing treatment. Accumulation of ice or other naturally occurring contaminants shall be removed so that the aircraft is kept in an airworthy condition prior to take-off.*

A critical surface or component is one which could adversely affect the mechanical or aerodynamic function of an aircraft. As frozen contaminants of almost any kind can compromise the safety of an aircraft, deicing and anti-icing methods are used to ensure that aircraft critical surfaces are clean for takeoff. The purpose of these deicing and anti-icing techniques is best described by the clean aircraft concept. The clean aircraft concept means that an aircraft must be free of all frozen contamination that could prevent a safe takeoff. The most common deicing and anti-icing (commonly combined as "deicing/anti-icing") technique is the application of deicing/anti-icing fluids, although other mechanical and physical methods may be used. SAE fluid types are both deicing and anti-icing fluids, but the different types are commonly used as one or the other, thus, two separate fluids are often used to ensure a clean aircraft.

Deicing fluids are used to remove existing contamination. They are normally supplied as a concentrate.

For maximum effect, deicing fluids shall be applied close to the surface to minimize heat loss. Fluid temperature and pressure should not exceed aircraft maintenance manual requirements. The heat in the fluid effectively melts any frost, as well as light deposits of snow, slush, and ice. Heavier accumulations require the heat to break the bond between the frozen deposits and the structure; the hydraulic force of the fluid spray is then used to flush off the contamination. The deicing fluid will prevent refreezing for a period of time, depending on aircraft skin and outside air temperature (OAT), the fluid used, the mixture strength, and the weather.

They are not primarily intended to prevent adherence of further active frozen contamination, although limited protection is afforded by the heat from the fluid. When that protection is relied upon to keep an aircraft clean for takeoff, then the Type I is being used as both a deicing and an anti-icing fluid. Other fluids and mixtures can be used to deice dependent on experience and availability, such as:

1) Heated water (only when above freezing conditions).
2) Heated mixture of water and Type I fluid.
3) Heated premix Type I fluid.
4) Heated Types II, III, or IV fluid.
5) Heated mixture of water and Types II, III, or IV fluid.

NOTE 1: All of the above have a specific effect (deicing or holdover time) based on the temperature in which they are used. These are all defined (except water which has no HOT) in FAA and TC Holdover Time Tables. They are published each year, and only current tables shall be used for operational purposes.

NOTE 2: Unheated fluids are ineffective to deice.

Anti-icing fluids are designed and used to protect treated surfaces from contamination for a specified range of times (the "holdover time"). Fluid Types II, III, and IV are usually applied unheated. The holdover time allows the aircraft to move to the runway from the location where it was treated, and then remain in the takeoff queue for a limited time, without the danger of active frozen precipitation adhering to the treated surfaces prior to takeoff. Integral to the design of these fluids is that they must not excessively interfere with the smooth flow of air over the surfaces at takeoff. Anti-icing fluids therefore have two distinct performance criteria: (1) to remain on the aircraft, preventing active precipitation from adhering, until the start of the takeoff roll; and (2) to flow off of the surfaces during the take-off, which is referred to as the aerodynamic performance requirement. WOM 3.2, WOM 3.1, and WOM 3.4 have been written to give best-practice guidance for the use of deicing/anti-icing fluids to provide a clean aircraft for a safe takeoff.

3.2.4.2 Organisational Requirements

The organisational requirements for the effective and safe deicing/anti-icing of aircraft during winter weather are described in more detail in WOM 3.4. A short summary is provided here as an introduction to these requirements.

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The main concepts contained in WOM 3.4 are based on the quality management methods set out in ISO 9001 and can be summarised in two points:

- The need to demonstrate and consistently provide a product or service that meets customer and applicable regulatory requirements, plus
- Aims to enhance the product or service through effective systems and processes for continual improvement.

For aircraft deicing/anti-icing, the safety-critical nature of this work requires complete conformance to the principle of the clean aircraft concept, as this is the critical customer and regulatory requirement. It involves both conformance to standards of operation and its continual improvement in line with the principles of quality management. The deicing service provider shall establish, document, implement, and maintain a quality management system (QMS) and continually improve its effectiveness. The deicing service provider shall:

- Determine the processes needed to manage effective aircraft deicing/anti-icing.
- Determine the criteria and methods needed to ensure that the operation and control of these processes are effective.
- Ensure the availability of resources necessary to support the operation and monitoring of these processes.
- Monitor, measure (where applicable), and analyse these processes.
- Implement actions necessary to achieve the planned results and to continually improve these processes.

NOTE: The extent of the QMS documentation can differ from one organisation to another due to:

- The size of the organisation and types of activities;
- The complexity of their processes and interactions and he competence of the personnel.

3.2.4.3 The Essential Elements of a Deicing Training Programme

3.2.4.3.1 Organisation

An organisation shall have in place within its management plan and organisational structure descriptions of key personnel (e.g., Head of Deicing Training, Programme Manager, Deicing/Anti-Icing Training Instructor, etc.) and their duties pertaining to training, qualification, and oversight responsibilities. The management plan and the structure of the organisation shall specify the individuals who are responsible for the deicing/anti-icing training programme. The individuals specified with this responsibility shall have sufficient knowledge of deicing/anti-icing operations and training to be qualified for this position. Although this qualification may be renewed annually, it is recommended that the responsible individuals complete training and qualification on an annual basis through self-study, under the oversight of their superior or responsible designee (where applicable), as specified within the organisation's management plan and organisational structure.

Deicing/anti-icing training shall be conducted exclusively by personnel who are trained, qualified, and proficient within the relevant subjects applicable to the personnel they are designated to instruct (e.g., flight crew, dispatch, or ground personnel) or by other personnel or through other means under the oversight of such qualified individuals. Individuals designated to develop or facilitate deicing/anti-icing training should have some familiarisation, background, and training in the area of education and facilitation techniques through relevant experience or education. This training may be performed as part of a train-the-trainer programme. Individuals designated to conduct deicing/anti-icing training within an organisation's management plan and organisational structure shall be required to complete initial and subsequent annual recurrent training in order to maintain their qualification. This training shall be facilitated internally within an organisation by an individual responsible for this function as specified within the organisation's management plan and organisational structure (e.g., Training Manager/Head Trainer) or other personnel as designated, or by a third-party organisation (e.g., air operator, contracted deicing/anti-icing training vendor, etc.).

3.2.4.3.2 Training of Deicing Personnel

Only trained and qualified personnel shall perform aircraft ground deicing/anti-icing procedures. A deicing training programme shall be maintained and executed by the organisation that performs the deicing. The training programme shall address all elements of the training material, levels of qualifications, verification of success, functions, duties, responsibilities, quality control, and regular overview of instructing. The training programme shall refer to current industry standards and regulations. All training records shall be kept as per the regulatory or company's recordkeeping policy. The training programme shall be reviewed at least annually to ensure that it covers all current aspects of deicing/anti-icing operations.

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The Head of Deicing Training is responsible for developing the training programme. The Head of Deicing Training may also be the instructor. In that case, previous deicing experience is strongly recommended. The company shall evaluate and approve the Head of Deicing Training for the task according to established requirements. This approval by the senior management team shall be documented.

3.2.4.3.3 Computer-Based Training

Computer-based training (CBT), e-learning/distance learning, and computer-based deicing simulators (CBDS) may be utilised in place of traditional instructor-facilitated training for theoretical training components and limited practical training components (dependent on the CBDS Level utilised). It is recommended that CBT/e-learning/distance learning or CBDS training be facilitated and administered under the oversight of suitably qualified training personnel.

To simulate classroom interactivity, it is recommended that when a trainee requires assistance or has a question, there be various means in place so that the assistance can be obtained or question can be answered prior to completion of the course and before exams or evaluation. This may include the use of poll questions, email, online assistance, etc.

It is recommended that if CBT/e-learning or CBDS is used as part of the examination or evaluation process, effective measures should be in place to prevent academic dishonesty and plagiarism (i.e., individual login/password, random questions drawn from a question pool, measures to prevent skipping/fast-tracking of training, oversight by a proctor, etc.).

It is the responsibility of the CBT/e-learning or CBDS manufacturer/developer and user to ensure that all applicable requirements as stated within this document are met, as applicable to the personnel they are intended to instruct.

3.2.4.4 The Complementary Fit between WOM 3.2, WOM 3.1, and WOM 3.4

While the WOM 3.2 deals with the key requirements for training personnel for aircraft ground deicing/anti-icing, it is complementary to two other standards with which it should be read, interpreted, and understood. The three complementary standards are:

- WOM 3.1: Aircraft Ground Deicing/Anti-Icing Processes.
- WOM 3.2: Aircraft Ground Deicing/Anti-Icing Training and Qualification Programme.
- WOM 3.4: Aircraft Ground Deicing/Anti-Icing Quality Management.

While this standard focuses on the training aspect of aircraft ground deicing/anti-icing, a complete understanding of the processes and quality management aspects are only available through the full appreciation of the other two standards.

3.2.5 Authority and Roles in Deicing/Anti-Icing

3.2.5.1 Senior Management Team

Senior management shall:

- Provide evidence of its commitment to the development and implementation of a suitable management system for the effective deicing/anti-icing of aircraft.
- Ensure that responsibilities and authorities are defined and communicated within the organisation.
- Appoint a manager on an annual basis who may be known by a title such as Programme Manager, Responsible Person, Accountable Executive, Accountable Person, or some other title identifiable as the responsible person accountable to senior management for the effective delivery of this service.
- Establish position requirements for and appoint a Head of Deicing Training. If agreed by senior management, the Programme Manager/Responsible Person/Accountable Executive/Accountable Person and the Head of Deicing Training may be the same person.

For more detailed and specific guidance on the roles of the senior management team, the Programme Manager and the Head of Deicing Training, refer to the appropriate section of WOM 3.4.

3.2.5.2 Winter Programme Manager and Head of Deicing Training

3.2.5.2.1 Winter Programme Manager

Senior management shall appoint a manager on an annual basis who, irrespective of other responsibilities, shall be responsible for:

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- Ensuring that the process needed to maintain the quality of systems to deliver clean aircraft during winter operations are established and maintained.
- Reporting to senior management on the performance and effectiveness of these systems and any need for improvement,
- Ensuring that the need to conform to the clean aircraft concept is communicated throughout the organisation.

This person may be known by the title "Winter Program Manager/Responsible Person/Accountable Executive/ Accountable Person, or some other title that identifies as responsible and accountable to senior management for the effective delivery of all winter services and activities.

3.2.5.2.2 Head of Deicing Training (see also DI-L70, WOM 3.2.5.12 below)

It is often common to abbreviate "deicing/anti-icing" as just "deicing," such as for the title of this position. Thus, when the term "deicing" is used, one must be mindful of the context and know whether it is also meant to include anti-icing.

Senior management shall appoint a manager on an annual basis who, irrespective of other responsibilities, shall be responsible for:

- Ensuring that their own understanding and competence is sufficient to hold this position.
- Ensuring the effective delivery of the training programme for the organisation.

If agreed by senior management, the Programme Manager, Responsible Person, Accountable Executive, Accountable Person, and the Head of Deicing Training may be the same person.

3.2.5.3 Operational Levels of Training and Qualification

The qualification level for all operational positions shall be clearly defined. Qualified people shall be fully aware of their approved functions. A person may hold several approvals depending on the job function. A suggested structure for levels and groups of qualifications is (DI-L = De Icing – Level):

DI-L10	Deicing Vehicle Driver
DI-L20	Deicing Operator
DI-L30	Deicing Supervisor
DI-L30B	Pre/post deicing Inspector
DI-L40	Deicing Instructor
DI-L50	Deicing Coordinator
DI-L60	Fluid Quality Inspector (laboratory staff)
DI-L70	Head of Deicing Training
DI-L80	Flight Crew (winter operations) [basics of deicing/anti-icing]

Initial qualification is achieved after successful theoretical training (including a written examination) is completed, and practical training (including assessment where relevant) is also successful. Each qualification shall be renewed annually, including the theoretical instruction and written examination. The training topics do not need to be covered repeatedly for each initial level of qualification if the same person is performing several duties. In order to maintain each qualification, it is highly recommended that the company keep records of the experience of each individual. The level of experience is recommended to be such that each individual is familiar with all relevant elements of the qualification responsibilities and can perform the required task in a safe manner. The programme and records shall reflect the experience in performing the tasks of the relevant qualification in actual conditions. If the experience is limited after the winter season, it is recommended that the annual recurrent training of the individual reflects this lack of adequate experience in order to have all relevant operational topics refreshed more thoroughly.

3.2.5.4 Duration and Content of Training

The length of time required for theoretical and practical training will vary among operators and will also vary depending on local conditions. All elements relevant to a specific deicing qualification level should be covered in training as recommended in Table 1 (WOM 3.2.6.2).

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Guidance for course content to use in theoretical training is provided in Tables 2 and 3 (WOM 3.2.8.2). A written exam for theoretical training must be completed in accordance with the process described in WOM 3.2.8.1. Tables 4 and 5 provide elements for practical training. Assessments of the trainee must be performed during practical training in accordance with the process described in WOM 3.2.8.3.

3.2.5.5 Deicing Vehicle Driver, DI-L10

The deicing vehicle driver qualification (DI-L10) qualifies the person to maneuver the vehicle and perform the communication procedures, but it does not include any other deicing levels. There shall be a note of the restriction on this qualification if some of the duties are not performed as mentioned. The driver shall receive training covering relevant parts mentioned in the standard teaching plan. Also, where relevant, local procedures shall be taken into account and emphasised more than others.

Recommended times are in Table 1C inAppendix 3 "Example Training Times" of this document. The practical part shall cover all types of vehicles and types of operation that can be in use, and it shall include an assessment. The length of training depends largely on the type of operation and number of different vehicles, but practical training shall not be shorter than the theoretical part. Local settings may demand more/less extensive training, and the recommendations given here are not binding. The qualification must be renewed annually, with a theoretical part including a written exam. All new equipment and operational changes require practical training as well.

3.2.5.6 Deicing Operator, DI-L20

The deicing operator qualification (DI-L20) includes the preflight contamination check (check for the need to deice the aircraft), performance of deicing/anti-icing treatment, and the post deicing/anti-icing check. This level of qualification includes driving the deicing vehicle (DI-L10) and the pre/post deicing inspector qualification level (DI-L30B). There shall be a note of restriction to this qualification if some of the duties are not performed as mentioned. The deicing operator shall receive training covering in detail all parts mentioned in the standard teaching plan (except coordination and instructional procedures). Where relevant, local procedures shall be taken into account and emphasized more than others (e.g., some airports perform only centralized deicing, and some perform a mixed gate and centralized operation).

Recommended times are in table 1C inAppendix 3 "Example Training Times" of this document. It is recommended that the practical part be adapted according to local requirements and operational needs. A qualified instructor shall assess the practical part with the trainee performing “a demonstration of skill” during actual deicing/anti-icing treatment of an aircraft. Prior to practical assessment, the trainee shall receive sufficient practical training in order to be able to perform deicing/anti-icing in a safe manner. The qualification must be renewed annually with a theoretical part including a written exam. All new equipment and operational changes may require additional practical training as well.

3.2.5.7 Deicing Supervisor, DI-L30

This level of qualification includes the performance of the post deicing/anti-icing check, driving the deicing vehicle (DI-L10) and the deicing operator qualification (DI-L20). There shall be a note of restriction to this qualification if some of the duties are not performed as mentioned. The person supervising the deicing/anti-icing and performing the required checks shall receive training covering relevant parts mentioned in the standard teaching plan. Local procedures shall be taken into account and emphasised more than others where relevant.

Recommended times are in table 1C inAppendix 3 "Example Training Times". This training is similar to that for the DI-L20 qualification, and there is therefore no need to hold two separate courses in order to be qualified for both levels. Local settings may demand a more extensive training and these recommendations are not binding. It is recommended that the practical part be adapted according to local requirements and operational needs. A qualified instructor shall assess the practical part with the trainee performing “a demonstration of skill” during actual operation involving an aircraft. The qualification must be renewed annually with a theoretical part including a written exam.

3.2.5.8 Pre-/Post-Deicing Inspector, DI-L30B

This level of qualification includes the Contamination Check (check for the need to deice the aircraft) and the pre/ post deicing/anti-icing checks. This level is more limited than the DI-L30 and is only focused on duties to determine the need for deicing/anti-icing and the checking procedures. There shall be a note of restriction to this qualification if some of the duties are not performed as mentioned. The person determining the need for deicing/anti-icing and

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performing the required checks shall receive training covering relevant parts mentioned in the standard teaching plan. Local procedures shall be taken into account and emphasised more than others where relevant.

Recommended times are in table 1C inAppendix 3 "Example Training Times" of this document. Practical training for licensed technical staff (e.g., aircraft mechanics) is not required. Theoretical and practical parts can be combined where relevant. This training is similar to that for the DI-L30 qualification, and there is therefore no need to hold two separate courses if the initial training is for DI-L30. Local settings may demand a more extensive training and these recommendations are not binding. It is recommended that the practical part be adapted according to local requirements and operational needs. A qualified instructor shall assess the practical part with the trainee performing "a demonstration of skill" (excluding above mentioned licensed technical staff) during actual operation on an aircraft. The qualification must be renewed annually with a theoretical part including a written exam.

3.2.5.9 Deicing Instructor, DI-L40

Training shall be conducted by personnel who have demonstrated competence in the deicing/anti-icing subjects to be instructed and who have the skills to deliver the training effectively. The instructor shall have received the proper training for a DI-L20 qualification, including the performance of deicing/anti-icing treatment, supervision of deicing/ anti-icing (DI-L30), and driving the deicing vehicle (DI-L10). The instructor shall have proper training in instructional methods and sufficient knowledge of the training subject (e.g., aircraft critical areas and systems, fluid types, deicing vehicles, etc.). It is also recommended that the instructor attends or performs practical training and deicing/anti-icing of an aircraft on an annual basis in order to maintain necessary experience and knowledge. There shall be a note of restriction to this qualification if some of the duties are not performed as mentioned. The deicing instructor shall receive training covering all parts mentioned in the standard teaching plan. Local procedures shall be taken into account and emphasised more than others where relevant. There may be cases where specialists in a related field (e.g., a meteorologist, air traffic control staff, etc.) are used as instructors for a particular subject. These specialists do not need to be qualified in deicing/anti-icing.

Recommended times are in table 1C inAppendix 3 "Example Training Times" of this document. If the instructor has previously had basic practical training, there is no need for a practical part unless there are changes in the procedures or the operation. The training for deicing instructors should be considered to be held as a separate session. The length of this training may be adjusted according to local demands. Local settings may also demand a more extensive training and these recommendations are not binding. The deicing instructor is qualified to assess any demonstration of skill where needed. The qualification must be renewed annually, with a theoretical part including a written exam. The annual recurrent training will renew all previous qualifications (DI-L10 to 40).

3.2.5.10 Deicing Coordinator, DI-L50

The deicing coordinator qualification (DI-L50) entitles the person to coordinate and manage the deicing/anti-icing operation and/or work as a team leader. This qualification is intended for coordinating deicing/anti-icing operations mainly at remote and/or centralised deicing facility areas or for other similar/anti-icing coordination functions at an airport. The qualification includes the performance of deicing/anti-icing treatment (DI-L20), supervision of deicing/ anti-icing (DI-L30), and driving the deicing vehicle (DI-L10). There shall be a note of restriction to this qualification if some of the duties are not performed as mentioned. The deicing coordinator shall receive training covering in detail all parts mentioned in the standard teaching plan. Local procedures shall be taken into account and emphasised more than others where relevant.

Recommended times are in table 1C inAppendix 3 "Example Training Times"of this document. Local settings may demand a more extensive training, and these recommendations are not binding. The training for deicing coordinators should be considered to be held as a separate session where topics are covered regarding the appropriate way of coordination, management, and/or team leadership. The basic part of the training can otherwise be held together with the deicing training (DI-L20). The length of this training may be implemented according to local demands. The qualification must be renewed annually with a theoretical part including a written exam. The annual recurrent training will renew all previous qualifications (DI-L10 to 30B and DI-L50) unless specified otherwise (e.g., limited level).

3.2.5.11 Fluid Quality Inspector (Laboratory Staff Only), DI-L60

The fluid quality inspector (laboratory staff) qualification (DI-L60) includes the performance of the quality control of fluids. The qualification shall include training covering related parts mentioned in the standard teaching plan. Local procedures shall be taken into account. International standards and auditing requirements regarding fluid quality

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shall be taken into account. Fluid brand procedures shall be noted. In some cases, this qualification can be included in DI-L20 if local procedures so demand. However, appropriate training for quality checks and procedures shall be performed in any case. Both theoretical and practical training shall be performed. Local settings may demand more extensive training, and these recommendations are not binding. The qualification must be renewed annually with a theoretical part including a written exam. Any new fluid or procedural requirements need special attention.

NOTE: This level is not limited to laboratory staff. Anyone else having this qualification level would be considered as having an additional qualification but it is not a mandatory requirement for staff outside of the laboratory.

3.2.5.12 Head of Deicing Training, DI-L70

The Head of Deicing Training is responsible for the deicing training programme. The Head of Deicing Training shall have sufficient knowledge in deicing/anti-icing operations and training to be qualified for this position. The Head of Deicing Training qualification covers all other levels of qualification (DI-L10 to 50) with DI-L60 optional if required locally or for personal knowledge. The qualification must be renewed annually and will be renewed automatically as long as the responsibilities remain with the same person. These responsibilities include keeping up to date with the latest recommendations and standards involving relevant deicing/anti-icing issues. The Head of Deicing Training shall have received deicing instructor training and shall have sufficient knowledge in basic instructional methods (e.g., train the trainer) for this level of qualification. An annual refresher course is recommended but keeping up to date with deicing industry news and operational elements, as well as preparing the training programme (and/or acting as an instructor), is sufficient.

The Head of Deicing Training may also be the instructor and, therefore, previous deicing experience is strongly recommended. The company shall evaluate and approve the Head of Deicing Training for the task, and this approval shall be documented. It is the responsibility of the Head of Deicing Training to review all related standards and recommendations in order to have the most up-to-date information at hand. All material used for training shall be reviewed and approved by the Head of Deicing Training. All training sessions shall receive appropriate material content according to the particular qualification. Any company standard training material shall be under revision control, and appropriate standards and recommendations shall be referred to.

3.2.5.13 Flight Crew (Winter Operations), DI-L80

The flight crew is not normally engaged in daily ground deicing/anti-icing procedures, but knowledge of the process should be in place. The flight crew may have their own company training regarding winter operations. This training should cover all relevant aspects of the ground deicing/anti-icing process. This is an important factor in order to be able to communicate with the ground crew about proper treatment procedures and to have sufficient general knowledge of these subjects. The person responsible for deicing/anti-icing training for flight crews is the Flight Crew Trainer. The Flight Crew Trainer should agree and verify the training with the Head of Deicing Training and operation. The qualification must be renewed annually with a theoretical part including an examination.

3.2.5.14 Cabin Crew (Icing Awareness), DI-L80B

Cabin crews are required to have training in the awareness of the effects of frozen surface contaminants and the need to inform the flight crew of any observed surface contamination. The cabin crew is not normally engaged in daily deicing/anti-icing procedures, but an awareness of the process should be in place. The cabin crew may have their own company training regarding winter operations. The ability to identify icing on an aircraft is an important factor in order to be able to communicate with the flight crew about any ice contamination before and during flight.

3.2.6 Training Subjects and Their Fit With Deicing Roles

3.2.6.1 Recommended Elements of Deicing Training

The elements listed here are for use as a reference only. It is up to the individual instructors to give each and every one of the deicing operations the relevant instruction which can be based on the following subjects. These subjects shall be explained and understood according to the level of importance that each operation demands. The recommended area of operation may differ between regions, and it is thus important that the instructor notes local requirements and selects the level of instruction accordingly. Depending on the qualification being trained, the listed subjects are intended to be introduced during training but not necessarily mastered in some cases, as some elements can be for general knowledge.

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In order to obtain an overview of the essential aspects of aircraft ground deicing/anti-icing, there are several elements that need to be appreciated. These include:

- The requirement for aircraft ground deicing/anti-icing.
- The practical methodology for aircraft treatment with deicing/anti-icing fluids.
- Special aspects of aircraft ground deicing/anti-icing.
- Communication and pre/post deicing/anti-icing check procedures.

While each of these areas can be expanded into further topics to discuss, these broad headings show the flow of what must be taught. Firstly, there needs to be an appreciation of why aircraft deicing/anti-icing is vital and the regulatory requirements in place to reinforce this. Secondly, while there are a number of techniques available for aircraft deicing, by far the most common method is the use of fluids, which is also the only way to provide anti-icing. Lastly, there are a number of precautions, restrictions, and a need to learn from both any newer standards and guidance, plus findings from operational events and audits to enable continual improvement of the operations to take place.

3.2.6.2 The Fit Between the Recommended Elements of Deicing Training and the Deicing Roles

Table 1 shows the fit between a more detailed list of deicing/anti-icing aspects and the operational roles outlined in Section 4. However, it should also be appreciated that outside of the operational roles listed in the table, there are two other roles which will be involved.

- Senior Management Team: As this team has the accountability for the overall operation of the airport and aircraft safety, there is a requirement to ensure that there is up-to-date guidance, regulatory understanding, and operational learning embedded in the planning from winter to winter and is reflected in appropriate procedures and training programmes.
- Head of Deicing Training: This person shall ensure awareness of any need for updating both their own skills plus any theoretical and practical training for all of the other roles in the organisation.

- The different training subjects required to obtain the different functions are often the same. The differentiation will be made by adapting the duration of the training subject to the specific needs of the function.

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Table 1: Fit between Recommended Elements of Deicing Training and Deicing Roles

Recommended Elements for Training	Deicing (DI-) Qualification Level Reference									
	L10	L20	L30	L30B	L40	L50	L60	L70	L80	L80B
A. The requirement for aircraft ground deicing/anti-icing										
Basic knowledge of aircraft performance		X	X	X	X	X		X		
Effects of frozen contamination on aircraft performance		X	X	X	X	X		X	X	
The Clean Aircraft concept, regulations, and recommendations	X	X	X	X	X	X	X	X	X	
Meteorological considerations on ice formation		X	X	X	X	X		X	X	X
B. The methods for checking the aircraft for contamination										
Contamination Check (to establish the need for deicing)		X	X	X	X	X		X	X	X
Post Deicing/Anti-Icing Check		X	X	X	X	X		X	X	X
C. The practical methods for aircraft treatment with deicing/anti-icing fluids										
General techniques for removing frozen deposits from aircraft surfaces		X	X		X	X		X	X	
Deicing/anti-icing by fluids - procedures in general	X	X	X	X	X	X		X	X	
Basic characteristics of aircraft deicing/anti-icing fluids		X	X		X	X	X	X	X	
Types of fluid checks required and the equipment for this		X	X	X	X	X	X	X	X	
Deicing/anti-icing equipment operating procedures	X	X			X	X		X		
Fluid application and the use plus the limitations of Holdover Time (HOT) tables		X	X		X	X		X	X	
Communication procedures and deicing/anti-icing code	X	X	X	X	X	X		X	X	
Aircraft in general and common critical areas of surfaces and instruments	X	X	X	X	X	X		X	X	X
D. Special aspects of aircraft deicing/anti-icing operations										
Safety precautions and human factors	X	X	X	X	X	X	X	X	X	
Environmental impact and mitigation	X	X	X	X	X	X	X	X	X	
Deicing facility operation	X	X	X	X	X	X	X	X	X	
Learning from season operations, audit findings and updated standards for next season		X	X	X	X	X		X	X	
Local rules and restrictions and airport procedures	X	X	X	X	X	X		X	X	X

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3.2.7 Training and Qualification Process

3.2.7.1 Theoretical and Practical Training, Annual Assessments, and Record Keeping

Only trained and qualified personnel shall carry out aircraft ground deicing/anti-icing procedures. Theoretical and practical skills training shall be conducted by qualified instructors/trainers who have demonstrated the skills to deliver the training and who have competence (knowledge, skill, and experience) in the subjects to be instructed. Assessments shall be conducted by persons who have appropriate knowledge, skills, and experience in the functions being assessed. Training shall be a combination of theoretical (suitable and sufficient information and instruction relating to the topic being trained) and practical skills training to verify the trainees' understanding of, and ability to complete, the task being trained. Changes to methods and processes shall be communicated to relevant personnel, and additional information and training shall be delivered as appropriate. Companies providing deicing/anti-icing services shall have both a qualification program and a quality control program to monitor and maintain the level of competence.

Attendance at training sessions shall be recorded and kept for verification of the qualifications of each person. Records of theoretical sessions and exams, as well as records of practical training and training while working (where applicable), must be retained for each person qualified. The record shall clearly show that instruction has been given and received with signed documents the usual evidence. A training schedule for each qualified person shall be maintained. The record shall identify the date when the particular subject matter was delivered to the trainee. The trainer shall sign or initial that the training has been delivered. The trainee shall, as an acknowledgement and understanding of the training, sign or initial the appropriate subject matter on the training record form. Training content and records shall be made available for review by an authorised air operator representative or regulatory authority. Where electronic or computer-based training record systems are maintained, the content shall include, as a minimum, the trainee's name, test mark achieved, date of training, and course reference. The same procedure shall be followed where contract deicing is used. Names, dates, and the scope of training must be clearly stated. Practical evaluation and demonstration of skills for ground crew personnel shall be performed as part of a ground crew training and qualification programme.

The area of deicing training shall be divided into the following parts:

- Theoretical.
- Practical.
- Annual Recurrent.

Initial qualification of deicing/anti-icing personnel shall be accomplished under strict supervision of a qualified individual by at least one of the following:

1) On live aircraft during live deicing/anti-icing operations – recommended/preferred method.
2) By spraying on a mock-up surface/aircraft or deicing simulators that would simulate an actual live deicing/anti-icing operation.

If trainees have satisfactorily completed all simulated practical evaluations and demonstrations of skills required as part of the training and qualification programme, then they may participate in deicing/anti-icing operations under strict supervision of a qualified individual, until such time as the final qualification can be achieved.

For annual recurrent qualification:

- The practical evaluation and demonstration of skills for normal equipment and operational methods is expected.
- The practical training and demonstration of knowledge or skills where new equipment or operational methods are utilized is required.

Both initial and annual recurrent training shall be conducted to ensure that all personnel obtain and retain a thorough knowledge of aircraft ground deicing/anti-icing policies and procedures, including new procedures and lessons learned.

Training programmes must include a detailed description of initial and annual recurrent training and qualification concerning the specific requirements of the programme and the duties, responsibilities, and functions detailed in the programme. An ongoing review plan is advisable to evaluate the effectiveness of the deicing/anti-icing training received. The programme shall have a tracking system that ensures all required personnel have been satisfactorily trained. Records of personnel training and qualification (see Figures 1 and 2) shall be maintained as proof of qualification. Where an individual has passed an examination but has not achieved a perfect grade, it is

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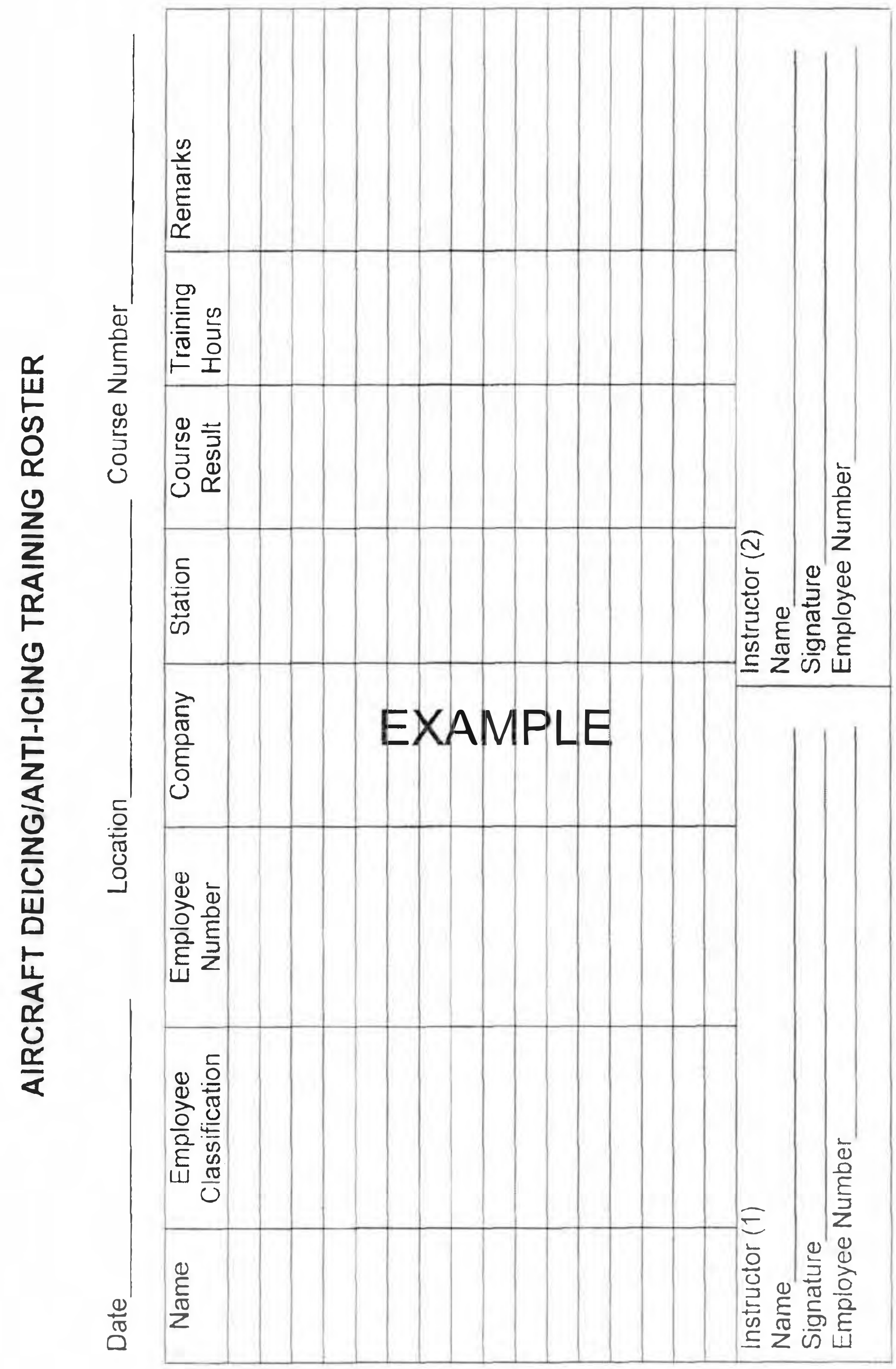
recommended that incorrect answers are reviewed with the individual to promote error-free learning. The training shall be divided into different groups according to levels of qualification and operational expertise.



AIRCRAFT DEICING/ANTI-ICING TRAINING ROSTER

Date______ Location______ Course Number______

Name	Employee Classification	Employee Number	Company	Station	Course Result	Training Hours	Remarks

EXAMPLE

Instructor (1)
Name______
Signature______
Employee Number______

Instructor (2)
Name______
Signature______
Employee Number______

Figure 1. Aircraft deicing/anti-icing training roster.

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Aircraft Deicing/Anti-icing Training Program

INSTRUCTIONAL AIDS	TOPIC / MAJOR POINTS	NOTES / REFERENCES
	EXAMPLE	

Figure 2. Aircraft deicing/anti-icing training programme.

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3.2.8 Theoretical Elements - Standard Teaching Plan

From Table 1 in Section 5, it is evident that there are a number of areas under each heading that can be taught as separate modules. This allows the personnel who may need to appreciate the different aspects of deicing to only need to be involved in their relevant subjects. Tables 2 and 3 offer guidance on how sessions may be run. Reference is made to the appropriate documents to support each session.

Table 2: Theoretical Elements – Standard Teaching Plan (Sections A and B)

Subject	Guidance Content (References)
Course Introduction (AS6286)	
TE1. Introduction	Trainer to introduce themselves. They will explain how they are qualified to train the subject, plus their experience. They will give an overview of the course content, the teaching method, and the requirement for a validation exam and pass mark
A. The requirement for aircraft ground deicing/anti-icing (AS6286 Appendix A)	
TE2. Basic knowledge of aircraft performance	Four forces that act on an aircraft. Airflow over and under the wings. Why an aircraft can take off. How lift is generated. The critical angle of attack. The aerodynamic window of operation. The biggest contributor to aircraft lift.
TE3. Effects of frozen contamination on aircraft performance	The effect of frozen contamination on lift and drag and the aerodynamic window of operation. The critical component areas for lift and maneuverability of the aircraft. The effect of a small layer of frost. Other effects of frozen contamination.
TE4. The clean aircraft concept, regulations, and recommendations	The "clean aircraft" concept. The regulatory requirements of various national authorities. The role of SAE International and the key global aircraft ground deicing standards. The main purpose of aircraft deicing and anti-icing.
TE5. Meteorological considerations on ice formation	General weather conditions and ice formation. Typical weather types leading to frozen contamination on the aircraft. Weather situations needing special attention. Weather conditions included in/excluded from the holdover time tables. Some forms of weather reporting. Effects of weather on airport operation.
B. The methods for checking the aircraft for contamination	
TE6. Contamination check (to establish the need for deicing)	How to examine the aircraft critical flight surfaces (wings, vertical stabilizer, horizontal stabilizers), top fuselage, undercarriage, nose radome, pitot-static orifices, angle of attack devices, windscreens.
TE7. Post deicing/anti-icing check	How to perform a post deicing/anti-icing check of the aircraft to make sure that no contamination (frozen deposits) remains after deice/anti-ice, the aircraft is clean and in proper condition for flight.
C. The practical methods for aircraft cleaning with deicing/anti-icing fluids (ARP1971, AS6285)	
TE8. General techniques for removing frozen deposits from aircraft surfaces	The various ways in which deicing can be carried out. The only way in which anti-icing can be carried out. The need to prepare equipment, procedures, and people. The areas of an aircraft to check for frozen contamination. Descriptions of one-step and two-step deicing/anti-icing.
TE9. Deicing/anti-icing by fluids - procedures in general	Critical aspects of deicing and the general process. Special care for composite wing deicing. The general process for using anti-icing fluids effectively. Use of Type I for anti-icing. The general use of Type II, III, and IV fluids.
TE10. Basic characteristics of aircraft deicing/anti-icing fluids	Why deicing/anti-icing fluids are the most usual way of deicing aircraft. The three safety requirements of deicing/anti-icing fluids. The differences between Type I, II, III, and IV fluids, and the colors of these. The unusual characteristics of anti-icing fluids and the precautions needed. The two ways to classify fluid performance. Incompatibility of certain types of fluids, e.g., EG & PG are not compatible with acetate or formate based fluids. Understanding of AMS1424/1 & /2 and AMS1428/1 & /2 and what is allowed to be applied to the aircraft per the manufacturer's Aircraft Maintenance Manual.
TE11. Types of fluid checks required and the equipment for this	The general handling and storage requirements of deicing/anti-icing fluids. The quality control checks to be performed on these fluids. Pumping, heating, and storage tank requirements.
TE12. Deicing/anti-icing equipment operating procedures	The variations of deicing vehicles, and the types of safety precautions to be taken. The operation of filling stations. Clear communications with the flightcrew. Equipment use, spray alternatives, and data collection. Basic vehicle components and safety equipment. **Refer to ARP1971.**
TE13. Fluid application and the use plus the limitations of holdover time tables	Details of the "clean aircraft" concept. The main areas of the aircraft to spray. The key aircraft areas to anti-ice. The purpose of holdover time (HOT) tables and how to read these. The difference between generic and fluid brand HOT tables. The importance of using the correct dilution when reading the appropriate HOT table.
TE14. Deicing/anti-icing codes and communication procedures	The anti-icing code/post deicing report. Communication to flightcrew with reference to **AS6285**. Operator/driver communication, two-way communication.
TE15. Aircraft in general and common critical surfaces and instruments	The critical aircraft surfaces to inspect. The precautions to take against clear ice. Critical areas not to spray. Understanding the use of the "no spray" diagrams in AS6286B (Revision B, dated 2016-11).

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Table 3: Theoretical Elements – Standard Teaching Plan (Section C)

Subject	Guidance Content	Reference
D. Special aspects of aircraft deicing/anti-icing operations (ARP5660, WOM 3.4, WOM 3.2 Appendix 2)		
TE16. Safety precautions and human factors	Safety assessment by hazard identification and risk management. Personal safety (contamination, working at height, etc.). Safety of others (contamination, struck by vehicle, etc.). Aircraft safety (damage prevention). Personal Protective Equipment (gloves, visors, clothing, etc.).	
TE17. Environmental impact and mitigation	Environmental impact and mitigation.	
TE18. Deicing facility operation	The need for special procedures for central deicing facilities and remote deicing facilities with reference to **ARP5660**.	
TE19. Learning from season operations, audit findings, and updated procedures.	Review of season operational performance with reference to **WOM 3.4**. Review of any incidents, both local and in the industry. Review findings from internal and external audits as appropriate. Consolidate learning with updates to procedures and instructions for next winter season.	
TE20. Local rules and restrictions, airport procedures	Local procedures, permits, requirements, documentation, and operations. Compliance with all SAE Standards referenced.	

3.2.8.1 Theoretical Elements - Examination Process

The examination process contains a theoretical exam, for which a minimum passing score of 75% shall be required. The practical part (where applicable) only contains a pass/fail determination. Since 75% is a passing score for the theoretical part, this means that up to 25% may still be misunderstood. This “gap” shall be noted and wrong answers corrected with the trainee such that 100% understanding is achieved in order to secure a safe deicing operation. The written exam can be performed as an open-book exam so that pertinent holdover time tables and other data sources such as refractive index tables can be referenced. Normal deicing procedures should be basic knowledge, so there should not be any material available during the test explaining these subjects.

The examination for any particular course should be built so that all relevant subjects are covered by the questions. The level of difficulty per question should reflect the level of qualification and the relevance of the subject for that particular qualification. As a rule of thumb, a minimum of one question per subject relating to the qualification level should be included in the written exam. The minimum number of questions shall reflect the qualification level and may vary accordingly; however, this minimum amount should not be less than 15 questions (starting with the least demanding level of qualification/training hours). The theoretical examination shall be in accordance with national requirements and/or local regulations. The questions should be multiple choice containing a minimum of three possible answers per question. If there are differing procedures from normal deicing operations, then written answers can be used to explain this. The exam questions shall be periodically reviewed and updated to cover all current standards and regulations.

The Head of Deicing Training shall include the following elements in the training programme:

- The questions should always be based on facts and not perceptions.
- The question should not be misleading and should be clearly written such that it is not possible for it to be incorrectly interpreted.
- Misinterpretations may lead to remembering the subject in an incorrect way.
- The question series should cover all aspects of operation and include the local arrangements (if any).
- Evaluation should include oral quizzing where practical items are covered (e.g., reading holdover time tables and/or refractive index limits, etc.).

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3.2.8.2 Practical Elements - Standard Teaching Plan

Upon the successful completion of the theoretical part of the training, practical training will need to be carried out at the airport. A standard teaching plan for this part of the training is shown in Tables 4 and 5. The following points shall be noted:

- The teaching plan shows most of the elements expected for practical hands-on training. However, this must also be subject to local management guidance, requirements, and resources.
- All elements in Tables 4 and 5 are applicable to DI-L10, DI-L20, DI-L40, and DI-L70. Any exceptions to this are noted in the appropriate element. These exceptions are noted for DI-L30, DI-L30B, DI-L50, and DI-L60.
- Most of the operations below require the use of a suitable deicing truck and aircraft.
- The timescale for most of these elements is open to allow for the development of the required level of skill for the trainee.

Table 4: Practical Elements – Standard Teaching Plan, Part 1 of 2

Element		Content
PE1	Overview of deicing/anti-icing equipment and its operation plus facilities (e.g., storage tanks)	Deicing/anti-icing equipment, vehicle description (type, make, nozzles, guns, tanks, etc.). Vehicle operation. Safety features. Manual versus proportional mixing. Facilities. Storage requirements. Filling. Heating equipment (as applicable for engine ice removal).
PE2	Cab layout and operation	Pre-operation checks. Seat and mirror adjustment. Gear shift selection. Park brake. Heater and pump controls. Boom controls (if fitted). Communication and connections (headset). Start and stop procedures. Driving controls (wipers, lights, and indicators, etc.).
PE3	Deicing unit control panel	Start/restart/stop. Emergency stop procedures. System indicators. Switches.
PE4	Basket operation	Emergency stop procedures. Emergency boom lowering procedures. Harness attachment point(s) and harness use. Communications and connections (headset). Light switch operations. Pump delivery selection/pump override/pump operation. Anti-ice/deice and snow gun operation. Boom controls. Extend/retract/raise/lower/rotate. Personal Protective Equipment.
PE5	Auxiliary engine operation (if fitted)	Start/restart/stop/emergency stop procedures. Manual accelerator control. Fire extinguisher operation.
PE6	Fluid heater operation (if fitted)	Start/Shut down procedures. High flame/low flame indicators. No flow indicator. Low fluid indicator. Pump pressure gauge.
PE7	Ground hose operation	Position of hose. Operation of ground gun. Fluid flow rate.
PE8	Pre-Spray checks	All doors/hatches closed. All personnel clear. Aircraft configuration.
PE9	Communication (also, DI-L30, DI-L30B and DI-L50)	Communication with Flight Deck. Engineering (i.e., Aircraft Configuration). Anti-icing code/Post deicing report. Communication between driver and sprayer. Multiple vehicle operations, vehicle to vehicle Centralized operation. Coordination.
PE10	Vehicle positioning	Optimum positioning for spraying. Communication with operative. Driving safely around the aircraft.

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Table 5: Practical Elements – Standard Teaching Plan, Part 2 of 2

Element		Content
PE11	Vehicle safety around aircraft	Approaching aircraft (i.e., engines/anti-collision lights). Vehicle brake check. Vehicle height. Vehicle speed. Awareness of other ramp users. Accident/Incident reporting and safety reporting.
PE12	Fluid spraying	Critical surfaces. No-spray areas. Fluid temperature. Spraying distance (heat retention). Spray patterns (nozzle settings).
PE13	Other de/anti-icing procedures (also DI-L30B)	Pre-deicing treatments. Local frost prevention. Deicing engines, sensors, probes, etc. Related checks.
PE14	Driving the deicing truck	Maneuvering the vehicle. Handling characteristics. Emergency situations. Fault situation.
PE15	Deicing scenarios (where applicable)	Gate deicing. Remote/centralized deicing. Multiple vehicle deicing.
PE16	Emergency situations (clarify theoretical elements in practice) (also DI-L30)	Safety at work. Collisions and other accidents. Procedures and situations. Human Factor situations. Environmental control.
PE17	Quality checks (if applicable) (also DI-L60)	Fluids, limits, and reporting. Sampling. Measurement instruments and use. Filling station, fluid quality. Fluid delivery.
PE18	Contamination check (also DI-I30 and DI-L30B)	Different contaminations on the aircraft. Aircraft types. Clear ice checks, tactile check. Reporting/communication. Final release, anti-icing code. Safety elements, human factors.
PE19	Spraying and using hot air (practice as needed) (also DI-L30)	Fuselage, underwing, wing, and tail. Engine and propeller ice. Landing gear instruments.
PE20	Practical validation	Each trainee shall be able to demonstrate competence in: 1. Driving/positioning equipment/quality control and fluid handling/communication/reporting and/or spraying (as applicable)/pre-post check. 2. Trainees shall also be tested on the operation of the vehicle, in particular, safety aspects and features (as applicable). 3. Actual deicing/anti-icing operations on an aircraft (as applicable) shall be assessed before initial qualification and evaluated over a period of time (i.e., events), as applicable. 4. A verbal assessment of things learned during training shall be performed.

3.2.8.3 Practical Elements - Assessment Process

A practical assessment shall be performed as applicable for the qualification to be achieved. The practical assessment shall be performed in actual operational conditions involving an aircraft (as applicable) before initial qualification. Further evaluations may be performed as applicable for the local demands and/or company requirements. The practical assessment shall include a verbal assessment of the trained theoretical topics, as well as the practical parts trained. In order to have an “independent” evaluation, it is recommended that the assessment be performed by another qualified instructor rather than the instructor who has trained the trainee. The parts to be covered during the practical assessment shall include all of the material for the qualification level at hand. These are to demonstrate competence in (as applicable):

- Driving vehicles.
- Positioning equipment.
- Quality control and fluid handling.
- Contamination check.
- Post-deicing/anti-icing check.
- Communication.
- Reporting and documentation.
- Spraying.
- No spray areas.
- Local operational requirements.

The trainees shall also be tested on the operation of the vehicle, in particular, its safety aspects and features. The practical assessment should focus on the most common operational aspects that are locally experienced, e.g., typical aircraft at the station and typical deicing/anti-icing operations. The training syllabus under WOM 3.2.8.2 describes the practical training in more detail, and the assessment shall reflect those parts that were trained.

3.2.8.4 Training System and Records

3.2.8.4.1 Training System and Renewal

All training should be performed according to a pre-established training programme. This programme should include all levels of training and their relevant requirements. The theoretical part should be categorised according to the qualification, thus dividing the training sessions from each other. This training programme will easily identify what course is leading to which qualification. This numbering system presented here does not need to be the same for every company but is a logical sequence to follow if desired. To remain qualified to perform certain deicing duties, annual recurrent training is required. An annual recurrent course should be presented as a training session that renews previous qualifications. This recurrent training does not have to be performed exactly or before the date of the previous qualification. A prior year's qualification remains valid for the beginning of the next deicing season but must be renewed before the year's end. As an example: if a trainee was qualified on November 1, 2015, the qualification renewal shall be completed between November 1 and December 31, 2016. This date-range flexibility eases the burden of training large groups at the beginning of the deicing season. However, it is highly recommended that the training be performed as early in the season as practicable. Conducting training sessions before the beginning of the season is also an option for theoretical aspects.

Local regulation could overrule the end-of-year requirement.

NOTE: Initial and recurrent training courses:

Management (of the trainee's company) is responsible for the level of competence of staff attending courses. If employees are competent through continuous activity in deicing, they only require "refresher" training. If employees have a lengthy absence from practical activities (e.g., no active deicing was performed for two consecutive seasons), they would normally require initial or requalification training.

3.2.8.4.2 Records

Records shall be kept of all tests and scores, for both the theoretical exam and the practical assessment. A test record shall indicate the trainee, the qualification being sought, the date of the test, the evaluating instructor, and the score. A failed examination can be retaken, and this must be noted in the record. The evaluation process must lead to a qualification before the trainee shall be allowed to carry out the required role. Any restriction to a qualification shall be documented. A certificate should be given to the person to verify all training and qualifications. A copy of the certificate should be kept. All documentation for the current season should be kept easily at hand for verification by approved deicing staff. Records shall be retained in accordance with applicable timelines established by local regulatory, air operator, or organizational record retention requirements.

3.2.8.4.3 Quality of Training

Only trained and qualified persons shall perform deicing/anti-icing procedures. This applies to both ground and flight crews. The deicing operator is responsible for performing, evaluating, and recording any and all training performed for Company personnel and subcontractors, as well as developing and/or executing a training-quality programme. Training subjects shall include those presented in Section WOM 3.2.7. Both initial and annual recurrent training is required, including practical training where applicable. The training shall cover all relevant topics, and qualifications shall be issued to all trainees who pass the evaluations.

Material used for training shall be of the latest edition of any relevant documentation, including customer manuals. A system of revision of manuals shall be established with the company concerned. Material used for reference or training only shall be marked accordingly.

A periodic quality review of the deicing/anti-icing training programme shall be conducted and a training-quality programme established. These should include a method of evaluating and monitoring the effectiveness of the deicing/anti-icing training delivered. Various measures of trainees' successful completion of their evaluations may be employed (e.g., score trends; percentage of first-try passes, re-takes, and additional training required, etc.). Training records described in WOM 3.2.8.4.2 should be maintained in a manner that ensures that they are easily retrievable by persons responsible for executing these programme-quality reviews.

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3.2.8.5 Computer-Based Deicing Simulator (CBDS) Standards

As computer-based deicing simulator (CBDS) systems are commonly used as part of deicing/anti-icing training programmes, this section identifies which components of CBDS systems may be used in lieu of, or as a part of a particular training curriculum. Due to their current limitations, CBDS systems cannot fully replicate all aspects of deicing vehicle familiarity training, and thus, the use of CBDS systems shall not replace the requirement to perform hands-on training on the actual deicing vehicle type for training aspects not encompassed by a CBDS's capabilities.

In order to determine and qualify a particular CBDS's capabilities, the capabilities are defined by "Levels". Levels A, B, C, and D (ranked by generic purpose and by realism to full-scale replica) CBDS systems are defined, and deicing training capabilities shall be categorised based on the capabilities of each level of simulator. Tables 6 and 7 define the minimum capability requirements for each CBDS level. Table 8 defines training requirements that CBDSs may be used in place of or to complement. Once a CBDS has been evaluated and qualified, based upon the operational/functional requirements specified in Tables 6 and 7, and the CBDS level has been established, Table 8 may then be utilised to determine the components of a training programme for which the CBDS may be used in place of traditional real-world practical training. Regardless of level, a CBDS system may be used to complement theoretical, practical, and deicing vehicle familiarity training. Where a CBDS system is designed based on a specific equipment manufacturer's vehicle type, this system can still be utilised to complement some elements of training where other equipment types may be utilised, as they have the capability to demonstrate generic deicing and anti-icing requirements. The evaluation and qualification of a CBDS system in order to determine the level category based upon minimum operational/functional requirements specified in Tables 6 and 7, and subsequent training capabilities in Table 8 as determined through Tables 6 and 7, shall be the collaborative responsibility of the CBDS manufacturer and end CBDS user owner.

Table 6: CBDS Minimum Operational and Functional Requirements, Part 1 of 2

	CBDS Level				Remarks
Hardware Requirements	**A**	**B**	**C**	**D**	
Contains a computer system and associated hardware (keyboard, mouse/track pad, monitor, and sound system), capable of operating system to potential required.	X	X	X	X	
Contains an audio and visual system capable of meeting all the standards of this appendix.	X	X	X	X	
Contains a sound system (i.e., speakers, headset) that is capable of replicating primary and secondary sounds.	X	X	X	X	
Contains a visual system (i.e., monitors, displays, goggles) that is capable of displaying all pertinent scenery and surroundings, additional controls and inputs as required, and relevant data as required by the operator.	X	X	X	X	
Contains a visual system whereby the operator can adjust viewing angles and directions as required.			X	X	
Has a multi-monitor visual system or head-motion-controlled goggles to depict 3D realism.				X	Optional
Contains a suitable workstation/platform to support the placement of equipment required to operate CBDS.	X	X	X	X	
Contains a seat position for operator.	X	X	X	X	
Contains a seat position for an instructor, in close proximity to the operator (either within workstation or adjacent to).	X	X	X	X	
Contains controls to simulate fluid application including nozzle and/or joystick (open bucket or enclosed cab types) and has capability to adjust between various nozzle settings.	X	X	X	X	
Contains controls to select between fluid types.	X	X	X	X	
Contains controls to simulate boom elevation/lowering; extension/retraction; spray arm extension/retraction and basket/cab rotation.	X	X	X	X	
Contains full scale replica of equipment controls/joysticks, switches, and other devices as found in equipment type represented.			X	X	Controls provided by OEM manufacturer
Controls oriented and located relative to actual location found in equipment type represented.		X	X	X	Controls provided by OEM manufacturer
Controls feel dynamics which replicate the vehicle simulated.			X	X	Controls provided by OEM manufacturer
Control inputs shall mimic the logic and result in the same manner as found in the equipment type represented (e.g., "dead-man pedal," etc.).		X	X	X	Controls provided by OEM manufacturer
Contains an operating cab/basket position.	X	X	X	X	
Contains a driver position (not necessary for one person operation from the operating cab/basket position).			X	X	
Has the capability to network between multiple CBDS systems and display real-time activity of the primary and secondary users during a scenario/exercise.		X	X	X	Optional
Has a motion system that physically maneuvers the operating cab/basket platform amongst multiple degrees of freedom (3 or 6). Areas simulated include all vehicle centrifugal motions, and can also include wind, jet blast, and collision.				X	Optional

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Table 7: CBDS Minimum Operational And Functional Requirements, Part 2 of 2

Software Requirements	A	B	C	D	
Contains a computer system and associated software (CPU, graphics card, sound card, etc.), capable of operating system to potential required.	X	X	X	X	
Computer capacity, accuracy, resolution, and dynamic response sufficient for the qualification level sought.	X	X	X	X	
Real-time, in-the-loop simulation.		X	X	X	
Has the capability to network between multiple CBDS systems and display real-time activity of the primary and secondary users during a scenario/exercise.		X	X	X	Optional
Capable of setting pre-determined scenarios.		X	X	X	
Capable of setting up individual operator login and password in order to track progress.		X	X	X	
Capability of recording participant activity for later playback and evaluation.			X	X	
Contains visual replica of operating cab/basket.		X	X	X	
Contains all relevant instrumentation and indications as on equipment, including lighting.			X	X	
Equipment depicted shall act and appear as equipment type represented.			X	X	
Motions associated with maneuvering of any component shall be precise to specifications of the equipment type represented (i.e., turning radius, operating height, etc.).			X	X	
Motion (force) cues perceived by the operator representative of the vehicle motions.		X	X	X	
Depicts ground maneuvering operating characteristics of equipment type represented, including motion when of parts and equipment when brought to a stop, deceleration, braking, and turning radius.		X	X	X	
Depicts boom/basket/spray arm maneuvering operating characteristics of equipment type represented.		X	X	X	
Contains any associated requirements applicable to the equipment type represented.		X	X	X	
Contains primary sounds, such as engine noise, ambient noise, vehicle component noises (boom, wipers, forced air blower, etc.), aircraft engine/APU noise, precipitation, wind noise, etc.		X	X	X	
Contains secondary sounds, including applicable equipment alarms, and warnings (i.e., spraying of a no-spray area), proximity sensor contact, and crash.		X	X	X	
Contains realistic aircraft with general permissible spray areas and no-spray areas.	X	X	X	X	
Accurately depicts permissible spray areas and no-spray areas specific to the aircraft type selected. Should a no-spray area be directly sprayed at, indicates a warning to the Operator.		X	X	X	
Depicts aircraft contamination, and is removable once fluid applied.	X	X	X	X	
Accurately depicts various forms of aircraft contamination and contamination amount and type is adjustable.			X	X	
Demonstrates removal of contamination once fluid is applied.	X	X	X	X	
Accurately depicts the way in which deicing and anti-icing fluid moves through the air, flows across the surfaces of aircraft, and exchanges heat with the air, contaminates, and aircraft surface.			X	X	
Demonstrates removal of contamination using forced air (where equipped).	X	X	X	X	Optional
Accurately depicts the way in which forced air flows, including velocities, and removal of contamination relative to dispersion angle.			X	X	Optional
Contamination removable is variable, dependent on the quantity of fluid applied and the quantity of contamination present.			X	X	
Shows effects of winds (including cross wind, high wind speeds, and gusts), precipitation type and intensity, fog, and jet blast/prop wash (where engines-on deicing is simulated).			X	X	
Shows special effects associated with aircraft de/anti-icing, i.e., collision, braking, bumps, jet blast (both exhaust plumes and effects of maneuvering within).			X	X	
Outside air temperature is displayed and is adjustable.			X	X	
Fluid temperature is displayed, and visual cues (steam) are present where fluid is heated.			X	X	
Fluid quantities are displayed.			X	X	
Time from start of simulation scenario is displayed and tracked.		X	X	X	
Daylight/darkness capability, with artificial and non-artificial lighting.			X	X	
Scenery showing generic deicing location and common airport surroundings and fixtures.		X	X	X	
Scenery showing precise site-specific deicing location and specific airport surroundings and fixtures.			X	X	Optional
Scenery showing static positioned in proximity to a live aircraft, whereby precise equipment movement simulation is required in order to prevent conflict.			X	X	Optional

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Table 8: CBDS Training Capabilities

Training Capabilities	CBDS Level				Remarks
	A	B	C	D	
Check of critical surfaces.		X	X	X	Generic aircraft representation.
Deicing fluid application techniques and requirements.	X	X	X	X	
Forced Air deicing techniques and requirements.	X	X	X	X	Where equipped.
Anti-icing fluid application techniques and requirements.	X	X	X	X	
Contamination removal techniques dependent on type and amount.	X	X	X	X	
Vehicle maneuvering.		X	X	X	Recommend being combined with real world hands-on training on actual equipment.
Vehicle patterns applicable to aircraft type/code/group.		X	X	X	
On-gate/stand deicing.		X	X	X	
CDF/DDF deicing.		X	X	X	Recommend site specific scenery be included to represent local requirements.
Deicing in adverse conditions (i.e., night, low visibility, high winds, etc.).			X	X	
Engines running deicing.			X	X	Where performed.
Propeller aircraft deicing.			X	X	Where performed and a propeller aircraft must be included in the CBDS aircraft library.
Aircraft familiarization, including location of no-spray areas, and different operating procedures/requirements.		X	X	X	Recommend complementing with real world hands-on training. Recommend a variety of aircraft be included in the CBDS aircraft library.
Communications - cab/basket operator to driver operator; operator to deicing coordinator and/or operator to aircraft.	X	X	X	X	An instructor presence is required unless system can accurately simulate interactive communication.
Multiple vehicle deicing.		X	X	X	Networking capability required.
Post de/anti-icing check requirements.		X	X	X	
Tactile check (based on aircraft type and locations on aircraft).		X	X	X	Recommend complementing with real world hands-on training.
Deicing equipment familiarity and basic safety guidelines.			X	X	Recommend complementing real world hands-on training.

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3.2.8.6 Language Proficiency Rating Scale

This section describes the requirements for determining English language proficiency that shall be used to communicate applicable deicing/anti-icing information in the English language. Where this is a requirement, personnel shall, at a minimum, meet the equivalency of a Level 4 Operational rating, as specified in the ICAO "Language Proficiency Rating Scale" shown as Figures 3 and 4. This scale is taken from Appendix A of ICAO Doc. 9835 AN/453, Manual on the Implementation of ICAO Language Proficiency Requirements, First Edition, 2004. Further information pertaining to these requirements can be found in that document.

1.1 Expert, Extended and Operational Levels

Level	*PRONUNCIATION* *Assumes a dialect and/or accent intelligible to the aeronautical community*	*STRUCTURE* *Relevant grammatical structures and sentence patterns are determined by language functions appropriate to the task*	*VOCABULARY*	*FLUENCY*	*COMPREHENSION*	*INTERACTIONS*
Expert 6	Pronunciation, stress, rhythm, and intonation, though possibly influenced by the first language or regional variation, almost never interfere with ease of understanding.	Both basic and complex grammatical structures and sentence patterns are consistently well controlled.	Vocabulary range and accuracy are sufficient to communicate effectively on a wide variety of familiar and unfamiliar topics. Vocabulary is idiomatic, nuanced, and sensitive to register.	Able to speak at length with a natural, effortless flow. Varies speech flow for stylistic effect, e.g. to emphasize a point. Uses appropriate discourse markers and connectors spontaneously.	Comprehension is consistently accurate in nearly all contexts and includes comprehension of linguistic and cultural subtleties.	Interacts with ease in nearly all situations. Is sensitive to verbal and non-verbal cues and responds to them appropriately.
Extended 5	Pronunciation, stress, rhythm, and intonation, though influenced by the first language or regional variation, rarely interfere with ease of understanding.	Basic grammatical structures and sentence patterns are consistently well controlled. Complex structures are attempted but with errors which sometimes interfere with meaning.	Vocabulary range and accuracy are sufficient to communicate effectively on common, concrete, and work-related topics. Paraphrases consistently and successfully. Vocabulary is sometimes idiomatic.	Able to speak at length with relative ease on familiar topics but may not vary speech flow as a stylistic device. Can make use of appropriate discourse markers or connectors.	Comprehension is accurate on common, concrete, and work-related topics and mostly accurate when the speaker is confronted with a linguistic or situational complication or an unexpected turn of events. Is able to comprehend a range of speech varieties (dialect and/or accent) or registers.	Responses are immediate, appropriate, and informative. Manages the speaker/listener relationship effectively.
Operational 4	Pronunciation, stress, rhythm, and intonation are influenced by the first language or regional variation but only sometimes interfere with ease of understanding.	Basic grammatical structures and sentence patterns are used creatively and are usually well controlled. Errors may occur, particularly in unusual or unexpected circumstances, but rarely interfere with meaning.	Vocabulary range and accuracy are usually sufficient to communicate effectively on common, concrete, and work-related topics. Can often paraphrase successfully when lacking vocabulary in unusual or unexpected circumstances.	Produces stretches of language at an appropriate tempo. There may be occasional loss of fluency on transition from rehearsed or formulaic speech to spontaneous interaction, but this does not prevent effective communication. Can make limited use of discourse markers or connectors. Fillers are not distracting.	Comprehension is mostly accurate on common, concrete, and work-related topics when the accent or variety used is sufficiently intelligible for an international community of users. When the speaker is confronted with a linguistic or situational complication or an unexpected turn of events, comprehension may be slower or require clarification strategies.	Responses are usually immediate, appropriate, and informative. Initiates and maintains exchanges even when dealing with an unexpected turn of events. Deals adequately with apparent misunderstandings by checking, confirming, or clarifying.
Levels 1, 2 and 3 are on subsequent page						

Figure 3. Language proficiency table, part 1.

1.2 Pre-Operational, Elementary and Pre-elementary Levels

Level	PRONUNCIATION Assumes a dialect and/or accent intelligible to the aeronautical community	STRUCTURE Relevant grammatical structures and sentence patterns are determined by language functions appropriate to the task	VOCABULARY	FLUENCY	COMPREHENSION	INTERACTIONS
Levels 4, 5 and 6 are on preceding page						
Pre-operational 3	Pronunciation, stress, rhythm, and intonation are influenced by the first language or regional variation and frequently interfere with ease of understanding.	Basic grammatical structures and sentence patterns associated with predictable situations are not always well controlled. Errors frequently interfere with meaning.	Vocabulary range and accuracy are often sufficient to communicate on common, concrete, or work-related topics, but range is limited and the word choice often inappropriate. Is often unable to paraphrase successfully when lacking vocabulary	Produces stretches of language, but phrasing and pausing are often inappropriate. Hesitations or slowness in language processing may prevent effective communication. Fillers are sometimes distracting.	Comprehension is often accurate on common, concrete, and work-related topics when the accent or variety used is sufficiently intelligible for an international community of users. May fail to understand a linguistic or situational complication or an unexpected turn of events.	Responses are sometimes immediate, appropriate, and informative. Can initiate and maintain exchanges with reasonable ease on familiar topics and in predictable situations. Generally inadequate when dealing with an unexpected turn of events.
Elementary 2	Pronunciation, stress, rhythm, and intonation are heavily influenced by the first language or regional variation and usually interfere with ease of understanding.	Shows only limited control of a few simple memorized grammatical structures and sentence patterns.	Limited vocabulary range consisting only of isolated words and memorized phrases.	Can produce very short, isolated, memorized utterances with frequent pausing and a distracting use of fillers to search for expressions and to articulate less familiar words.	Comprehension is limited to isolated, memorized phrases when they are carefully and slowly articulated.	Response time is slow and often inappropriate. Interaction is limited to simple routine exchanges.
Pre-elementary 1	Performs at a level below the Elementary level.	Performs at a level below the Elementary level.	Performs at a level below the Elementary level.	Performs at a level below the Elementary level.	Performs at a level below the Elementary level.	Performs at a level below the Elementary level.

Figure 4. Language proficiency table, part 2.

NOTE: The Operational Level (Level 4) is the minimum required proficiency level for radiotelephony communication. Levels 1 through 3 describe Pre-Elementary, Elementary, and Pre-Operational levels of language proficiency, respectively, all of which describe a level of proficiency below the ICAO language proficiency requirement. Levels 5 and 6 describe Extended and Expert levels, at levels of proficiency more advanced than the minimum required standard. As a whole, the scale provides benchmarks for training and testing, and in assisting candidates to attain the ICAO Operational Level (Level 4).

3.2.9 Contract Deicing/Anti-Icing

3.2.9.1 General Training Recommendation

Many air operators use other service providers to perform their deicing/anti-icing operations. Training for contractor deicing/anti-icing services should include at least one of the following criteria in WOM 3.2.9.2 through WOM 3.2.9.4.

3.2.9.2 Training by Outside Contracted Party

A contract training programme meeting the requirements of this document can be implemented.

3.2.9.3 Contractor Training Staff Competence

All contractors must meet AS6286 requirements and any approved program requirements of their clients.

The client is responsible for the assurance of competence post-training.

3.2.9.4 Management Plan

The air operator will develop, coordinate with other affected parties, implement, and use a management plan to ensure proper execution of its approved deicing/anti-icing programme. The air operator's management plan shall identify the manager responsible for the overall deicing/anti-icing programme and each subordinate manager. It shall describe each manager's functions and responsibilities, relative to properly managing the air operator's deicing/anti-icing programme. To manage the overall QMS, refer to AS6332.

3.2.10 Guidance for Running Deicing Training Sessions

3.2.10.1 General

This section is intended as a guide for instructors who are responsible for deicing training (either theoretical or practical), producing the relevant material, and evaluating the training processes. It is important that there is a training programme established that all instructors follow. Deicing operations as a ground service may seem less important to emphasise but this attitude should not be taken. Deicing operations have a direct impact on the safety of the flight, and the instruction should make this point very clear in all areas of the process. Deicing operators are all adults, and the teaching process should be directed to an audience with variable life backgrounds. The instructor should show consistency in teaching, instill high standards for the process, detect and correct unsafe habits, and show professionalism and knowledge of the subject. If the trainer is not interested in the subject, then the trainee will not take the process seriously. Even if the operational aspects may seem easy and manageable, a knowledge of all relevant items is needed to clarify the "what, why, and how" of the whole process. The main purpose of this training education is to help the deicing operator translate facts and knowledge into the required professional action.

3.2.10.2 The Learning Process

Learning is an individual process. Each trainee sees a learning situation from a different perspective. The knowledge required to perform deicing/anti-icing operations cannot be poured into the trainee's head; the trainee can only learn from individual experiences. The learning of a physical skill requires actual experience in performing that skill. Do not assume that something once told will be remembered instantly. The theoretical aspect needs "practice and drill" to be effectively learned. The trainees must be taught correctly from the beginning because it is much harder to "unteach" incorrect habits than to teach them anew. Normal individuals acquire most of their knowledge through sight and visual aids and far fewer just through listening. Thus, when teaching something that the trainee can see and hear (for both theoretical and practical training), most of the learning process will be achieved.

There is no room for trial and error in practical deicing operations. It is therefore a major responsibility for the instructor to organise demonstrations and explanations and to direct trainee practice, so that the trainee has adequate opportunities to understand the interrelationship of the many kinds of experiences that have been taught and understood. Adults tend to have their own idea of many processes since they may have previous experiences in many related work areas. It must be made clear from the beginning that there cannot be any improvising when it comes to the safety of deicing operations. When the trainee is motivated to learn and has the opportunity to perform the skill learned, then it will become an understanding process of theory and practice, which are linked together.

The deicing/anti-icing training is an annual process. Every refresher training course should naturally include any changed procedures and should also provide a refresher of basic operational issues. Even if the deicing crews have some practical experience gained over the years, forgetting basic procedures is normal. That is why things not often used or covered in training are usually the things that are forgotten and should therefore be repeated in refresher training. It is also important to give meaningful examples for issues so they will be easier to remember and the trainee can adapt the knowledge in practice whenever needed.

3.2.10.3 The Teaching Process

The instructor should prepare each instructional session according to the level of the deicing qualifications (see Section 4). All aspects may be relevant to cover, but some issues can be more important for one group while other issues can be more important for another group. The training should be specific and not taught as a general subject. After the preparation, a presentation of the deicing procedure should be performed in a manner such that the trainees can remember the procedures in practical application. The review and evaluation of trainees' command of the procedures are performed with theoretical tests and practical assessments where applicable. A review and evaluation are always recommended because it is the only way to ensure that there are no misconceptions of deicing operations.

There are some elements that need to be noted when teaching deicing operations to a group with different background knowledge of aviation procedures (if they have any experience at all). The main thing is to have a good arrangement of material and procedures to be taught. The trainee should not have to find out procedures for

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themselves in basic training. Some guidance to remember is to keep the trainees motivated and informed, and to present all information consistently. It is important to identify mistakes and review the related issue to correct any misconceptions. The instructor should admit errors in teaching instead of trying to improvise if they do not remember. Elements about which the instructor is uncertain can be clarified later. Good human relations promote more effective learning.

English is not the native language in many cases, even though much of the material available is only available in English. It is the responsibility of the Head of Deicing Training to make available any relevant material. This material can be in any language, but the reference must be explained and covered in training. Deicing procedure material is not all that should be delivered. All pertinent information that has something to do with the entire deicing operation should be included (e.g., airport regulations, winter programmes, customer requirements, etc.). All material should be distributed in basic training. Trainees in refresher training should receive all new information, but basic material should be available for easy access. There may be more than one instructor teaching the procedures, and in this case, an instructor briefing is recommended to clarify what is to be taught by whom (and the related material).

3.2.10.4 Teaching Methods

There are several ways to conduct deicing training. The instructional session depends on the group at hand. Deicing procedures are usually presented in a “lecture method,” which is not always the most effective way. There are many elements that simply are not possible to teach in another way but the interest of the group must be established. The lesson should be organised with an introduction, development, and conclusion. The trainees must be made aware of their responsibility and develop a receptive attitude toward the subject. The appearance and attitude of the instructor toward the subject is critical in giving trainees their first indication of the importance of deicing. The introduction should get the trainees’ attention, motivate them, and give an overview of the area to be covered. In short, the introduction sets the stage for learning. When developing the lesson, the instructor must logically organise the material to show the relationships between the main points. There are many subjects that need to be explained which might not seem relevant at first but are important for an understanding of how deicing operations reflect these elements. Meaningful transitions from one point to another keep the trainees oriented and helps them understand how each issue relates to the deicing procedures. Examples of real cases are often used, and this has a good effect for showing “what if” scenarios. When concluding the training, it is important to focus on the main deicing procedures, providing a brief overview of the operation. An effective conclusion retraces the important elements of the lesson and relates them to the objective.

Although most of the subjects must necessarily be explained using a lecture method, a more effective alternative method is an “illustrated talk,” where the instructor reflects the ideas to the trainees with the help of visual aids (pictures, films, etc.). Depending on the size of the group, a guided discussion method may be used. This method of instructing gets the trainees more involved but the trainees should have some knowledge of the subject in order to make the lessons productive. Some subjects can be taught by demonstration-performance methods (such as ice/ frost formation, refractive index tests, etc.), and this technique can be a healthy change from the theoretical part. Case studies can also be used for some subjects (such as vehicle incidents, aircraft icing, etc.) to cover lessons learned and encourage a brief discussion of the importance of deicing. Human Factors are an important element of the training since case studies may give a valuable insight into the real operation that may perhaps otherwise be overlooked.

The teaching of instructors may be easier in the sense that they have previous knowledge and the emphasis can be set on issues more important and relevant for their particular operation. It is important to cover the basic ideas of correct deicing operation and set standards, according to which all procedures are to be followed. After reviewing new and changed issues, a discussion of deicing procedures within the group may be a good way of retrieving information on how each person sees a particular procedure. It may be that information of correct deicing procedures has changed down the line, particularly in large companies when instructors train others. All misconceptions must be corrected, and emphasis on approved procedures shall be made. This can also be the case when teaching subcontractors and their trainers. The problem may be that control of proceedings is not as good within a subcontracted company as in the main company. For subcontractor trainers, it is important that the correct procedures are understood, and the training elements are covered, since there may not be any further control of instruction.

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3.2.10.5 Instructional Aids

Instructional aids should be used whenever possible while teaching deicing subjects because the material is in large provided as a lecture. Getting and holding trainees' attention is essential to learning. The instructor should present an overview of the material before distributing or showing the related subject material. The use of any instructional aids should be planned and fit in for a specific subject. Pictures, films, examples, and related tools can be used. There is a large amount of related material available for deicing, standards and recommendations, vehicle and aircraft documentation, videos, etc., and the material should not be unfamiliar to the instructor. Instead of simply distributing the material, an explanation of the content should be provided. It must therefore be clear to the instructor what the film or printed material contains in order to explain it correctly. This is especially so when using material that originates from outside of the company. Note that there are many old films and pictures of deicing operations, and their use is not recommended unless they still present the subject correctly.

Computer-based training (CBT) and presentation is a modern way of teaching that also gets the trainees' attention. However, computers and their deicing programmes are not available everywhere. Computer-based instruction must be presented in a manner that is understandable for the trainee. If "self-study" programmes are available for deicing, then a briefing should be held on the subjects so that the content is correctly read and understood. CBT programs can be a helpful aid to reinforce something already presented. However, one caution is that any additional study programme can also be harmful if English is the instructional language but the trainee lacks sufficient understanding of all terms and directions. Whenever using copied material, videos, CBT-programmes, etc., it must be made clear what the current procedures are and what information is only for reference.

3.2.10.6 Evaluation

The training programme must contain procedures of training and evaluation. The evaluation process must be considered when building up the time schedule for training. It must be made clear to trainees in the beginning that deicing training contains an evaluation process. This may motivate the trainees to be more active toward the subjects. The evaluation does not benefit safety when it is introduced by surprise. Theoretical evaluation is performed with exams, and practical evaluation can be performed by an assessment of operation. Note that a good debriefing can clear up misconceptions better than simply failing or approving trainees. Evaluation of the deicing training is one last process during which misconceptions can still be corrected. It is very important that the evaluation benefits the trainee as well as the deicing operation. The ultimate goal of the training process is to result in safe deicing operations.

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APPENDIX 1 THEORETICAL ELEMENTS GUIDANCE CONTENT

0 TE0: AN INTRODUCTION TO THIS APPENDIX

The purpose of WOM Appendix 1 is to outline the principles and methodology of aircraft ground deicing. This document has been written to support the needs of training as defined in Tables 2 and 3 of the main WOM 3.2 document. It does not seek to repeat or reinterpret the operating methods and instructions that are to be found in other SAE aircraft ground deicing standards, rather it seeks to fill in the concepts and accepted approach to aircraft safety during winter weather when there is the potential for aircraft safety to be lower due to frozen contamination. These other key aircraft ground deicing standards are:

AS6285	Aircraft Ground Deicing/Anti-Icing Processes
AS6332	Aircraft Ground Deicing/Anti-Icing Quality Management
ARP1971	Aircraft Deicing Vehicle - Self-Propelled
ARP5660	Deicing Facility Operational Procedures

NOTE: WOM 3.2/Appendix 1 is not an instruction for aircraft deicing processes or procedures, in the case of any conflict between the advice given here and these other standards, the other standards take precedence.

1 TE1: TRAINER AND COURSE INTRODUCTION

1.1 At the end of this section, the trainee should understand in detail:

- The name and background of the trainer.
- The way in which the trainer has been qualified to do the training job and also approved by senior managers to do this training as part of their commitment to safety for the airport operation.
- An overview of the content of the training course, the way in which it will be taught, the schedule of the training session and any breaks that have been built into the day.
- The requirement for a final exam and the achievement of a suitable pass mark.

1.2 The Trainer

Aircraft deicing trainers are likely to be very experienced in carrying out aircraft deicing and so senior members of any airport operations team. However, training others in the safe and efficient ground deicing of aircraft requires a very different set of skills – planning, managing time, managing course content, managing people, checking for understanding, etc. Some ideas of the fundamentals of training are included in the main WOM 3.2 document in Section 9. A suggested schedule of training is shown in Tables 2 and 3 of WOM 3.2. The rest of this WOM 3.2 Appendix outlines the essential content expected for Tables 2 and 3 and supports the more process and instructive elements in the other SAE Standards with which the trainer should be familiar.

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SECTION A: THE REQUIREMENT FOR AIRCRAFT GROUND DEICING/ANTI-ICING

2 TE2: BASIC KNOWLEDGE OF AIRCRAFT PERFORMANCE

2.1 At the end of this section, the trainee should be able to describe in detail:

- The four forces that act on an airplane.
- Airflow over and under the wings, and the pressures on the wings.
- Why an airplane can take off.
- How lift is generated.
- The critical angle of attack.
- The aerodynamic window of operation.
- The biggest contributor to airplane lift.

2.2 How Planes Take Off and Fly

Airplanes can fly because they are able to efficiently manage four forces acting on them. When these are balanced, the airplane can fly straight and level.

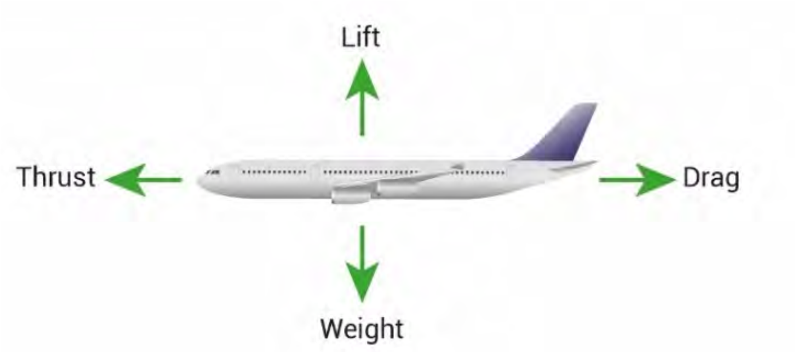

Figure A1. The four forces that act on an airplane.

a) **Weight:** the weight of the airplane due to gravity

b) **Lift:** a force primarily derived from the wings that can overcome gravity

c) **Thrust:** a force required to generate lift and overcome drag

d) **Drag:** the forces that are acting to hold back the airplane.

However, to get an airplane into the air, it needs to lift off from the ground and climb to its cruise height. The key to understanding aerodynamics is to understand how lift is generated by the wings from the applied thrust. Airplanes on level ground will usually have their wings tilted slightly upward. As they accelerate down a runway, air flows under and over the wings. As a result of this, the air below the wing is compressed and is higher in pressure, and the air above the wing is expanded and has a lower pressure. The combination of these two effects leads to enough lift to overcome both the weight and drag of the aircraft, which then takes off. A simple picture is shown in Figure A2, showing the **airfoil** shape of the wing cross-section. In summary, for an airplane to take off, the **lift** generated by the airplane must be greater than the **weight** and **drag** of the airplane.

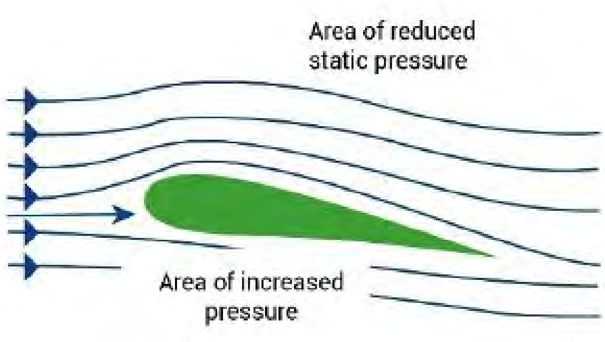

Figure A2. Flow of air over an airfoil.

2.3 How Lift is Generated

To have a better understanding of lift, a further idea needs to be added when describing the airfoil. The airfoil illustrated in Figure A2 is shown as tilted at an angle to the airflow. This tilt is referred to as the "Angle of Attack". The combination of thrust (speed) and the airfoil Angle of Attack then generates lift.

Lift needs **Thrust** (speed) plus **Airfoil Angle of Attack**

Physically, the combination of the speed and Angle of Attack is to divert airflow downward. By pushing air down, the wing itself is pushed up – lifted. This airflow is summarised in Figure A3, showing a smooth flow both above and below the wing. The important point is the deflection of air downward, causing the wing, and hence the airplane, to be pushed upward. The smooth (laminar) airflow is also required to ensure good lift (see Figure A3). Similarly, helicopters work by using a rotating wing (the rotors) to push air downward, causing the helicopter to go upward.

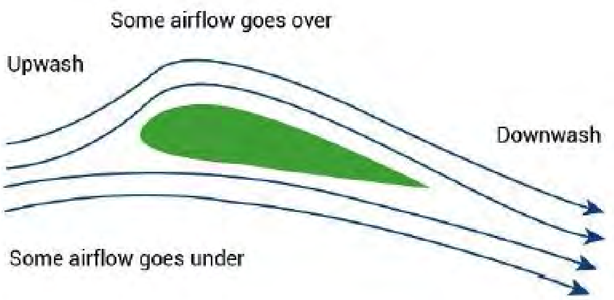

Figure A3. Airflow around a wing.

This reliance on the Angle of Attack is easy to show. Some airplanes (stunt fliers, for example) can fly upside down. This is done by maintaining the right Angle of Attack of the wing plus the required speed. Lift can be achieved in either orientation with the same wing.

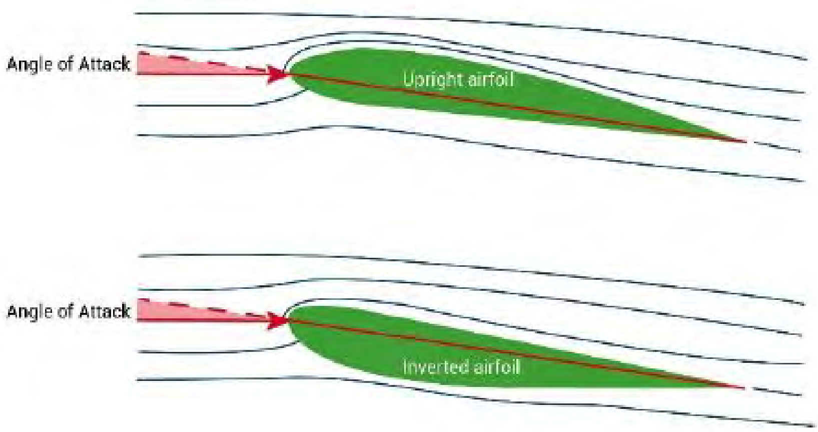

Figure A4. Lift can be achieved with an airfoil in either orientation.

2.4 The Limit of Using Angle of Attack to Generate Lift

However, there are limits to the amount of lift any airplane can generate. For a certain thrust (size of engine), the lift generated by an airfoil will increase as the Angle of Attack increases. Beyond a certain angle, the smooth (laminar) flow of air above the wing breaks down and becomes **turbulent**, destroying the lift effect. This critical angle at which lift becomes poor and drag increases too much is known as the **critical angle of attack**, leading to **aerodynamic stall**. An overall measure of generated lift (the coefficient of lift, C_L) is shown for typical airfoils in Figure A5.

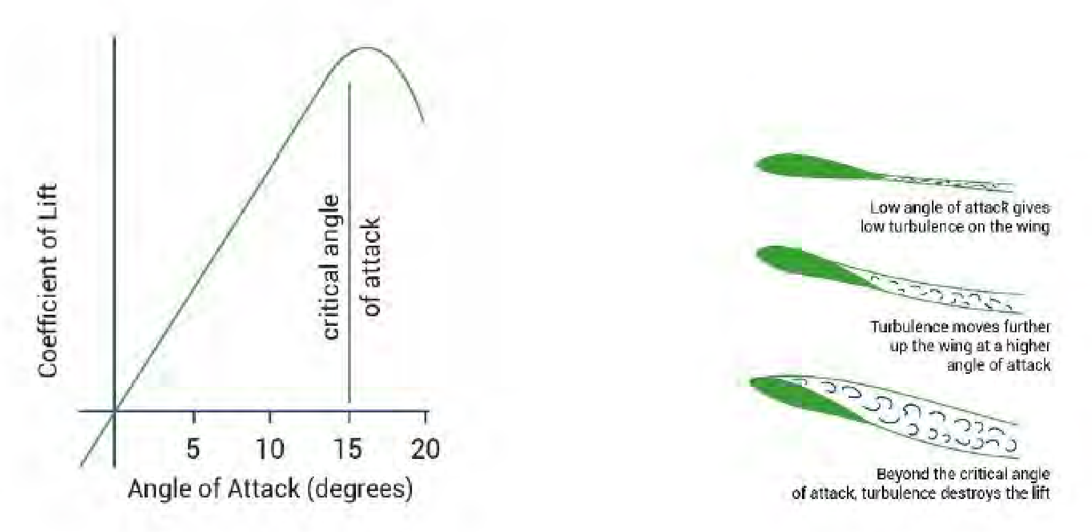

Figure A5. Coefficient of lift and the angle of attack.

There is one further important point to note from the above description of aerodynamic stall. While some air is pushed down by the higher pressure under the wing, it is the top of the wing that is the biggest contributor to airplane lift. Disruption of this flow of air over the top of the wing has the greatest impact in destroying lift. Referring to Figure A5, the loss of lift at an angle greater than about 16 degrees is shown only for the top surface. This is also why most additional equipment on airplane wings (engine mountings, ancillary fuel tanks) are located under the wings, rather than on top. For most airplanes, the top surface is kept smooth and uncluttered.

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2.5 The Aerodynamic Operating Envelope

In addition to this aerodynamic stall that happens due to a high angle of attack, the aircraft also stalls due to a low speed – this is called **"stall speed"**. Essentially, the aircraft does not have enough thrust to gain lift from the wings. There is hence an **aerodynamic operating envelope**, which can be defined in terms of both aircraft speed and the Angle of Attack. These limits can be summarised as:

- The speed of the aircraft must be between the minimum required (**stall speed**) and the maximum at which the aircraft can safely operate, and
- The Angle of Attack must be between the minimum required to achieve lift and the maximum possible (limited by **aerodynamic stall**).

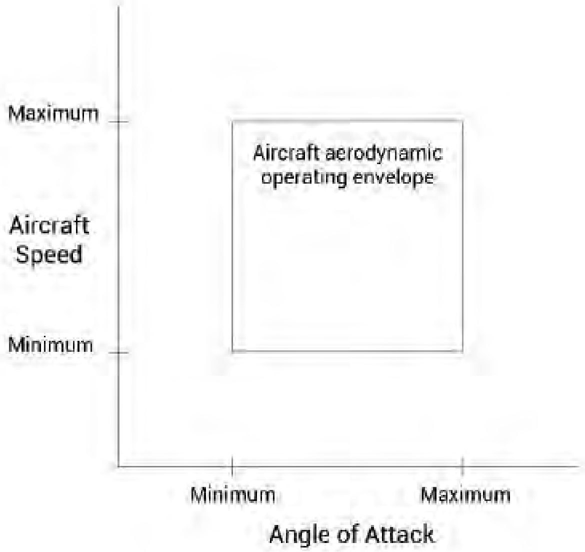

Figure A6. Aerodynamic operating envelope.

3 TE3: EFFECTS OF FROZEN CONTAMINATION ON AIRCRAFT PERFORMANCE

3.1 At the end of this section, the trainee should be able to describe in detail:

- The effect of frozen contamination on lift and drag of an airplane.
- The effect of frozen contamination on the aerodynamic operating envelope.
- The critical component areas for lift and maneuverability of an airplane.
- How even a small layer of frost may affect lift, drag, and stall speed.
- Other effects of frozen contamination on an airplane.

3.2 General

This section explains how operating in winter conditions can affect aircraft performance. The basic concept will be introduced that any **frozen contamination** (ice, frost, slush, or snow) on aerodynamic surfaces affects the aerodynamic performance, and why the deicing ground crew should note any and all factors relating to the aerodynamic surfaces of the aircraft will be discussed. Subjects in this section are simplified to a large extent and further investigation would clarify issues in more detail, but this is not necessary for the deicing ground crew.

3.3 Frozen Contamination and the Effect Upon Aerodynamics

The specific performance of any aircraft is determined and certified with the assumption that all of its **aerodynamic surfaces are clean**. Any contamination will decrease this performance, and such a decrease in performance and control has not necessarily been assessed. The clean aircraft concept must be very clear for a deicing ground crew. The motto for winter operations is: "make it clean and keep it clean."

Any ice on the wings of an airplane causes multiple detrimental effects:

- The airfoil surface becomes rougher, disrupting the smooth flow of air. This more turbulent air on top of the wing decreases lift dramatically. Just a small buildup of ice (e.g., frost) can reduce or destroy the lift.
- With the rougher surfaces of ice on the aircraft, there is also an increase in the drag forces.

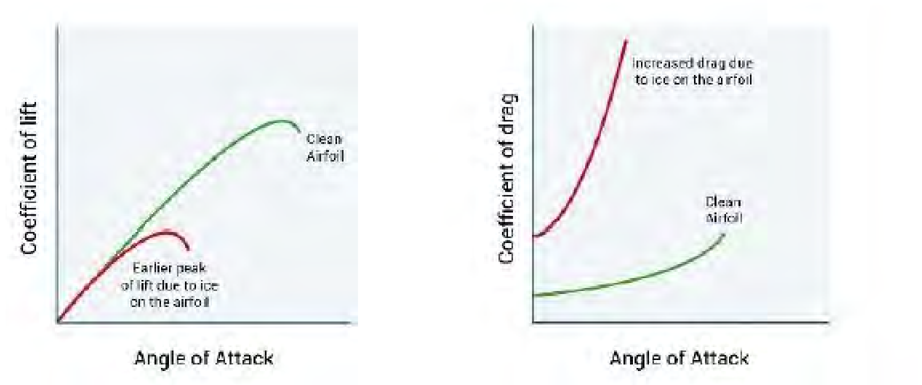

Figure A7. Decrease in airfoil stall angle and increase in drag coefficient.

The consequences of this frozen contamination on the aircraft performance are:

- Stall speed is higher, meaning that the airplane will stall at a higher speed than expected.
- Because the stall speed increases, the stall angle of attack decreases. Thus, an aircraft climbing after takeoff could unexpectedly stall at a "normal" climb angle of attack for a clean aircraft.
- Hence, the aerodynamic operating envelope is much smaller, leaving the pilot with fewer options for airplane performance and control.

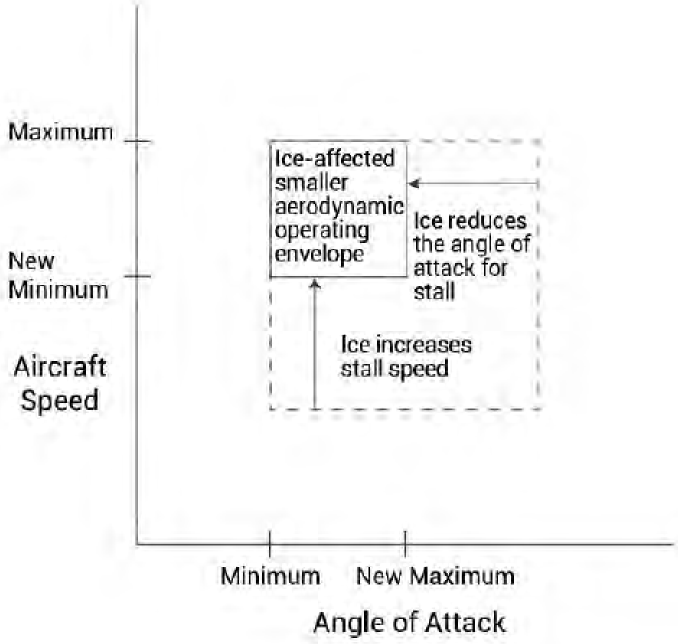

Figure A8. The smaller aerodynamic operating envelope due to frozen contamination on the wings.

3.4 Aircraft Icing

3.4.1 Ground Icing and Deicing/Anti-Icing

Icing of aircraft outer components on the ground is normally very obvious to observe due to the presence of snow, ice, slush, or frost. The way in which most aircraft are treated to remove and prevent frozen contamination on the ground is with deicing/anti-icing fluids to ensure that the aircraft is free of contamination at the point of take-off.

3.4.2 In-Flight Icing

In-flight icing occurs when an aircraft flies through a cloud of supercooled droplets (not ice particles), which then freeze onto the aircraft surface. This build up of ice on the aircraft during flight can be quick or may be insidious, as the speed will bleed off as drag increases. Pilots need to be aware that they may be in a cloud of supercooled droplets which may cause ice accretion. In-flight icing is typically managed with onboard deicing/anti-icing systems, which are entirely different from deicing/anti-icing treatment for ground icing. Deicing/anti-icing treatment for ground icing does not protect against ice accumulation in flight. In-flight icing is not addressed further in this standard.

3.5 Frozen Contamination and Aircraft Components

The critical effects of frozen contamination are the resulting decrease in lift, increase in drag, and potentially limited maneuverability. The **leading edges of the wing and of the vertical and horizontal stabilizers** are the most critical areas with regard to the airflow around the aircraft. The leading edges are where the airflow becomes divided evenly around the wing surface (or tail surfaces). As the angle of a wing to the airflow (the angle of attack) is increased, the air flows smoothly along the surfaces at first (called laminar flow), but then after a certain point starts to break away (called turbulent flow), depending on the angle of attack for the specific wing design. Any contamination at the leading edge will upset the air flow, and it will become turbulent earlier than intended, reducing lift and increasing drag.

The aircraft moves around three axes: longitudinal, horizontal, and vertical. The flight crew controls this movement by changing the position of the primary flight controls: ailerons, spoilers, rudder, and the elevator and horizontal tail, depending on the particular flight situation. Any frozen contamination on these control surfaces may restrict their movement or cause them to be less effective, and in worst case, can cause a loss of control of the aircraft.

Different aircraft are designed in different ways, but the basic lifting physics remain the same. Any part on the aircraft that changes the airflow is there for a reason, and the deicing ground crew must assure that these areas are free of contamination, whether they are identified as a critical lifting surface or not. Such other aerodynamic parts on an aircraft can be trailing-edge flaps, strakes, vortilons, winglets, pylons, stall strips or vanes, vortex generators, etc. However, it is crucially important to also make and keep clean the in-spar and aft regions of wings and tails (aft of the leading edges). Lowering leading-edge slats and trailing-edge flaps, for example, exposes different surfaces that were nested before and where contamination can also adhere. If slats and flaps are in a lowered position while the aircraft is on the ground, such areas shall be checked and cleaned as necessary. Contamination on these parts will cause irregular airflow, which can cause performance or maneuverability problems when they are lowered in flight. In addition, stowing contaminated flaps and slats can cause structural damage to the surfaces.

The fuselage is not a critical lifting surface, but contamination shall be removed in the same manner as other surfaces. The main concern is that snow, slush, or ice will break off and damage the engine or aircraft surfaces that can cause a dangerous situation during takeoff. Another concern can be the additional weight of the contamination, which could affect takeoff performance such as field length. Light frost may be allowed on the fuselage in certain circumstances (must be able to read lettering, etc.), depending on the aircraft manufacturer's requirements, company procedures, and regulatory requirements.

The upper surfaces of the wings and tail are not the only areas to check and treat. The lower surfaces are also highly important. The wing lower surfaces shall be free of ice and snow, but frost may be allowed in some areas (typically the fuel-tank area), depending on the aircraft manufacturer's requirements, company procedures, and regulatory requirements. However, the horizontal stabilizer's lower surface shall be clean in all cases. The horizontal stabilizer is an inverted airfoil, so the lower surface is the lifting surface. It creates a lifting force either up or down depending on how the elevator (and tabs) is positioned. A tail "down force" is pronounced and essential for takeoff, and the horizontal tail shall therefore be verified as clean on both sides.

It is obvious that if an aircraft is covered with large amounts of snow, slush, or ice, it will affect lift and performance, but even "lighter" contamination that seems minor or insignificant to the eye, such as frost, can have a considerable

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negative effect. Even if the loss of performance is not enough on its own to cause an accident, safety margins can be reduced, so that if another problem arises, such as an engine failure, the combination of problems may be enough to transform an incident into a major accident. Any loss of performance will also cause the aircraft to use more fuel, but the main focus of this guide is on the flight safety consequences of contaminated aircraft surfaces, rather than other impacts.

3.6 The Effect of Frost on Lift

Tests have been performed on some aircraft of how different thicknesses of frost affect the lifting performance. The effect on other types of aircraft may be similar, but this particular example was studied to assess the performance of a narrow-body jet aircraft. Three configurations were compared: clean wing, a thin layer of frost (e.g., 1 mm or less), and a thick layer of frost (e.g., 1 to 2.5 mm). First, normal takeoffs with these configurations were compared, then takeoffs with an engine-out (loss of one of the main engines). Commercial jet airliners are fitted with powerful engines that in normal cases produce a certain amount of excess thrust. A thick layer of frost always has some effect on normal lifting performance. However, when there is an engine-out situation, even a thin layer of frost may have a notable effect on lift compared to a clean wing under these conditions. When there is a thick layer of frost during an engine-out on takeoff, lifting capabilities may be dramatically reduced. It must be noted that these situations may differ greatly between different aircraft and in some cases, frost may even be allowed to some extent. Aircraft manufacturer limitations shall be noted in all cases.

3.7 Effects of Frost on Stall

Tests have also been performed on how different thicknesses of frost affect stall performance. This particular example was to assess the performance of a narrow-body jet aircraft. Each aircraft has a particular critical angle of attack when the wing stops lifting; this is called a stall. Below the stall angle of attack, higher angles of attack produce more lift, which is a phenomenon needed especially during takeoff and landing. When a thin layer of frost is on the wing, it reduces the maximum angle of attack by a certain amount, and the wing stalls earlier than anticipated, perhaps even without any stall warning. This scenario will also increase the drag of the wing, causing it to stall somewhat earlier than anticipated with the same takeoff angle. The same scenario can be seen with a thicker layer of frost, but in this case the effect is even more dramatic. Due to these effects, usually no amount of frost is permitted on the wing upper surface for takeoff. Certain frost configurations may have been tested by the aircraft manufacturer and certified or otherwise approved by the regulatory authority as safe for flight; this atypical information should be in the aircraft flight manual.

3.8 Other Effects on Performance

As discussed above, contamination will affect the amount of drag of an aircraft, as well as lift. The more contamination there is on an aircraft, the more drag is produced, and thus the aircraft will have less performance than a clean aircraft. The contamination does not have to be on aerodynamic lifting surfaces (which must be cleaned anyway) to create drag, it can be on anything - the landing gear, fuselage, etc. These areas must be cleaned as well. If contamination exists on these components, thrust must be added (if excess thrust is available) to compensate for the reduced performance. This is perhaps most notable for propeller aircraft, which often do not have much excess thrust available for takeoff. The propeller is itself a lifting device and its surface must be clean using the proper cleaning procedures according to the aircraft manufacturer’s requirements. Any contamination of the blade surface can reduce the pulling force effectiveness of the propeller. Vibration of the propellers due to contamination may also be a factor. The same applies for jet aircraft – fan blades must be clean. A visual check of the fan blades, and especially on their rear side, is necessary to detect frozen contamination adhering to them. The presence of ice on fan blades can lead to vibration, performance loss, and even engine damage.

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4 TE4: THE CLEAN AIRCRAFT CONCEPT, REGULATORY BODIES, AND RECOMMENDATIONS

4.1 At the end of this section, the trainee should be able to describe in detail:

- The "clean aircraft concept".
- The regulatory requirements of various regional authorities.
- The role of SAE International and the key global aircraft ground deicing standards.
- The main purpose of aircraft deicing and anti-icing.

4.2 The Clean Aircraft Concept

Regulations governing aircraft operations in ground icing conditions shall be followed. The International Civil Aviation Organization (ICAO) Annex 6, Part I, mandates specific rules for the safe operation of aircraft during ground icing conditions, and all member states subsequently are required to have regulations in place to ensure this. In part, these state:

> *4.3.5.6: A flight to be planned or expected to operate in suspected or known ground icing conditions shall not take off unless the aircraft has been inspected for icing and, if necessary, has been given appropriate deicing/anti-icing treatment. Accumulation of ice or other naturally occurring contaminants shall be removed so that the aircraft is kept in an airworthy condition prior to take-off.*

Paraphrased, these rules specify that no one may dispatch or take off an aircraft with frozen deposits on components of the aircraft that are critical to safe flight. A critical surface or component is one which could adversely affect the mechanical or aerodynamic function of an aircraft. The intent of these rules is to ensure that no one attempts to dispatch or operate an aircraft with frozen deposits adhering to any aircraft component critical to safe flight. This is known as the **"clean aircraft concept"**.

4.3 Regulatory Requirements

The requirement to ensure that all aircraft are free of all frozen contamination at takeoff is enforced by the aviation authorities, including:

- The U.S. Federal Aviation Administration (FAA).
- Transport Canada (TC).
- The European Aviation Safety Agency (EASA).
- The Civil Aviation Administration of China (CAAC).

Guidance and advisory material are made available by the International Civil Aviation Organization (ICAO), the International Air Transport Association (IATA), and aircraft manufacturers such as Boeing and Airbus.

4.4 The SAE Aircraft Global Deicing Standards

SAE International publishes standards for the aviation industry. For aircraft ground deicing/anti-icing, the group that specifically deals with this area within SAE is the G-12 group. This group is composed of representatives from many different areas concerned with aircraft ground deicing, including:

- Aircraft manufacturers.
- Airlines.
- Airline pilots.
- Ground equipment manufacturers and operators.
- Ground service providers.
- Deicing/anti-icing fluid manufacturers.
- Regulators.
- Researchers.
- Other interested parties.

This group has developed and maintains documentation to provide advice on best practices, equipment, materials specifications, and fluid qualification test requirements for aircraft deicing/anti-icing. ICAO, SAE, and IATA worked together to simplify the many different sets of documents to be used within the industry and produce a series of guidance known as the Global Aircraft Ground Deicing Standards. While the total number of G-12 standards is around 25, the key documents that mainly apply to the practical aspects of aircraft ground deicing of are far fewer. These most important documents are shown in Figure A9.

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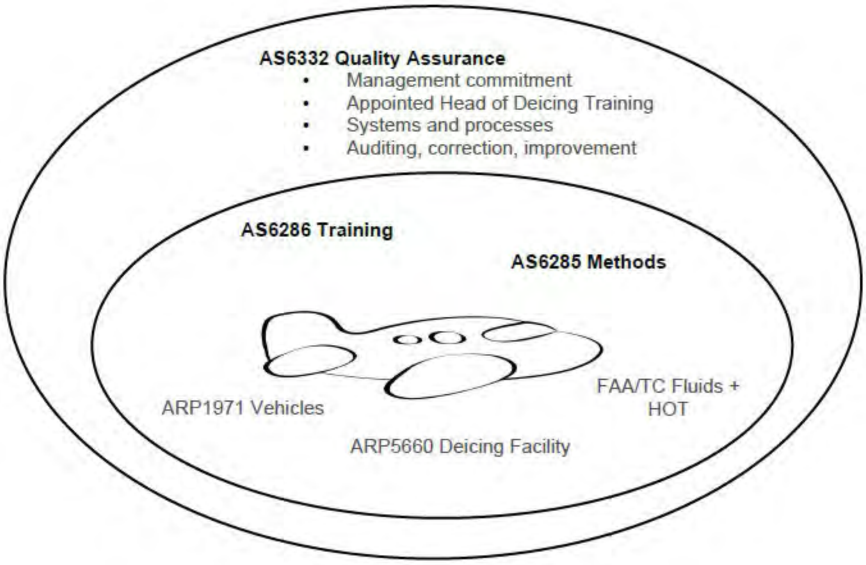

Figure A9. The global aircraft ground deicing standards (shown in bold)

4.5 SAE Global Aircraft Ground Deicing Standards

There are three major new SAE global aircraft ground deicing standards which are the result of a collaborative effort between the SAE, ICAO, IATA, and regulators. The three standards (identified here by their shortened titles) are:

- **WOM 3.1: Methods**. This standard specifies the methods and processes to be used to ensure that aircraft are deiced and anti-iced effectively. This includes ensuring the quality of the deicing and anti-icing fluids to be used, the communications procedures between ground crew and flight crew, the critical external components of the aircraft that must be deiced, the checks necessary to ensure deicing has been carried out effectively, the ground equipment to be used, the detailed methods and best practices for carrying out the deicing/anti-icing treatment, and the requirement for all deicing staff personnel to be suitably qualified for the position.

- **WOM 3.2: Training**. This standard specifies the way in which staff is to be trained and qualified as competent to carry out deicing and anti-icing of aircraft. Appendix A describes more supplementary material to provide a context for the necessity to carry out deicing safely and effectively, and AS6286B (Revision B, dated 2016-11) includes a guide to deicing/anti-icing treatment for almost all aircraft types currently in commercial operation, as well as where spraying with deicing or anti-icing fluid should not be done (“No Spray Diagrams”).

- **WOM 3.4: Quality**. This document specifies the necessary commitment of senior staff to ensuring that deicing and anti-icing are effectively carried out, that all staff are suitably trained, that all procedures are documented and all results are recorded, and that learning from incidents and events is captured, analysed and used to provide continual improvement of all of the deicing/anti-icing processes and methods. As such, this standard applies to how well the deicing and anti-icing of aircraft is carried out and how it can be improved further.

4.6 Other Related SAE Standards and Documents

Although the four SAE global standards above contain most of the information and best practices necessary to carry out deicing/anti-icing of aircraft, there are a few other documents that provide additional guidance.

a) **ARP1971: Vehicles**. This standard concerns the main features and operability of vehicles designed to use deicing and anti-icing fluids to treat aircraft. Although TE12 of this document also describes these, ARP1971 remains an additional source of information and instruction for vehicles.

b) **ARP5660: Deicing Facility.** The purpose of this document is to provide guidelines for the standardisation of safe operating procedures to be used in performing the services and maintenance at Designated Deicing Facilities (central or remote deicing facilities) that are necessary for proper deicing/anti-icing of aircraft on the ground.

c) **FAA/TC Holdover Time Guidelines and List of Fluids:** This documentation provides current lists of fluids that have been tested and accepted as suitable for the effective deicing and anti-icing treatment of aircraft, as well as some of their properties. In addition, holdover time tables are published, which are guidelines on the amount of time any particular fluid can be expected to prevent the adherence of frozen contamination on treated surfaces under various specific conditions of freezing precipitation (snow, freezing rain, etc.) and temperature. FAA and Transport Canada also publish supplemental information that is meant to be used with the holdover times guidelines, namely, the Revised FAA-Approved Deicing Program Updates, Winter 20xx-20yy (latest version) and Transport Canada Guidelines for Aircraft Ground Icing Operations TP 14052 (latest edition).

d) **Other SAE Fluid Standards and the Qualification Process:** While there are numerous SAE standards which refer to the way in which deicing/anti-icing fluids are tested for their performance and materials compatibility, these are not of direct relevance to an airport ground crew. The important outcome of these processes is that when qualified to these standards, the fluids are then listed in the FAA/TC publications and holdover time guidelines are provided for them. The common types of fluids and their performance properties are described in TE10 of this standard.

4.7 The Main Purpose of Aircraft Deicing and Anti-Icing

Frozen contamination on the surface of an aircraft can have far-reaching safety implications, and no national aviation authorities allow the dispatch of aircraft that have not been suitably deiced/anti-iced before takeoff. The purpose of deicing/anti-icing treatment can be summarised as:

“To result in a performance as close to the original aerodynamics of the ice-free aircraft as the deicing/anti-icing techniques will permit.”

In Figure A10, the frozen contamination on the aircraft surfaces must be removed such that the decreased operating envelope caused by the contamination is expanded to be as close to the original certified performance of the aircraft

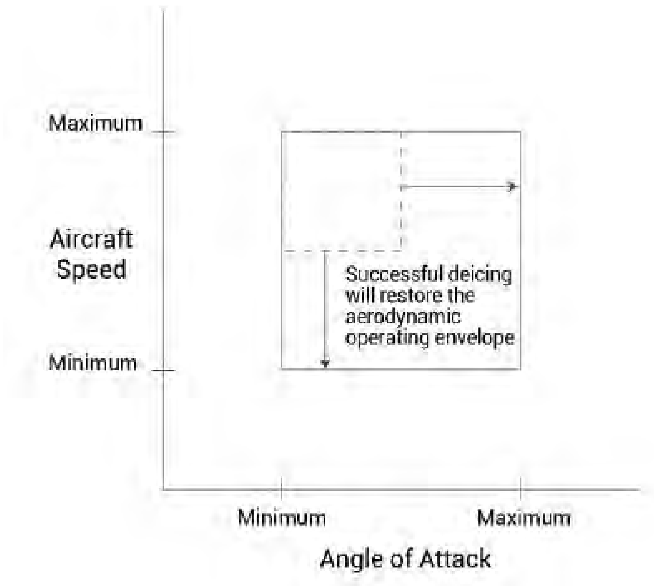

Figure A10.Restoration of aerodynamic performance by deicing and anti-icing of the aircraft

5 TE5: METEOROLOGICAL CONSIDERATIONS FOR ICE FORMATION

5.1 At the end of this section, the trainee should be able to describe in detail:

- General weather conditions and ice formation.
- Typical weather conditions that can lead to frozen contamination on an aircraft.
- Weather conditions or situations that may need special attention.
- Recognition that some weather conditions are included in holdover time guidelines, and some are not.
- Some forms of weather reporting common to airports.
- Potential weather effects on airport operations.

5.2 General Weather Conditions and Aircraft Ground Icing

5.2.1 General Considerations of Aircraft Ground Icing

Aircraft ground icing (the accumulation of frozen contamination on aircraft) may occur during any season of the year, but in temperate climates, icing is more frequent in winter. Polar regions have the most notable ground icing weather in spring and fall. During the winter, the air is normally too cold in the polar regions to contain heavy concentrations of moisture necessary for aircraft ground icing. This does not, however, rule out the possibility of such events in these areas. Arctic regions, as could be expected, are very cold in winter, but due to local terrain and the movement of pressure systems, occasionally some areas are surprisingly warm.

Ice, snow, frost, and slush have a direct impact on the safety of flight. They degrade lift and takeoff performance or maneuverability, and they can also cause engine failures and structural damage. Fuselage-mounted engines are the most susceptible to this “foreign object damage” phenomenon caused by winter operations but wing-mounted engines can also experience this damage. The worst case is when ice on the wing breaks off during takeoff due to the flexing off the wing and goes directly into an engine leading to surge, vibration, and possible complete loss of thrust. Snow, even light snow, that comes off of the surfaces or the fuselage can also cause engine damage leading to surge, vibration, and thrust loss. Leakage of the water and waste panels can cause ice build up, which can also break off, causing damage and hazardous situations. Even if ice does not go into an engine, it can severely damage, for example, the tail surfaces (mainly leading edges), causing performance issues or even vibration problems. It should also be noted that ice could fall onto the ground during takeoff and flight, causing dangerous situations for anyone or anything that might be struck by it.

5.2.2 Frost Formation

Frost can form due to many reasons. Frost forms near the surface primarily in clear, stable air with light winds. Thin metal airfoils are especially vulnerable surfaces on which frost will form. Frost does not change the basic aerodynamic shape of the wing, but the roughness of its surface spoils the smooth flow of air, increasing the drag and thus causing a slowing of the airflow. This slowing of the air causes early flow separation over the affected airfoil, resulting in a lift loss. In coastal areas during spring, fall, and winter, heavy frost and rime ice may form on aircraft parked outside, especially when fog or ice fog is present.

Wing surface temperatures can be considerably below ambient temperature due to contact with cold fuel and/or close proximity to large masses of cold-soaked metal. In these areas, frost can build up on wing surfaces and may result in the entire wing requiring deicing/anti-icing prior to the subsequent departure. A special procedure provides recommendations for the prevention of local frost formation in cold-soaked wing tank areas during transit stops in order to make deicing/anti-icing of the entire wings unnecessary under such circumstances. This procedure does not, however, supersede standard deicing/anti-icing procedures and has to fulfill the proper requirements. This procedure also does not provide relief from any requirements for treatment and checks in accordance with aircraft manufacturer manuals.

Hoarfrost may be allowed on the fuselage if the markings are still readable. A layer of frost due to cold fuel may be allowed on the underwing surfaces. No frost is allowed outside the fuel tank area on the underwing surfaces. The flight crew shall be informed of any existing frost remaining on the aircraft so that they can make the possible recalculations concerning the takeoff. The lower surfaces of the horizontal stabilizer shall be clear of frost and ice. Air operator and aircraft manufacturer limits for allowing a certain amount of frost (and areas where allowed) should be noted.

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5.3 Definitions of Freezing Weather Conditions

This section lists the generally accepted definitions of weather types that may lead to the buildup of frozen contamination on an aircraft. The general terms are standardized, and they are understood in the same way everywhere. Weather information is essential for the deicing crew as official temperature and weather characteristics must be obtained for proper analysis of deicing, anti-icing, fluid mixture requirements, and holdover time procedures.

a) Active frost

Active frost is a condition when frost is forming. Active frost occurs when:

1. The aircraft surface temperature is at or below the frost point.

OR

2. There is water in liquid form (e.g., dew) on the aircraft surface and the surface falls to/or below 0 °C (frozen dew).

b) Dewpoint and frost point

DEWPOINT: Temperature at which unsaturated air must be cooled to cause saturation with respect to liquid water. The moisture condenses to liquid water either on surfaces as dew or as tiny liquid droplets suspended in air.

FROST POINT: Temperature, at or below 0 °C, at which air undersaturated with moisture must be cooled (at constant pressure) to cause saturation with respect to ice. The moisture directly deposits, without going through the liquid phase, as frost on exposed surfaces providing nucleation sites. The frost point is higher (warmer) than the dewpoint by about 10% at a given humidity level in air. Air temperature readings given by a thermometer are applicable to the height above ground of the thermometer itself. Because cool air sinks and the ground often cools very quickly, especially on clear nights, the ground temperature on clear, still nights is invariably lower than the temperature only a few feet higher. Thus, frost can form even when a thermometer gives a reading above freezing. The same happens with aircraft - frost can form on aircraft when the thermometer air temperature reading is above 0 °C.

c) Freezing drizzle

Fairly uniform precipitation composed exclusively of fine droplets (diameter less than 0.5 mm [0.02 inch]) very close together which freezes upon impact with the ground or other exposed objects.

d) Freezing fog

A suspension of numerous tiny water droplets that freeze upon impact with ground or other exposed objects, generally reducing the horizontal visibility at the earth's surface to less than 1 km (5/8 mile).

e) Frost/hoar frost

Ice crystals that form from ice saturated air at temperatures below 0 °C (32 °F) by direct deposition on the ground or other exposed objects.

f) Hail

Precipitation of small balls or pieces of ice with a diameter ranging from 5 to >50 mm (0.2 to >2.0 inches) falling either separately or agglomerated.

g) Ice pellets/small hail

Precipitation of transparent (grains of ice), or translucent (small hail) pellets of ice, which are spherical or irregular, and which have a diameter of 5 mm (0.2 inch) or less. The pellets of ice usually bounce when hitting hard ground.

h) Light freezing rain

Precipitation of liquid water particles which freezes upon impact with the ground or other exposed objects, either in the form of drops of more than 0.5 mm (0.02 inch) or smaller drops which, in contrast to drizzle, are widely separated. Measured intensity of liquid water particles is up to 2.5 mm/h (0.10 in/h) or 25 g/dm2/h, with a maximum of 0.25 mm (0.01 inch) in 6 minutes.

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i) Moderate and heavy freezing rain

Precipitation of liquid water particles which freezes upon impact with the ground or other exposed objects, either in the form of drops of more than 0.5 mm (0.02 inch) or smaller drops which, in contrast to drizzle, are widely separated. Measured intensity of liquid water particles is more than 2.5 mm/h (0.10 in/h) or 25 g/dm2/h.

j) Snow

Precipitation of ice crystals, most of which are branched, star-shaped, or mixed with unbranched crystals. At temperatures higher than -5 °C (23 °F), the crystals are generally agglomerated into snowflakes.

k) Snow grains

Precipitation of very small white and opaque particles of ice that are fairly flat or elongated with a diameter of less than 1 mm (0.04 inch). When snow grains hit hard ground, they do not bounce or shatter.

l) Snow pellets

Precipitation of white, opaque particles of ice. The particles are round or sometimes conical; their diameters range from about 2 to 5 mm (0.08 to 0.2 inch). Snow pellets are brittle and easily crushed; they bounce or break on hard ground.

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5.4 Weather Conditions or Situations That May Also Lead to the Buildup of Frozen Contamination on an Aircraft

5.4.1 Clear Ice

Clear ice refers to the formation of a layer or mass of ice which is relatively transparent because of its homogeneous structure and small number and size of air spaces. During winter months, aircraft surfaces are regularly wet and appear shiny; however, as clear ice has the same appearance, the possibility that icing may be occurring must always be considered. Factors which favor clear icing are large drop size, rapid accretion of super-cooled water, and slow dissipation of latent heat of fusion. Aircraft are most vulnerable to this type of buildup when:

a) Wing temperatures remain below 0 °C (32 °F) during the turnaround/transit

b) Ambient temperatures between -2 and +15 °C (28 and 59 °F) are experienced

c) Precipitation occurs while the aircraft is on the ground, and/or

d) Frost or ice is present on the lower surface of either wing.

NOTE: Clear ice can form at other temperatures if conditions (a), (c), and (d) exist.

5.4.2 Cold-Soak Effect and Clear Ice

The wings of aircraft 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 re-fueled with very cold fuel. Other aircraft structural components are also considered cold-soaked following flight at high altitude, due to the extremely cold temperature of the structural material after landing. Whenever precipitation falls on a cold-soaked aircraft when on the ground, clear icing may occur. Even in ambient temperatures between -2 and +15 °C (28 and 59°F), ice or frost can form in the presence of visible moisture or high humidity if the aircraft structure remains at 0 °C (32 °F) or below. This cold-soak effect may lead to the presence of clear ice. Clear ice is very difficult to detect visually and may break loose during or after takeoff. The following factors contribute to cold-soaking: length of flight time at high altitude, temperature and quantity of fuel in fuel tanks, type and location of fuel tanks, temperature of re-fueled fuel, and time since re-fueling.

5.4.3 Incidental Water Spray

Water blown by propellers or jet engines, or splashed by wheels of an aircraft as it taxis or runs through pools of water or slush, may result in serious aircraft icing. Ice may form in wheel wells, brake mechanisms, flap hinges, antennas, etc., and prevent the proper operation of these parts. Water may freeze in cavities and it is very hard to note without a closer examination. Fan blades of a jet engine can be susceptible to icing if conditions are right. Ice fog and high humidity in general may be major factors contributing to fan blade icing. Aircraft may experience icing while flying through clouds for landing, in which case ice can be found on all leading-edge and frontal areas after landing. The heated aircraft cabin may melt any ice and/or snow from the top of the fuselage, and the melt water may drain downward and freeze on the wings and underneath the fuselage. All of these areas must be checked and proper treatment performed if necessary.

5.5 Weather Conditions Assessed for Holdover Time Tables

Holdover time tables (see **TE11**) are guidelines for the use of aircraft deicing and anti-icing fluids in certain weather conditions. The two required functions of these fluids (**TE8**) are:

- To allow the cleaning of frozen precipitation from the aircraft (deicing).
- To prevent the aircraft surfaces from refreezing (after deicing) or to prevent the accumulation of frozen precipitation on the aircraft surfaces (after anti-icing) for a limited amount of time.

The holdover time tables are guidelines of how long, after the start of application, anti-icing fluids can be expected to provide protection and how long an aircraft might reasonably be expected to remain clean if the weather conditions remain fairly constant. Holdover times are subject to the variability of the weather conditions at the time. Other variables include fluid concentrations and jet blast.

The holdover time tables include established times for the following weather conditions:

- Freezing drizzle.
- Freezing fog.
- Frost.
- Light freezing rain.
- Light snow, snow grains, or snow pellets.
- Moderate snow, snow grains, or snow pellets.

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- Rain on a cold soaked wing.

The holdover time tables do not include times for the following conditions (meaning that takeoff is not permitted, except for certain ice pellet conditions that have allowance times permitting takeoff):

- Hail or small hail.
- Heavy freezing rain.
- Heavy snow.
- Ice pellets.
- Moderate freezing rain.

5.6 Airport Weather Reporting

5.6.1 Interpreting Weather Data

Weather information can be gathered from various sources. Some of this written information can be difficult to understand at times, but it all follows the same logic. For the deicing crew, temperature, dewpoint, precipitation, intensity, and forecast information are elements that affect their operations. Some of these terms are explained below, as well as an example of a local meteorological report.

5.6.2 METAR

A METAR is a Meteorological Report (local) of the current weather situation, also known as METREP, SPECI, AUTO-METAR. These are normally reported every 30 minutes and can include a possible TREND-forecast. An example report:

SA EFHK 090720 26006KT –SN 5000 SCT006 BKN008 M02/M03 Q0998 NOSIG 1529//75 2229//75=

SA	= METAR report
EFHK	= ICAO Airport code, Map area E Finland Helsinki-Vantaa
090720	= Observation day (09) and time (0720), UTC
26006KT	= Wind (260º and 06 Knots)
-SN	= Light snow
5000	= Visibility (m)
SCT006	= Clouds (coverage and height) BKN008= Clouds (coverage and height)
M02/M03	= Temperature (-2ºC) and dewpoint (-3ºC)
Q0998	= Air pressure (QNH 998 hPa)
NOSIG	= TREND forecast (no significant changes)
1529//75	= SADIS-group
2229//75	= SADIS -group
=	= End of report

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5.6.3 TAF

A TAF is a Terminal Area Forecast for the airport, including changes. It is valid for 9 to 18 hours, or as long as the airport is open. It is renewed every 3 to 6 hours. An example forecast report:

FC EFHK 090500 090615 22013KT 6000 -RASN BKN006 TEMPO 0610 2000

-DZ BKN004 BECMG 1012 33010KT 9999 SCT010 BKN030 TEMPO 1014 5000 -SNRA BKN007 =

FC	= TAF
090500	= Time when forecast prepared
090615	= Time valid, Day 09 between 06 to15 UTC
22013KT	= Wind
-RASN	= Light rain and snow (slush)
6000	= Visibility (m)
BKN/SCT	= Cloud coverage and height
TEMPO	= Temporary change (time when)
2000	= Visibility (m)
-DZ	= Light drizzle
BECMG	= Becoming (time when)
33010KT	= Wind
9999	= Visibility (not stated, better than 10 Km)
-SNRA	= Light snow and rain (slush/sleet, snow dominating)
=	= End of report

TREND	Forecast (time based on METAR report)
SIGMET	Significant Meteorological Report
SWC	Significant weather chart
AIREP SPECIAL	Pilot Report

Other usable means of determining weather conditions are the automated weather service (VHF-frequency at the airport), weather charts, weather radar, etc. Even if weather sampling is not an everyday routine for everyone, it is important that someone informs the deicing crew of the official and correct temperatures in order to use correct glycol concentration. It is also important to refer to the right weather column for holdover times. This information should be updated as weather and temperature situations change.

5.7 Potential Weather Effects on Aircraft Operations

Winter operation in harsh winter climates is bound to affect the punctuality of any air operator. Not only is ground operation impaired, but also snow and ice on apron, taxiway, and runway areas affect aircraft operations. However, there is **no shortcut permitted for a safe deicing/anti-icing procedure on the ground.** Flights are in some cases restricted to a certain takeoff time irrespective of season. This “window” of departure causes undue pressure for the completion of ground procedures, but this shall not cause any diversions from normal and safe deicing/anti-icing procedures. Heavy winter weather conditions occurring often make the ground deicing procedure more of a normal task than an exception to consider. Air operators that do not operate on a regular basis in these areas might not be as aware of the importance of an appropriate contamination check and treatment. Milder winter seasons in warmer regions do not rule out the importance of using the same deicing/anti-icing procedures as in other regions.

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SECTION B: THE METHODS FOR CHECKING THE AIRCRAFT FOR CONTAMINATION

6 TE6: HOW TO CHECK THE AIRCRAFT CRITICAL SURFACES

6.1 At the end of this section the trainee should be able to describe in detail:

- How to examine the aircraft critical flight surfaces (wings, vertical stabilizer, horizontal stabilizers), top fuselage, undercarriage, nose radome must be clean, pitot-static orifices, angle of attack devices, windscreens.

7 TE7: POST DEICE/ANTI-ICING CHECK

7.1 At the end of this section the trainee should be able to describe in detail:

- How to examine the aircraft to make sure that no contamination (frozen deposits) remain after deice/anti-ice, no re-freezing has happened if anti-ice fluids have failed, the aircraft is clean and in proper condition for flight.

SECTION C: THE METHODS FOR AIRCRAFT TREATMENT WITH DEICING/ANTI-ICING FLUIDS

8 TE8: GENERAL TECHNIQUES FOR REMOVING FROZEN DEPOSITS FROM AN AIRCRAFT

8.1 At the end of this section the trainee should be able to describe in detail:

- The various ways in which deicing can be performed.
- The only way in which anti-icing can be performed.
- The need to prepare equipment, procedures, and people before deicing/anti-icing an aircraft.
- The areas of an aircraft to inspect for frozen contamination.
- The descriptions of one-step and two-step deicing and anti-icing processes.

8.2 Deicing/Anti-Icing Operations – General Information

8.2.1 Deicing Operations

Deicing operations can be and have been performed in a variety of ways throughout the years. These methods may include the use of paste on leading edges; wing covers to prevent frozen contamination from adhering; ropes, brushes, or brooms to remove large accumulations of snow, and the use of a variety of deicing fluids. More recently, some newer methods have been used, such as the use of forced air or infrared technology to remove contamination. It is worth noting that there is no single correct method for performing deicing for every case. The operation must be suited for each airport, company, and local setting. Whatever method is used for deicing an aircraft, the resulting requirement is that all critical surfaces shall be clean. Brushes and forced air methods are useful when deicing areas where fluid application is limited or forbidden. Using alternate methods for cleaning the surfaces can be used to help shorten the time spent deicing/anti-icing with fluids. This, in turn, will help the departure efficiency relating to deicing operations.

8.2.2 Anti-Icing Operations

Anti-icing the aircraft can only be achieved by applying anti-icing fluids. Mechanical methods are not anti-icing procedures because they do not provide protection from the adherence of incoming active precipitation (e.g., such as when it is still snowing after deicing). Only qualified anti-icing fluids and industry-accepted procedures may be used. While deicing operations can be assisted by the removal of frozen contamination using alternate methods, only anti-icing fluids can protect the aircraft after that, and even then, **only for a limited time. For the remainder of this training document, only the use of anti-icing fluids** shall be considered. This is the method used in the vast majority of aircraft deicing/anti-icing operations.

8.2.3 Tasks Prior to Deicing/Anti-Icing Treatment

Before a deicing operation begins, a check of the equipment and supplies should be made. This check should include all relevant aspects for the proper functioning of the equipment, personal safety gear, and the fluids to be used. After these have been checked, a verification of the latest procedures for deicing/anti-icing should be performed. The appropriate procedures will vary according to the method of the deicing operations needed. The necessary checks and communications can be performed at the gate. However, for remote or centralised deicing operations, appropriate information must be provided to the deicing crew in another way (e.g., coordinator communication). The determination of the need for deicing/anti-icing can be made by qualified persons other than the deicing crew. Once an affirmative determination is made, a verification of the deicing/anti-icing procedures to be used must be performed with the flight crew in order to ensure that there are no misunderstandings. The information to be

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verified with the flight crew includes areas of the aircraft that will be deiced and anti-iced, the fluids and mixtures to be used, the start clearance for deicing, the results of checks, and any aircraft-specific information the crew wishes to note.

8.2.4 Contamination Check to Establish the Need for Deicing

Requests for deicing/anti-icing shall specify the parts of the aircraft requiring treatment. Certain questions must be considered, such as:

- Any aircraft-specific requirements and precautions.
- Whether the deicing operation will be performed at the gate or a remote location.
- Whether the aircraft can have the engines started and be taxied to a remote deicing location with the adhering contamination (e.g., frozen contamination on engine components may prevent this).
- Who makes the request for deicing/anti-icing.
- Verification of proper procedures, with all parties involved (ground crew, flight crew, and deicing crew).
- Whether forced air or brushes will be used before the application of fluids.

The contamination check is performed by the flight crew or ground crew prior to departure to verify the presence of adhering contamination to establish the need for deicing/anti-icing. It may be part of the flight crew walk-around before the flight. A Contamination Check shall visually include all critical parts of the aircraft and shall be performed from points offering sufficient visibility of those parts (e.g., from the deicing vehicle itself or any other suitable piece of equipment, including ladders, or from inside the aircraft – whatever means are necessary to perform a thorough check must be employed). Any frozen contamination found, except frost allowed in certain areas, shall be removed by a deicing treatment; this shall be followed by an anti-icing treatment if required per the weather conditions.

Some areas can be cleaned manually during the check; a deicing procedure might not then be necessary, although this procedure must be confirmed with the flight crew. The captain of the aircraft has the final authority and accountability for the aircraft, but the more conservative, safer option shall always be considered, whether it is the opinion of the flight crew or the ground crew (specific company and aircraft limits to be noted).

During winter operations, aircraft critical surfaces and certain instrumentation must always be inspected, and this can be accomplished prior to communications with the flight crew. These include:

- Wings (upper and lower surfaces, including control-surface gaps and deployed leading-edge/trailing-edge high-lift devices (e.g., slats and flaps)).
- Horizontal tail (upper and lower surface, including control-surface gaps).
- Vertical tail and rudder (including gaps).
- Fuselage.
- Any other aerodynamic surfaces.
- Engine inlets and fan blades or propellers (front and back sides of blades), as applicable.
- Pitot probes and static ports.
- Antennas and sensors.
- Landing gear and landing gear doors.

For more detailed information on these checks, refer to WOM 3.1.

After checking these areas, a decision can be made with the flight crew regarding the deicing/anti-icing procedures. The weather elements and taxi distances will affect the choice for the Type and mixture of fluid to use. For certain aircraft types, additional requirements exist; for example, special checks for **clear ice**, such as tactile checks of the wings. These special checks are not always included in the contamination check. Air operators shall make arrangements for suitably qualified personnel to perform such checks. When an aircraft has been deiced and anti-iced sometime prior to the arrival of the flight crew, an additional contamination check may be necessary prior to departure to establish whether further treatment is required.

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8.3 One-Step and Two-Step Deicing/Anti-Icing

8.3.1 General Information

If an aircraft is contaminated with frozen precipitation of any kind (ice, snow, frost, or slush), then it must be deiced before dispatch. Even though safety is the overriding consideration, there are two recognised ways in which this can be carried out for greatest efficiency.

- When aircraft surfaces are simply contaminated by frozen precipitation, and if there is no active frost condition and no active freezing precipitation taking place, then the aircraft shall be deiced prior to dispatch.
- When aircraft surfaces are contaminated by frozen precipitation and there is active frost or freezing precipitation occurring, there is a risk of contamination of the surfaces after deicing and before the time of dispatch; in this case, aircraft surfaces shall also be anti-iced. If both deicing and anti-icing are required, the procedures may be performed in one or two steps. The selection of a one- or two-step process depends upon weather conditions, available equipment, available fluids, and the holdover time necessary before take-off.

8.3.2 One-Step Deicing/Anti-Icing

Some contamination, such as frost, can be removed and the surface can be protected from recontamination at the same time using the same fluid and same mixture. This is called a one-step process. One-step deicing/anti-icing is performed with either a heated unthickened fluid (SAE Type I) or a diluted and heated thickened fluid (SAE Types II, III, and IV). When thickened fluids are used, caution must be taken for the dry-out characteristics and gel-residue problems of this particular treatment, as thickened fluids contain polymers that may remain on the aircraft after the flight. The types of fluid used for deicing/anti-icing are described in detail in **TE10**. The fluid to choose for a one-step process is the mixture that provides the needed protection. The fluid concentration shall be chosen to achieve the desired holdover time, which is dictated by the outside air temperature (OAT) and weather conditions. Wing skin temperatures may differ from and, in some cases, be lower than the OAT. A stronger mix (more glycol in the glycol-water mixture) can be used under these conditions. The stronger mix will not improve the holdover time, but it will lower the freezing point of the mixture.

8.3.3 Two-Step Deicing/Anti-Icing

Two-step deicing/anti-icing is performed when freezing precipitation is taking place (active frost, freezing drizzle/ rain, or snow). Deicing is first carried out to remove the frozen contamination on the aircraft surfaces. After deicing, a second, separate over-spray of anti-icing fluid shall be applied to protect the relevant surfaces while the freezing precipitation continues to take place. A two-step process is common during active freezing precipitation. The correct anti-icing fluid concentration shall be chosen to achieve the desired holdover time, which is dictated by the OAT and weather conditions. The second step shall be performed before the first step fluid freezes; if necessary, the second-step fluid shall be applied area by area. The second-step fluid shall be applied in such a way that it results in complete coverage, with a sufficient and even layer of anti-icing fluid on the treated surfaces. It is the responsibility of the Deicing Operator to ensure that all frozen contamination has been removed from the treated surfaces before applying the second-step fluid.

NOTE 1: Anti-icing treatment protects the aircraft from recontamination for a limited amount of time (the holdover time). The selection of the correct anti-icing fluid therefore strongly depends upon the likely time between deicing/anti-icing the aircraft and take-off. If the holdover time of the anti-icing fluid is exceeded, the aircraft will need to be deiced and anti-iced again.

NOTE 2: **Under no circumstances** should an anti-icing treatment be applied to an aircraft that has already been anti-iced. It must first be deiced again to remove the original anti-icing fluid before a further anti-icing treatment is applied.

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9 TE9: DEICING/ANTI-ICING BY FLUIDS – PROCEDURES IN GENERAL

9.1 At the end of this section, the trainee should be able to describe in detail:

- The critical aspects of the deicing process.
- The general deicing process.
- The special care required for deicing composite aircraft wings.
- The general process for using anti-icing fluids effectively.
- When Type I fluids may be used for anti-icing an aircraft.
- What Type II, III, and IV fluids are designed to do.
- The limitation of anti-icing fluids in terms of the time between aircraft treatment and take-off (holdover time).

9.2 The Critical Aspects of the Deicing Process

Ice, snow, slush, or frost may be removed from aircraft surfaces by heated fluids, mechanical methods, alternate technologies, or combinations thereof. Heavier accumulations require the heat of the fluid to break the bond between the frozen contamination and the structure, and the hydraulic force of the fluid spray is then used to flush it off of the surface. For normal deicing of an aircraft, fluid should be sprayed heated. Fluid temperature and pressure should not exceed aircraft maintenance manual requirements. For maximum effect, fluids shall be applied close to the surface of the skin to minimize heat loss. The heat of the fluid effectively melts any frost, as well as light accumulations of snow, slush/sleet, and ice. Choosing a **correct spray method** may vary as much as the winter weather does. The procedure must be adapted according to the situation and local settings.

9.3 The General Deicing Process

During deicing (and anti-icing), movable aircraft surfaces shall be in the position specified by the aircraft manufacturer. When removing frost, a nozzle setting giving a solid cone (fan) spray should be used. This ensures the **largest droplet pattern** available, thus retaining the **maximum heat** in the fluid. When the hot fluid is applied close to the aircraft skin, a minimal amount of fluid will be required to melt frozen contamination. When removing snow, a nozzle setting sufficient to flush off deposits and minimise foam production is recommended (note that foam can be confused as snow). The procedure adopted will depend on the equipment available and the depth and type of snow (e.g., light and dry or wet and heavy). In general, the heavier the accumulation, the heavier the fluid flow that will be required to remove snow effectively and efficiently from the aircraft surfaces.

For light deposits of both wet and dry snow, similar procedures as for frost removal may be used. Under certain conditions, it will be possible to use the heat of the fluid, combined with the hydraulic force of the fluid spray, to melt and subsequently flush off snow. Wet snow is more difficult to remove than dry snow, and unless the accumulation is relatively light, selection of a high fluid flow will be more effective. A heavy accumulation of snow will always be difficult to remove from aircraft surfaces and large quantities of fluid may be consumed in the attempt. Under these conditions, serious consideration should be given to manually removing the bulk of the snow before performing the fluid deicing procedure.

Heating the fluid is very important when removing ice, as is the pressure of the spray to break the ice bond. The method makes use of the high thermal conductivity of metal aircraft skin. A stream of hot fluid is directed at close range onto one spot at an angle of less than 90 degrees until the aircraft skin is exposed. The aircraft skin will then transmit the heat laterally through the metal in all directions, raising the temperature above the freezing point and thereby breaking the adhesion of the ice to the aircraft surface. By repeating this procedure a number of times, the adhesion of a large area of ice (or snow) can be broken. The contamination can then be flushed off with either a low or high flow, depending on the amount of accumulation. **Nonmetallic surfaces (composites)** have a lower heat transfer capability than metallic surfaces. Deicing may take longer, and more fluid may be needed as heat is not as effectively transmitted through the wing surface.

9.3.1 Cold Dry Snow or Ice Crystals

Cold dry snow or ice crystals, in very cold conditions (generally below -10 °C [14 °F]), may not adhere to a cold dry aircraft nor its critical surfaces. Under these conditions, it may swirl as it blows across the surfaces, making it evident it is not adhering. Therefore, the critical surfaces remain free of adhering contaminants. However, if frozen contamination has accumulated on critical surfaces, it must be adequately removed. It cannot be assumed that these accumulations will blow off during takeoff. During cold dry conditions, the air operators will need to take into consideration the following elements:

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1) Refueling with fuel warmer than the wing skin temperature may create a condition whereby previously non-adhering precipitation may adhere to the wing surfaces.

2) The use of heated deicing fluids may increase the risk of cold dry snow or ice crystals to adhere to critical surfaces post application. Under such operational conditions, an anti-icing treatment might need to be considered.

CAUTION

A close monitoring of deicing/anti-icing fluid's LOUT is required to ensure a safe operation.

3) Monitor the location of heat-releasing equipment such as ground power units or bridges that may create conditions for non-adhering precipitation to start adhering to aircraft surfaces.

4) The location where the aircraft is parked might increase the risk for non-adhering precipitation to start adhering (e.g., one wing in the sun, a building obstructing the wind, etc.).

5) Operations in close proximity to other aircraft may cause snow, ice particles, or moisture to be blown onto critical aircraft components; or can cause dry snow/ice crystals to melt and refreeze on aircraft critical surfaces. If it cannot be adequately demonstrated that cold dry snow or ice crystals are not adhering or accumulating, then it must be removed before takeoff.

CAUTION

Aircraft with rear mounted engines are more susceptible to ingest frozen accumulation that might cause damage or engine failure.

When the presence of frost or ice is limited to localised areas on the surfaces of the aircraft and no holdover time is likely to be required, only the contaminated areas will require treatment. Deicing to remove local area contamination can only be performed when no precipitation is falling or expected. This contamination will generally be found on the wing and/or stabilizer leading edges or in patches on the wing and/or stabilizer surfaces. A heated fluid and water mixture suitable for a one-step procedure shall be used, and the treatment shall be symmetrical (e.g., both wings must receive the same treatment). The treatment and removal of contamination must be checked by a trained and qualified person, and the Pilot in Command must be informed of the procedure using words such as, "wing local area deicing only, holdover times do not apply." It is the responsibility of the Deicing Operator to ensure that the treatment is performed symmetrically and that all frozen contamination has been removed.

9.4 The General Anti-Icing Fluid Application Strategy

Anti-icing fluid shall be applied to the aircraft surfaces (assuming that they have already been deiced and are clean of any ice, snow, frost, or slush) if it is anticipated that there will be active precipitation that will accumulate on the aircraft before takeoff. For effective anti-icing, **an even layer of sufficient thickness of fluid** is required over the prescribed aircraft surfaces. Two anti-icing procedures are recognised; the choice of which to use will depend on the severity of the weather conditions. The types of fluid referred to in this section are described in detail in **TE10**. All fluid types are and can be used as both deicing and anti-icing fluids. It is very common within the industry to refer to Type I fluids as deicing fluids and Types II, III, and IV as anti-icing fluids, based upon one way that they commonly used; it is, however, not technically correct.

9.4.1 Use of a Type I Fluid for Anti-Icing

Type I fluids are generally designed to be used for the cost-effective deicing of aircraft. They are diluted with water to have a freezing point at least 10 °C (18 °F) lower than the outside air temperature, and they are then heated to at least 60 °C (140 °F). For Type I fluid, an additional minimum of 1 L/m2 (0.264 gal/m²) with a temperature of at least 60 °C (140 °F) at the nozzle shall be applied. If there is active precipitation, a Type I fluid will provide a limited holdover time, specified in the holdover time guidelines published by the FAA or Transport Canada. In conditions of active precipitation, the use of Type I fluids for anti-icing is most common when there is very little time between fluid application and takeoff (“spray and go” operations).

9.4.2 Use of a Type II, Type III, or Type IV Fluid for Anti-Icing

Type II, III, and IV fluids are specifically designed and manufactured to provide extended anti-icing protection time (holdover time). Under conditions of active freezing precipitation, these fluids must be used to ensure that a deiced aircraft will not become re-contaminated prior to take-off. These fluids can be diluted with water to either a 75% or 50% concentration, but they must have a freezing point at least 7 °C (13 °F) lower than the OAT. For longer anti-icing protection, unheated Type II, III, or IV fluid should be used. The high fluid pressures and flow rates normally associated with deicing are not required for anti-icing and, where possible, pump speeds should be reduced accordingly. The nozzle of the spray gun should be adjusted to provide a medium spray.

The fluid application process should be continuous and as short as possible. Anti-icing should be carried out as near to the departure time as operationally possible in order to utilise the maximum holdover time available from the fluid. During anti-icing (and deicing), movable aircraft surfaces shall be in the position specified by the aircraft manufacturer. For Type II, III, and IV fluids, the correct amount to use is indicated by fluid just beginning to run off of the leading and trailing edges of horizontal surfaces. The anti-icing fluid shall be distributed uniformly over all surfaces to which it is applied. In order to control the uniformity, all horizontal aircraft surfaces shall be visually checked during application of the fluid. Anti-icing fluids may not flow evenly over wing leading edges, horizontal and vertical stabilizers. These surfaces should be checked to ensure that they are properly coated with fluid.

When applying the anti-icing fluid as a second step in a two-step process, use a spraying technique which completely covers the first step fluid and provides a sufficient amount of second-step fluid. Where either recontamination of the aircraft or exceedance of the holdover time occurs following the initial treatment, both the first and second steps shall be repeated. The holdover time provided by the anti-icing fluid should be equal to or greater than the estimated time from the **start of anti-icing to the start of takeoff.** Aircraft shall be treated symmetrically; that is, the left-hand and the right-hand side shall receive the same and complete anti-icing treatment. Aerodynamic problems could result if this requirement is not met. Local area anti-icing is not permitted.

Anti-icing fluid may be applied to aircraft surfaces at the time of arrival (preferably before unloading begins) on **short turnarounds during freezing precipitation, and on overnight-parked aircraft.** This will minimise the accumulation of contamination prior to departure and often makes subsequent deicing easier. This procedure has a potential risk of building fluid residues and is not recommended to be performed continuously. Upon receipt of a frost, snow, freezing drizzle, freezing rain, or freezing fog warning from the local meteorological service, anti-icing fluid may be applied to clean aircraft surfaces prior to the start of freezing precipitation. This will minimise the possibility of the precipitation bonding to the surfaces or reduce the accumulation of frozen precipitation on the surfaces and facilitate subsequent deicing. The time factor must also be taken into account when considering these procedures (e.g., it may be worthwhile for turnarounds and short stops, but overnight stops should be considered carefully).

NOTE: This short turnaround or overnight anti-icing treatment shall not be considered a full deicing/anti-icing treatment sufficient for aircraft departure. It is only used to help make the subsequent deicing/anti-icing treatment of the aircraft easier. Full deicing and anti-icing must take place as usual, together with appropriate use of holdover times.

10 TE10: BASIC CHARACTERISTICS OF AIRCRAFT DEICING/ANTI-ICING FLUIDS

10.1 At the end of this section, the trainee should be able to describe in detail:

- Why deicing/anti-icing fluids are the most common way of removing and preventing frozen contamination on an aircraft.
- The three safety requirements of deicing/anti-icing fluids.
- The difference between Type I fluids and Type II, III, and IV fluids.
- The colors of the different deicing/anti-icing fluid types.
- The unusual characteristics of anti-icing fluids, and what precautions should be taken when using them.
- The two basic ways that deicing/anti-icing fluid performance is characterised.

10.2 The Use of Aircraft Deicing/Anti-Icing Fluids

Any ice, snow, slush, or frost on aircraft wings must be removed before flight, and this is mainly achieved using deicing/anti-icing fluids. Other techniques (brooms, ropes, infra-red, etc.) can be used, but the use of aircraft deicing fluids (ADF) is the most common method. This is due to their use being:

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- Widely applicable to any aircraft type.
- Easy to deploy.
- Good industry standard methods are available for deicing operations.

While the fluid is used to remove frozen contamination, the fluid itself must not compromise the safe aerodynamics of the aircraft for takeoff. This leads to the **three safety aspects of ADF:**

- ADF must be able to remove frozen contamination from an aircraft **(deice).**
- ADF must be able to keep an aircraft free of frozen contamination until the aircraft takes off **(anti-ice).**
- ADF **must not compromise the aerodynamics** of an aircraft during takeoff. This means that the fluid must be proven to have an acceptably low impact on the aerodynamics of the wing, in strict conformance with industry standards. Most of the fluid should shear off of the wing during the takeoff roll and rotation.

10.3 Deicing/Anti-Icing Fluid Information and Fluid Types

- Type I fluids are “unthickened” and orange in color.
- Types II and IV fluids are “thickened” using polymers. This results in these fluids staying on the surfaces until takeoff. They absorb incoming precipitation within the holdover time for the weather condition, keeping the aircraft free from frozen contamination. Type II fluids are yellow, and Type IV fluids are green. Fluids containing polymers may result in dried-fluid gel residues if the aircraft is not regularly cleaned, or if a two-step process (with the first step being deicing with a Type I fluid) is not carried out thoroughly. This is most susceptible to occurring when these fluids are used in a one-step process.
- Types I, II, and IV are the most common fluids. There is also a Type III fluid which contains less thickener than Types II and IV and thus provides less holdover time. They are bright yellow in color and are rarely used.

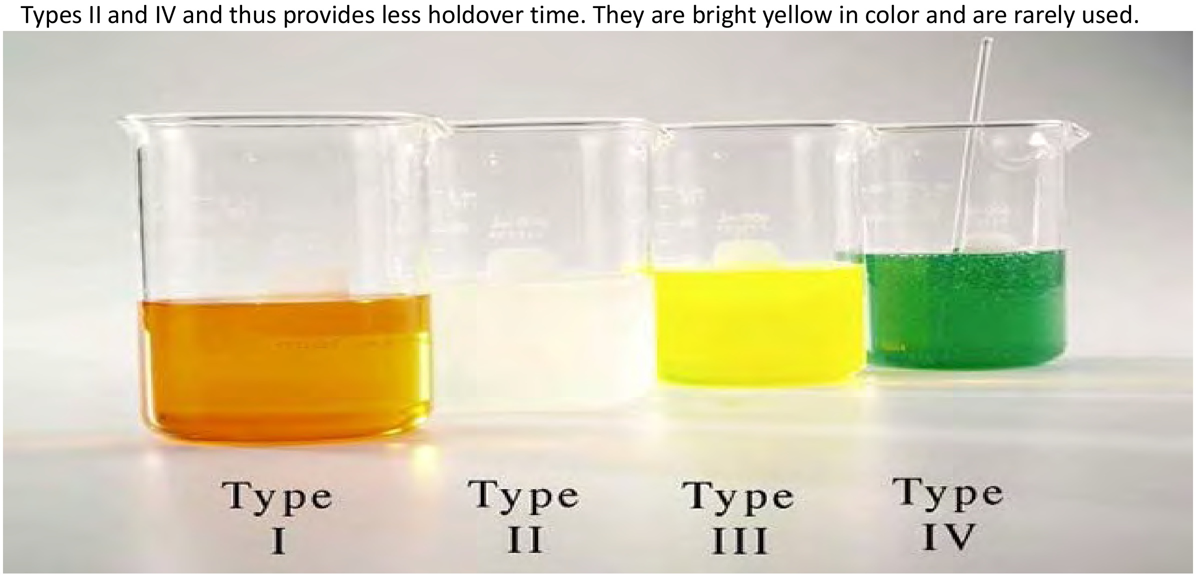

Figure A3. The colors of the four most common types (I, II, and IV left to right, respectively) of aircraft deicing/anti-icing fluids

For thickened fluids, the holdover time (HOT) is an estimate of the maximum time that the fluid will protect the aircraft before takeoff. If the HOT is exceeded before takeoff, the aircraft must undergo the whole procedure of deicing and anti-icing again. Current standards state that if anti-icing has been carried out and the HOT is exceeded, the aircraft cannot be treated with a second layer of anti-icing fluid and be deemed safe. It must first be decided before another treatment with an anti-icing fluid. While HOT guidelines/tables provide information over a wide range of conditions (see **TE11**), the categorization of ADF is done using “water spray endurance time” (WSET) values obtained under carefully controlled laboratory conditions, as shown in Table A1. The WSET process is described in more detail in WOM 10.7.

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Table 1A: Aircraft Deicing Fluid (ADF) Categorisation

SAE Fluid Type Designation	Primary Performance Criteria	Laboratory Endurance Times, Minutes	
		WSET Endurance	HHET Endurance
Type I (orange)	Efficient de-icing	More than 3	More than 20
Type II (yellow)	Anti-icing	More than 30	More than 240
Type III (bright yellow)	Anti-icing	More than 20	More than 120
Type IV (green)	Anti-icing	More than 80	More than 480

Note: Water Spray Endurance Time (WSET) and High Humidity Endurance Time (HHET) test results are determined in a laboratory under closely controlled conditions using test methods as described in AMS1424 and AMS1428 and standards mentioned therein.

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10.4 The Typical Process for Deicing and Anti-Icing of Aircraft

A generally applicable method for ensuring the safe takeoff of aircraft during very snowy or icy conditions is to perform a two-step procedure:

- Step 1: Deicing – This removes the frozen contamination from the aircraft. Deicing is commonly carried out with a Type I fluid, diluted to a freezing point of OAT (or below), and applied hot at the nozzle of the spray head. The second step shall be performed before the first step fluid freezes, if necessary, area by area.
- Step 2: Anti-Icing – Anti-icing fluid is then applied to a contamination-free aircraft to “keep it clean” during the HOT of the fluid.

A simple flow diagram of a two-step process is shown in Figure A12.

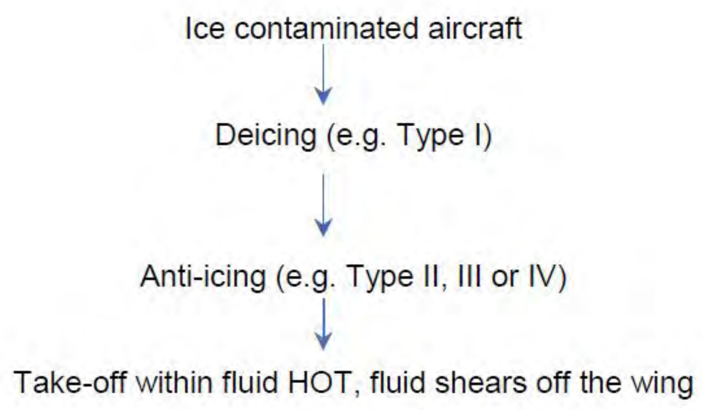

Figure A4. Example of fluid application

10.5 Understanding the Technology of Deicing and Anti-Icing Fluids

10.5.1 The Simple Concepts

Deicing and anti-icing fluids are similar in that the major component of these products is a chemical that lowers the melting point of ice or snow. The usual chemicals used for these products are propylene glycol and ethylene glycol. Both have excellent freeze-point depressant properties and good environmental profiles. However, ethylene glycol is toxic to mammals and must be used with caution. To melt and remove frozen contamination already settled on the aircraft it is also necessary to heat these fluids if used for deicing. Anti-icing fluids are normally applied neat (or diluted as per temperature requirements) and unheated once the aircraft is clean of contamination.

The two fluid categories, unthickened (Type I) and thickened (Types II, III, and IV) can be contrasted as follows:

- Type I: These are **unthickened glycol-based fluids**, diluted with water before use, which allows an efficient balance of the need to melt ice and snow with enough glycol, and the cost effectiveness of the operation. Type I fluids are usually supplied as concentrates containing 80 to 92% glycol with around 8 to 20% water and other additives. Diluted Type I mixtures are normally sprayed, heated, on the aircraft by deicing trucks. While this is an efficient way to remove frozen contamination from the aircraft, these heated Type I dilutions do not give much anti-icing protection in **active icing conditions**.
- Type II, III, and IV: These fluids are also glycol-based and are usually supplied as products with 50% glycol, and 50% water plus other additives. The key additional ingredient in these formulations is **a polymer thickener**. This material not only makes the product more viscous in nature but also maintains a fluid layer on the aircraft. This thick layer of fluid is then capable of absorbing more freezing precipitation for a length of time before (by being diluted) it eventually reaches a point where it may also freeze. **The time between the fluid being applied and its eventual failure to prevent icing is known as the holdover time (HOT).**

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10.6 The Properties of Anti-Icing Thickened Fluids – Newtonian Versus Non-Newtonian Flow

Newtonian fluids are liquids that behave in fairly predictable ways. Water and oil show patterns of flow and response to pumping that are easy to understand. The more force used to push them, the more resistance is encountered. The same is true of certain paints. Once applied to a vertical surface, they continue to flow and can form a pattern of drips below the brushstroke.

In contrast, there are also non-drip paints. When this material is pushed with a brush, it changes from being very stiff in its structure, to being able to flow and cover surfaces. However, once the paint is no longer being worked with the brush, it becomes stiffer in structure and does not drip as readily. This ability to flow under a shear force but to regain structure after the shear is removed is an example of a fluid that is non-Newtonian. It is also called shear-thinning or pseudo-plastic – it becomes **thinner** (less viscous) **under shear stress**. The application of these principles to aircraft deicing and anti-icing fluids now becomes clear.

- Type I fluids: As unthickened fluids, they are Newtonian, and can be pumped and sheared with no deleterious effect on their performance.
- Type II, III, and IV fluids: The ability of thickened fluids to be sprayed and to regain their structure when on the aircraft is obviously an advantageous property, regaining viscosity ensures a good thickness of the fluid layer, giving it the ability to protect the aircraft during the holdover time (HOT). However, **precautions must be used** in the handling of these fluids. If too much shear is applied to thickened fluids during offloading of tankers, transferring between tanks, truck filling and finally aircraft spraying, then the polymers may be degraded and HOT substantially lost. In addition, heating them for a long time or contaminating them with other chemicals or rust may also lead to degraded performance. Always follow the fluid manufacturer's recommendations.

10.7 Characterising Deicing and Anti-Icing Fluids

It is clear from the foregoing discussion that the deicing and anti-icing fluids are a critical part of the ability to ensure a "clean aircraft" on take-off. It is therefore unsurprising that much effort has gone into methods to characterise the performance aspects of these fluids.

Fluid users should make sure that the fluids meet all the requirements of AMS1424 and AMS1428 (see 4.5 c).

While most tests in the two standards AMS1424 and AMS1428 are similar in nature (corrosion, stability, compatibility effects), the thickened fluids undergo more testing due to the complex nature of non-Newtonian fluids. As each fluid manufacturer can use different chemistry and formulation methods to achieve the desired properties, the testing is primarily performance related rather than chemistry related. The two key performance tests that are applied to the thickened fluids are:

a) Fluid characterisation by the Water Spray Endurance Time (WSET) Test

A Type II fluid must have a minimum endurance of 30 minutes in a WSET measurement by definition. Type IV fluids must have a minimum of 80 minutes in a WSET test (see Table A1). The WSET process consists of covering with fluid an aluminum plate at an angle of 10 degrees, spraying a controlled amount of water onto the surface of the fluid at -5 °C, and measuring the time taken for the advancing front of frost on the plate to move past a line drawn 2.4 cm down the plate. As this procedure is well controlled, the repeatability and reproducibility of this method are very good, allowing accurate characterization of the endurance time of fluid and hence its classification.

b) Aerodynamic acceptance by fluid elimination

The balance of properties that is needed for thickened Type II, III, and IV fluids is that they must endure (give a defined WSET) and that **a specified amount must also be eliminated from the wing of the treated aircraft at the point of rotation (VR, see Figure A13)**. The maximum amount of residual fluid that can remain on the aircraft is established. As the fluid flows off, there is a direct correlation between what is known in aerodynamics as the Boundary Layer Displacement Thickness (BLDT) and the lift loss caused by the presence of the fluid. Each fluid is tested to ensure that its use will not result in a greater lift loss (in terms of measured BLDT) than the accepted standard. This is known as the **Aerodynamic Acceptance Test, AS5900**, also often called the flat-plate fluid elimination test.

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These two key performance measures ensure that both lifetime of the fluid before freezing and the ability not to interfere with aircraft aerodynamics are well defined for all qualified fluids.

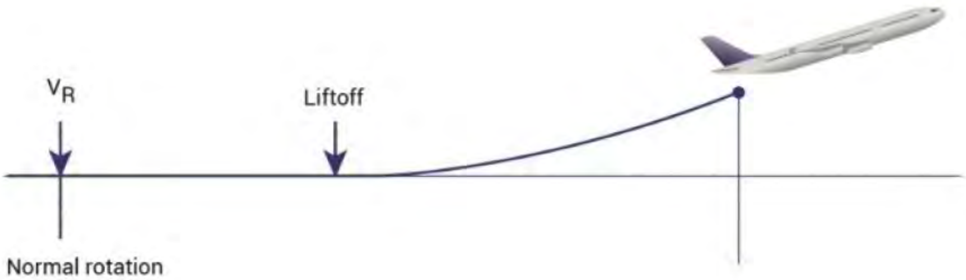

Figure A5. Aircraft takeoff profile.

11 TE11: TYPES OF FLUID CHECKS REQUIRED AND THE EQUIPMENT FOR DOING THIS

11.1 At the end of this section, the trainee should be able to describe in detail:

- The general handling and storage requirements of deicing/anti-icing fluids.
- The quality control checks to be performed on deicing/anti-icing fluids.
- Pumping and heating plus storage tank requirements.

11.1.1 General Fluid Handling and Storage Notes

Fluid handling is an important part of the deicing operational process. The fluid must be received, stored, pumped, heated, and used with the same level of quality and care throughout all processes. Fluids are designed to do the right job at the right time. They need to deice and anti-ice effectively, and then to shear off the aircraft at the point of rotation. This requires a balance of properties that such fluids are designed to provide if they are handled and treated in accordance with manufacturer's instructions. Failure to handle these complex fluids with care may result in damage to the fluids and a drop in expected performance.

As these formulations of deicing/anti-icing fluid are unique to each manufacturer, it is recommended that they are not mixed in storage or vehicle tanks, as the fluid chemistries may not be compatible. For fluid acceptance at delivery, it is necessary to check that the fluid delivered corresponds to the fluid ordered. Make sure that the brand name and concentration of the product specified in the delivery documents corresponds to the delivered fluid. Each container or road tanker shall be checked. Make sure that the brand name and the concentration of the delivered fluid corresponds to the brand name and the concentration of the storage or vehicle tanks. Before filling a storage tank or vehicle tank, take a sample from the delivered container or road tanker (each separate compartment, if applicable) and perform the usual quality control checks for each fluid.

Verify each delivery (container/tank truck) has an associated fluid certificate of analysis (C of A). The C of A, at a minimum, shall include test results conforming to the three (four for thickened fluids) items listed directly below. Additionally, the fluid manufacturer shall give assurances on the condition of each container and/or bulk loaded delivery tanker trailer (container/trailer status). This should be through cleaning certification documentation or previous load documentation.

11.2 Quality Control Tests to Be Performed

11.3 Pumping and Heating, Storage Tanks

Deicing/anti-icing fluids can degrade when exposed to excessive mechanical shearing. Therefore, only compatible pumps and spraying nozzles shall be used. The design of the pumping systems shall be in accordance with the fluid manufacturer's recommendations. Dedicated transfer lines shall be conspicuously labeled to prevent contamination and shall be compatible with the deicing/anti-icing fluids to be transferred.

Deicing/anti-icing fluids shall be heated according to the fluid manufacturer's guidelines. For Type I fluids, water loss may cause undesirable aerodynamic effects. For Type II, III, and IV fluids, thermal exposure and/or water loss may cause a reduction or increase in fluid viscosity, leading to lower holdover times or poorer aerodynamics.

Type II, III and IV are only required to be heated when used for deicing or for "spot" or local anti-icing on cold-soaked areas of the aircraft. When used for anti-icing they are normally applied unheated, either on deiced surfaces or to prevent the formation of ice.

The fluids shall be checked periodically. Caution must be taken to avoid unnecessary heating of fluid in vehicle tanks. Prolonged or repeated heating of fluids (directly or indirectly) may result in loss of water, which can lead to a performance degradation of the fluid.

Any of the following situations, or a combination of them, can accelerate the fluid performance degradation:

- Low fluid consumption.
- Trucks being in standby mode with heating systems on for extended periods of time.
- High temperatures in fluid tanks.
- High temperatures in water tanks, which are in direct contact with the fluid tank (no insulation between tanks).

The storage of fluids can be done in a variety of ways, large stainless steel (acid-proof or plain steel) containers, 1 m3 containers, barrels, drums etc. The storage procedure should be chosen according to the scope and amount needed for the operation. Heating of the fluid in the storage tanks depends on the equipment in use. If the equipment directly heats the fluid before spraying, then heating the fluid in the tanks may be unnecessary. The heating must fulfill any other requirements set for the fluid. Annual visual examination of all tanks must be performed. Stainless steel (or acid-proof) tanks must be visually examined annually, but more in-depth checks and tests, such as Non-Destructive Testing (NDT), may not be necessary on an annual basis. The testing periods should be conducted according to the container manufacturer recommendations or standards set for the deicing operation (reference SAE). Records must be kept for all examination/inspection/checks/tests of tanks and stations.

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12 TE12: DEICING/ANTI-ICING EQUIPMENT OPERATING PROCEDURES

12.1 At the end of this section, the trainee should be able to describe in detail:

- That deicing vehicles come in many different variations and must be understood in great detail
- The types of safety and emergency precautions that must be taken with deicing vehicles.
- The operation of filling stations.
- The need to be clear in communications with the flight crew.
- Equipment use and spray alternatives.
- The possible need to collect data on spraying operations.
- The basic vehicle components.
- Typical safety equipment and “before-use checks”.

12.1.1 Variations of Deicing/Anti-Icing Vehicles

The primary function of the vehicle is to apply deicing/anti-icing fluid from variable heights to the surfaces of aircraft while driving around the perimeter of the aircraft. There are many different vehicles on the market. These vehicles range from small to large, from open basket to closed cabin, from fixed spray nozzles to extended-boom nozzles, from movable units to fixed units, either one- or two-person operated, etc. The vehicles have been developed for specific tasks in specific regions. Some airports only serve smaller aircraft and do not need the large-capacity vehicles, and vice versa. The vehicles have variations in fluid use as well. Some have electrical heating, and some have combustion burners that heat the fluid just before spraying. Some vehicles have a three-tank version, with Type I, Type II/III/IV, and water stored separately, whereas others have only one or two tanks with pre-mixed fluid. The vehicles’ design concept has been to fulfill the requirements of one particular operator and operation. One aspect that is the same for all vehicles is that l**ifting devices require specific training before use**. Certain manufacturers provide special equipment for underwing spraying. Even if this is not a man-lift device, the vehicle cannot be operated without proper training.

12.2 Equipment Safety Precautions

Deicing vehicle operation involves many aspects where safety precautions must be noted. Some of these aspects are the use of hot fluids, the high pressure of the spray, large and heavy vehicles moving around aircraft, when filling the vehicle, when using the boom and maneuvering, communication between the sprayer and the driver (where applicable), the sometimes poor visibility while spraying, and the use of safety harnesses, among other things. The use of the vehicle should be performed in a manner that the next user of the vehicle can continue without any doubts about the safe performance of the vehicle. Any discrepancies shall be noted and communicated, and measures shall be taken to indicate to other users that the vehicle may not be usable or that its use is limited.

The vehicle should be checked for proper operation before use. The basic operation shall be verified, and discrepancies noted. The different systems used on the vehicle should be checked for proper performance, e.g., fluid quantity indication, burner for fluid heating, and other similar elements that have to do with the proper operation of the vehicle. Additional equipment shall be checked and located (e.g., safety harnesses, hearing protectors, fire extinguisher). The vehicle should be checked for all fluids needed when in use (e.g., windshield washing fluid, fuel, etc.). Note that the vehicle is usually used in areas where space is limited, where visibility can be limited, and where the surface is slippery due to ice or the mix of fluid and water on the ground. It is recommended to test the brakes before approaching the aircraft to verify how slippery the surface is and in general to test the performance of the brakes.

12.3 Emergency Requirements

A certain amount of emergency equipment is mandatory for a deicing vehicle to make sure that some particular situations can be solved or prevented. The emergency system must contain an emergency stop/emergency shut-off system at key points around or in the vehicle, an emergency lowering system for the boom, a fire extinguisher, and systems to prevent any overheating, overfilling, or overpressure in the deicing fluid system. A way of communicating must be in place in order to be able to resolve situations with the person in the basket or cabin. The operation and monitoring of these systems shall be included in the training, and each different vehicle requires similar comprehensive types of training.

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12.4 Operational Use of Equipment and Quality Control

There are some limitations on the use of deicing vehicles. These limitations refer, among other things, to the maximum wind velocity with the boom elevated, operational speed during deicing/anti-icing, movement velocity of the boom, load capacity of the basket/cabin, spray pressure, and heat of fluids. The vehicle boom extension must be in proportion to the average aircraft serviced at the airport. Some aircraft have a height of up to 25 m, but an average height is between 13 and 15 m for large transports and under 10 m for small transports. The boom (basket/cabin) in itself may not always extend to the particular height required, but there may be an extending nozzle boom that covers the remaining distance. It must be noted that the farther away the spraying is performed, the less heat and pressure is transferred to the aircraft surface. Note that the area sprayed shall also be visually checked. Any particular limitations or requirements shall be referred to in the current deicing vehicle standards and manufacturers' publications.

Some requirements need to be tested and verified for use, such as the spray system, emergency system, visibility during operation, controls, monitoring devices and displays, lights, speeds, warning devices, braking, and steering. The vehicles also need labeling at all appropriate areas, such as hoses, fluids, filling ports, instructional plates, etc. Labeling of different hoses and filling ports is important so that no confusion can exist when performing deicing and anti-icing separately. Since some operators use uncolored deicing/anti-icing fluids, this aspect is even more important. Spray tests must be performed periodically for thickened fluid to verify that the vehicle (pumps, nozzles, etc.) do not degrade the viscosity of the fluid when sprayed. There are many variables to consider and to note when using the vehicle. It is up to **each operator** to make sure that all functions are working and that they have been appropriately maintained. A **maintenance schedule** shall be developed, and maintenance recorded by the company performing such service. If the operator has leased this service, then a verification of the performance should be recorded. The quality control also includes a verification of the fluid used (visual and refractive index/freezing point) and a verification of the fluid temperature.

Many vehicles have temperature measurements from the tank but temperature at the nozzle shall also be verified. A minimum temperature of 60 °C (140 °F) must be maintained for Type I/water mix used for anti-icing. The vehicle may also be able to provide data for the customer after each deicing event. Minimum parameters shall be recorded, such as the date, aircraft deiced/anti-iced, fluid used, any dilutions used, and holdover time started. Additional data is usually collected and thus also provided.

Filling Stations

Each filling station is designed to serve the particular vehicles in use. The filling of fluid can be performed by an automated system that controls the level of fluid in the vehicle tank or manually, either with separate containers or by filling through manholes. It must be noted that all hoses, containers, and filling ports (including manholes) shall be marked with the appropriate label of fluid contained. Care should be taken to prevent fluids being mixed together. Application equipment shall be cleaned thoroughly before initially being filled with deicing/anti-icing fluid in order to prevent fluid contamination. Deicing/anti-icing fluid in trucks shall not be heated with a combustion burner in confined or poorly ventilated areas. The heating of fluids in containers/tanks may be performed electrically, or they may not be heated at all (anti-icing fluid is generally not heated). Unheated fluid can be filled in the tanks if the vehicle is equipped with a burner that heats the fluid before spraying. Thickened fluid is not heated in either the vehicle or at the filling station unless used diluted as a deicing fluid.

The amount of fluid and the fluid temperatures both for the filling station and vehicles should be monitored in order to secure a sufficient amount of and sufficiently heated fluid when needed. The operation of the filling station shall be included in the training, and all necessary precautions shall be noted.

12.5 Equipment Communication Requirements

The deicing vehicle needs to have an appropriate communication system that is suited for the operation in use, e.g., VHF, UHF, mobile phone, etc. A two-way communication needs to be established between the vehicle and the aircraft (or the coordinator). This communication needs to be performed via VHF-radio. The radio needs to be approved for use for aviation frequencies. An intercom communication (or similar) needs to be established when two persons are operating the vehicle. The external noise should be noted (e.g., aircraft engines) when using a headset type communication in open basket vehicles. External noise can disrupt the communication, and care should be taken to avoid the deicing operation continuing with misleading or no communication at all. When two or more vehicles are deicing an aircraft, other communication possibilities may be considered between these vehicles. Communication between vehicles is needed in order to verify proper treatment and procedures. The chain of

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communication depends on how the particular winter operation is planned and performed. Some use a coordinator (or team leader) for all the communication between the aircraft while others perform the communication from each vehicle. In some situations, a hardwire headset can be plugged into the aircraft for direct communication with the aircrews. Certain airports have separate frequencies for different areas of deicing operation. The communication equipment must be suited for the local setting and the personnel trained accordingly.

12.6 Equipment Fluid Use and Spray Alternatives

There are many variations in equipment design, capability, and operability. The variations impact how the deicing/ anti-icing fluids are stored in the vehicle and how they are sprayed. Basically, either the fluids can be pre-mixed before use, or a proportional mixing system will mix the appropriate solution of product fluid and water according to selection. Thickened anti-icing fluids are not generally mixed with water, but some operators do use these fluids diluted as deicing fluid. These differences are mainly dependent on what particular need each operator has and how local operations are set up. Vehicles using pre-heated fluid should monitor the temperature. Vehicles using burners should verify the correct temperature while spraying. Note that when the vehicle has not been in use for some time, it may take longer to achieve the proper temperature at the nozzle.

Where fluid tanks are heated, there is normally a need for insulation, as the heat loss from a full tank should not exceed 1 °C/h. The heating of diluted Type I mixture can also generate heat that can be absorbed by the thickened fluid. This should be monitored so that the temperature does not rise too high.

The fluid flow depends on the particular fluid used and the equipment in use. Generally, a flow rate of 20 to 100 L/ min may be used for thickened fluids. The requirement is that the viscosity loss is minimal after pumping and spraying to avoid degrading the fluid below the minimum viscosity. The pumps, lines, and nozzles should be such that minimum viscosity loss is achieved after spraying. The appropriate spray pressure and flow rate depends largely on elements such as the type and amount of contamination on the aircraft surfaces, wind conditions, temperature of the fluid, spraying distance, etc. Generally, a 50 to 275 L/min flow rate at a pre-nozzle discharge pressure of 650 kPa with the boom fully elevated will be suitable for any deicing task. However, guidance on pressures and flow rates should also be confirmed with the fluid manufacturer for best results.

To perform an effective deicing operation, the deicer should have full control over the movement of the nozzle. It is necessary for the nozzle to be able to vary the pattern between a cone shape and a solid stream, and the flow rate from minimum to maximum. The system should be able to indicate any mixing problems or be designed so that the mixture will become stronger instead of leaner if something fails (the mixture "fails in a safe manner"). It is the responsibility of the operator to make periodic and daily checks of the fluids, as well as visual checks according to current standards and recommendations, to make sure that correct mixtures are used. The deicing fluid and water in the lines may freeze in cold temperatures. Purging the lines and filling them with a high concentration of glycol should eliminate this. In turn, when deicing the aircraft after purging the lines, it must be noted that a certain amount of fluid needs to be sprayed before the correct mixture is reached at the nozzle.

12.7 Data Collection

To enable useful evaluation and follow-up of operator performance, a system for recording and controlling operations should be established. The data encompasses general customer needs, and regulations require a record keeping of this data. The data is usually computerised, and the system automatically records some parameters (e.g., mixtures, time of deicing, and time of anti-icing, etc.) but these can also be recorded manually. Other details supplied to the system (e.g., flight number, aircraft type, areas treated, duration of operation, volume and type of fluid used, temperature, etc.) will depend on the particular setting and vehicle system.

The data should be at hand, to be presented to the customer when requested. The data is also an invoicing requirement unless otherwise settled between ground operators/service providers and air operators. There are different ways of providing and recording this data, such as instant invoice capability or remotely via the coordinator or as a handmade receipt. Some airports also need verification of where and how much deicing fluid has been used. This data should be recorded as seasonal information and should not be needed on a daily basis. Some companies also require internet-based record keeping for all deicing events in order to fulfill certain aircraft-specific data analysis and reporting, as well as the generally required event information.

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12.8 Basic Vehicle Components

NOTE: The items listed are typically found on a deicing vehicle but may vary depending on model and manufacturer. For further details, refer to the manufacturer's documentation.

- Operator's basket (containing spray guns, communication connections, basket controls, harness point, and lights) or
- Operator's enclosed cabin (containing nozzle and boom controls, communication equipment, cabin movement controls, optional truck movement controls) (one-person operation).
- Hydraulic boom.
- Compartment (containing Donkey Engine, heater, and hydraulics).
- Fluid pump.
- Side gun (under-wing nozzle).
- Emergency boom controls.
- Deicing fluid refill point.
- Truck cab (containing heater controls, gauges, communication connections, and driving controls, etc.).
- Roof window.
- Truck fuel tank.
- Deicing fuel tank.
- Boom locating point.
- Inspection hatches.
- Beacon light.
- Fluid type (mix).
- Fire control.
- Fire access point.
- Fluid level gauges.
- Heater exhaust outlet.
- Ladder.

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12.9 Typical Deicing/Anti-Icing Vehicle Layout

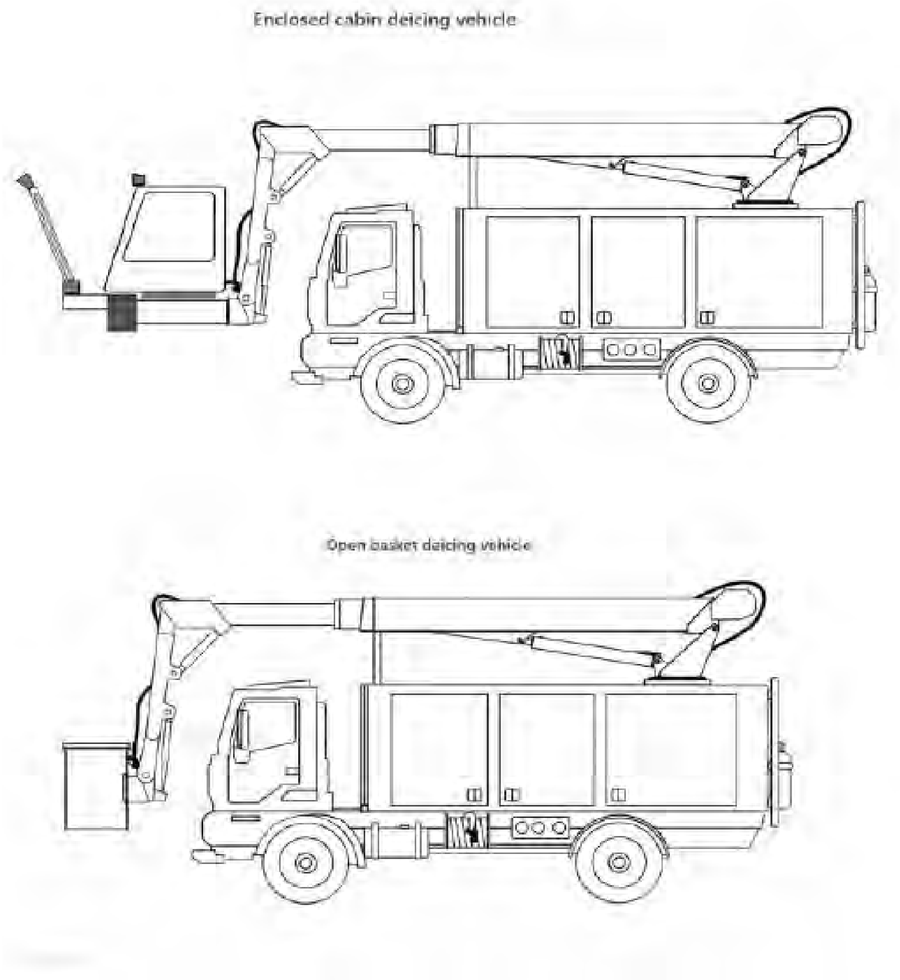

Figure A6. Typical deicing/anti-icing vehicles.

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12.10 Safety Equipment

- Seat belt and/or fall protection equipment (e.g., lanyard and harness).
- Eye/face protection.
- Respiratory protection (where required).
- Weatherproof clothing.
- Gloves.
- Hearing protection.
- Safety footwear.
- Any additional equipment identified by regulations or carrier.

12.11 Before-Use Checks

Before operating the deicer, a walk-around check must be performed. Each of these items must be operated and checked:

- Engine(s).
- Boom and basket/cabin operation.
- Heater and pump operation.
- Nozzle and spray gun operation.
- Emergency and safety equipment.

NOTE: Perform a manufacturer recommended pre-operation user's check before operating the unit.

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13 TE13: FLUID APPLICATION AND THE USE PLUS LIMITATIONS OF THE HOLDOVER TIME (HOT) TABLES

13.1 At the end of this section, the trainee should be able to describe in detail:

- Details of the clean aircraft concept.
- The main areas of the aircraft to spray, and the general method of doing this.
- The key aircraft areas to anti-ice and the other important areas to deice/anti-ice.
- The general purpose of holdover time table guidelines and how to read them.
- The difference between generic and fluid brand holdover time tables.
- The importance of using the correct dilution of anti-icing fluids when reading the appropriate holdover time table.

13.1.1 The Clean Aircraft Concept and Fluid Use

The clean aircraft concept must be understood as an important and fundamental foundation for the safety of the flight. A “clean aircraft” is considered to be one that is either totally clean or that has been cleaned of frozen contamination and protected with qualified deicing/anti-icing fluids (which still protect the surface and are able to provide the necessary aerodynamic performance). In addition, if there is any contaminated fluid on the surface, the aircraft must not be misunderstood to be clean; the contaminated fluid must also be removed. Under no circumstances shall an aircraft that has been anti-iced receive an additional coating of anti-icing fluid directly on top of the previous, contaminated fluid. If an additional treatment is required before flight, a complete deicing/anti-icing process shall be performed. Subsequent anti-icing only without the deicing step is not permitted. To be clear, any residues from a previous treatment that have “failed” (that is, fluid protection failure) must be flushed off before anti-icing re-treatment begins.

13.1.2 Spray Areas

Areas to spray on aircraft are, in most cases, the upper surfaces. However, underwing deicing may be very common for some aircraft types. The upper surfaces mainly refer to the wings, tails (including both sides of the vertical stabilizer), and fuselage. As a general rule, the deicing/anti-icing procedure should be performed from the top downward, from the leading edge toward the trailing edge, and from the aircraft front to the back. On most aircraft, it is usual to start at the wing tip and work toward the wing root. Specific areas to protect from recontamination depend on the aircraft limitations and company procedures, but at a minimum, the upper surfaces of the wings and the tail section shall be anti-iced. The fuselage may also need anti-icing. The lower sides of the wings are not generally anti-iced with thickened fluid, and using a deicing fluid with sufficient freezing point buffer is recommended.

13.1.3 Aircraft Surfaces

When using Type I for deicing, it will be applied heated. If the wing area is large and the active precipitation is heavy, previously deiced surfaces should be checked and if necessary, deiced again before anti-icing. Anti-icing fluid must be applied before the first-step deicing fluid freezes.

There is no single rule for the order in which aircraft surfaces should be sprayed that can be applied to all aircraft types. It is, however, generally recommended to start with the forward fuselage whenever it needs treatment. Following the standard process of spraying the aircraft starting from the top to the bottom, etc., it is usual to spray along the top center-line and then outward from there.

After the fuselage is deiced, it is typical to treat the wings. The way to treat the wings depends on the aircraft type and the place where deicing is performed (gate versus a remote station). Regardless, the wing should always be treated from the leading edge to the trailing edge (forward to aft). Mistakenly spraying from back to front can force fluid and contamination into gaps and balanced surfaces, cause gel residues to collect in gaps and on controls, and there is also the danger of removing grease from hinges and other parts. Most wings are to be sprayed from the wing tip inward. However, some aircraft have wing tips lower than the wing root, and in that case, deicing should be performed from the wing root outward.

The tail should be deiced from the top of the vertical stabilizer downward, including the aft fuselage/empennage area, before spraying the horizontal stabilizer (note that this does not apply to high-mounted horizontal tail, “T-tail,” aircraft). The tails must also be sprayed from leading edge to trailing edge (forward to aft).

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If there is active precipitation, at a minimum, the following surfaces shall be protected by anti-icing:

- Wing upper surfaces, including leading edges and all control surfaces.
- Wing tip devices.
- Both sides of vertical stabilizer and rudder to receive anti-ice protection when freezing precipitation conditions exist.
- Horizontal stabilizer upper surfaces including leading edges and elevator upper surfaces.
- Vertical stabilizer surfaces, including the rudder (both sides).

CAUTION

Anti-icing fluids may not flow evenly over wing leading edges, horisontal, and vertical stabilisers. These surfaces should be checked to ensure that they are properly coated with fluid.

It is the responsibility of the deicing service provider to ensure that the surfaces mentioned above are free of frost, snow, slush, or ice prior to the start of the anti-icing treatment, and that on completion of the treatment, these surfaces are fully covered with an adequate layer of anti-icing fluid.

The lower surfaces of the wings do not usually need anti-icing since the precipitation cannot fall onto this surface and limited frost in the area of the fuel tanks is usually acceptable for takeoff. A sufficiently high concentration of glycol in the fluid mixture (freezing point buffer) must be used to ensure that there is no recontamination within the holdover time after treatment.

NOTE: SAE Type II, III, and IV fluids used for anti-icing purposes are normally applied unheated on clean aircraft surfaces, but they may be applied heated and diluted for a one-step procedure. Refer to the fluid manufacturer's recommendation.

Gate deicing is somewhat different than remote/centralised deicing, and local settings and precautions should be noted. Using multiple deicing vehicles for one aircraft may change the spray order, but the same concept (**high to low, front to back**) should be applied. Different vehicles may also be needed for different applications (e.g., underwing or two-step area-by-area treatment); in such cases, the procedure should be written and verified accordingly.

NOTE: The repeated application of Type II, III, or IV fluid may cause **polymer residues** to collect in aerodynamically quiet areas, cavities, and gaps. The application of hot water or heated Type I fluid as the first step of a two-step deicing/anti-icing process may minimise the buildup of these residues. Residues may rehydrate and freeze at low (such as in-flight) temperatures and can block or impede critical flight control systems. Periodic inspection for accumulated residues may be necessary. Misting the aircraft with water may facilitate their visibility, as they will generally turn white and swell into a gel-like substance. Residue accumulations require removal.

13.1.4 Other Areas to Deice/Anti-Ice

Other areas on the aircraft need special attention or procedures for cleaning. Aircraft manufacturer recommendations and company procedures should be noted.

Windows need deicing but not anti-icing, and fluid shall never be directly sprayed onto windows as this can damage them; rather, spray above the windows such that the fluid flows down onto them. Some aircraft have limitations on how to clean them (again, manufacturer and company procedures should be noted) in some cases, a brush or cloth may be sufficient. If hot water is used for deicing (for example, on flight deck windows), it should be noted that water draining down from higher areas may freeze elsewhere on the fuselage. Other than this, there is no precaution for using hot water to deice windows.

The radome needs deicing and, in many cases, anti-icing. If the radome has been treated, caution must be taken so that large quantities of fluid cannot flow toward and up onto the flight deck windows during takeoff, reducing pilot visibility. Thickened fluid should be removed before departure if necessary. Static ports and pitot tubes need to be inspected. Any contamination, including fluid flowing from above, that exists on or forward of these safety-essential gauges shall be removed.

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NOTE: Ice ridges can form on the nose of the fuselage while on the ground. These ridges will disrupt air flow into the pitot tubes, which ca result in false measurements. All contamination shall be removed from this area.

Engine inlets and fan blades must be deiced in some cases, based on the engine or aircraft manufacturer and aircraft operator's instructions. Engine inlets can generally be cleaned with a brush or manually. Engine covers may be installed after engine shut down in order to minimise engine ice buildup (refer to air operator and engine manufacturer instructions). The engine fan blades and the bottom of the engine air inlet should be deiced with hot air (noting manufacturer recommended temperature limits), or other means recommended by the engine manufacturer. **No deicing/anti-icing fluid is to be sprayed into the engines**. Propellers may have ice along the leading edges and/or may collect snow/slush along the sides during a ground stop. This contamination can be removed manually with a soft cloth or by hand. Some manufacturers allow the propellers to be sprayed but some forbid the use of glycol-based fluids. Hot air, or any other means recommended by the engine manufacturer, can be used for the deicing of propellers. However, composite propellers may have temperature limits that must be noted and followed.

Aircraft external instruments, probes, and sensors may need deicing, and this should be performed using the aircraft manufacturer and operator procedures. This task shall only be performed and supervised by properly trained and qualified personnel.

For landing gear do not spray deicing/anti-icing fluid directly onto wheels and brakes. Ice and snow must be removed from the landing gear, paying particular attention to uplocks, downlocks, sensors, door mechanisms, and steering systems.

NOTE: It may be possible to mechanically remove certain accumulations, such as blown snow. However, if frozen contamination has bonded to the surfaces, they can be removed by the application of hot air.

Underwing deicing treatments must be symmetrical and include flap lower surfaces, if contaminated. Both wings must be treated identically (same areas, same amount and type of fluid, same mixture strength), even if the frozen contamination is only present on one wing. Underwing frost is usually caused by very cold fuel in the wing tanks, a condition known as **cold-soak frost**. Use a fluid/water mix with a higher concentration of glycol than is usually required by the outside air temperature to prevent recontamination.

13.2 Interpreting Deicing/Anti-Icing Fluid and Holdover Time (HOT) Tables

13.2.1 The Purpose of a Holdover Time (HOT) Table

In WOM 3.2/10.5, the classification of anti-icing fluids was explained: classifications are based on the water spray endurance time (WSET) test. Under laboratory conditions of freezing precipitation at -5 °C (23 °F), fluids will prevent freezing precipitation from accumulating beyond a standard level for a particular amount of time. While this is useful to evaluate a minimum amount of expected anti-icing protection time under these limited and very controlled conditions, there are many other forms of freezing precipitation (frost, snow, freezing drizzle, etc.), temperatures, and fluid dilutions that for which flight crews need protection-time guidance.

The Holdover Time (HOT) tables are guidelines of anti-icing protection times that have been obtained by performing a series of "endurance time" tests for each thickened fluid (including dilutions) in natural freezing precipitation conditions at a variety of temperatures. As there are a variety of precipitation conditions, and ranges of precipitation intensities and temperatures, the results of endurance time testing are presented as a table of "holdover times." Flight crews must use HOT guidelines to estimate the amount of time during which the aircraft should be free of frozen contamination ("clean") for takeoff. If the HOT for the prevailing weather condition is exceeded, the aircraft will need to be deiced and anti-iced again.

In this section, Tables A2, A3, and A4 show the typical format of a HOT table. The various freezing precipitation types are displayed along the top, and the range of outside air temperatures is displayed down the sides. For each cell in the table, a range of HOT is given.

Precipitation Intensity:

The HOT tables cells have a range of times published; the lower time value corresponds to more intense precipitation, while the longer time corresponds to lighter precipitation intensity.

Except for freezing drizzle, heavy precipitation intensities are not provided in any HOT guidelines.

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As an example, in Table A2, in freezing fog conditions at -2 °C, the holdover time range is 11 to 17 minutes. The lower time (11 minutes) corresponds to a more intense precipitation, while the longer time (17 minutes) corresponds to a lighter precipitation intensity.

If the deicing crew is asked to give this information to the flight crew, it is essential to give the time span. In the above case, it would be 11 to 17 minutes.

Snowfall intensity rates in grams per decimeter square per hour (g/dm2/h) and their liquid water equivalent (LWE) rates (generated by purpose-built systems) are as follows:

- Moderate snow: 10 to 25 g/dm2/h and 1.0 to 2.5 mm/h.
- Light snow: 4 to 10 g/dm2/h and 0.4 to 1.0 mm/h.
- Very light snow: 3 to 4 g/dm2/h and 0.3 to 0.4 mm/h.

If the precise rate cannot be determined, it is recommended to use the shorter time of the given cell.

For freezing rain, the range is confined to light freezing rain which can be up to 25 g/dm2/h.

It is the responsibility of the pilot in command to determine which time is to be used.

Appropriate use of the HOT tables relies upon the reader being able to determine which precipitation condition is applicable (plus the outside air temperature).

Alternatively, an automated system can be used, called a holdover time determination system (HOTDS) that identifies the precipitation type and intensity and displays the appropriate HOT for the crew.

The differences in the HOT values for the various precipitation conditions can also provide an indication of which types of precipitation present a greater or lesser threat of contaminating the aircraft prior to takeoff.

The above values are given for training purposes only. HOT tables are updated by the regulators every year, and the trainee should understand that only values from current, official HOT tables can be used in real-time operations.

The HOT tables represent a wide range of precipitation types and rates, and they must be interpreted by suitably trained personnel.

13.2.2 The Two Types of Holdover Time Tables and When the Holdover Time Starts and Ends

There are two different categories of holdover time tables in use, **generic** and **fluid brand**. The **generic tables** are developed using the lowest HOT for each cell of the table from those of all of the qualified fluids. For this reason, the generic tables may provide lower HOT values than the HOT table does for any one particular fluid.

The purpose of a generic table is that it can be safely used for **any qualified fluid of that type**, regardless of brand.

On the other hand, the fluid brand HOT tables are applicable to only that one particular fluid and cannot be used for any other fluid.

If the specific holdover time information for the fluid brand provided is unknown, the generic table shall be used. The HOT tables used by the various operators may vary a bit in content from the example. There may be differences in the precipitation categories (most commonly, those for snow, light snow, very light snow) and differences depending upon the authority or organisation that published the tables or country (e.g., FAA, TC).

Appropriately applied anti-icing fluids are expected to provide the appropriate published HOT. For a one-step deicing/anti-icing process, the HOT begins at the **start of fluid application**, and for a two-step process, at the **start of the final (anti-icing) step**. Holdover time ends either when the aircraft takes off, or when the fluid "fails." There are two types of fluid failure. The most commonly known type of fluid failure is due to freezing precipitation. This type of failure is visually identified by seeing either undissolved frozen precipitation in the fluid or frozen contamination starting to form or accumulate on treated aircraft surfaces (usually the wings). The second type of fluid failure is when the fluid fails to wet the surface upon application. This can be caused by contact with other materials, such as silicones. A fluid that does not wet the surface (spread evenly) is also a failed fluid.

Due to their properties, Type I fluids form a thin liquid wetting film, which provides a very short HOT time, especially in conditions of freezing precipitation. Most of the HOT comes from the heat of the applied fluid. With this type of fluid, no additional HOT can be obtained by increasing the concentration of the fluid in the fluid/water mix.

Types II, III, and IV fluids contain thickening agents, which enable the fluids to form a thick liquid wetting film on the aircraft surfaces. This thick layer of fluid provides significantly longer HOTs than Type I fluids.

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13.2.3 Type I Fluid HOT Table Example (Table A2)

Table A2 shows **a Type I HOT table**. The table provides times that can be used for all qualified Type I fluids. The lower value of the time span indicates the estimated time of protection during moderate precipitation, and the higher value indicates the estimated time of protection during light precipitation.

The table is read by first verifying the OAT and the form of precipitation; the HOT cell to use is where these two parameters cross. As an example, at a temperature between -3 and -6 °C (27 and 21 °F), in **moderate** snow conditions, a Type I fluid is expected to provide, **on an aircraft composed predominantly of aluminum**, a HOT between 0:05 and 0:08 minutes.

It is the responsibility of the pilot-in-command to determine which time is to be used based upon the intensity or rate of snowfall (if not provided with this information by other means). If the deicing crew is asked to give this information to the flight crew, it is essential to give the time span (e.g., 5 to 8 minutes).

All HOT tables contain several notes. The notes shall be observed accordingly. For Type I fluids, there are separate HOT tables for composite and metallic aircraft surfaces: which to use for which aircraft type is recommended by the aircraft manufacturer.

HOLDOVER TIMES FOR SAE TYPE I FLUID ON CRITICAL AIRCRAFT SURFACES COMPOSED PREDOMINANTLY OF ALUMINUM

Outside Air Temperature[1,2]	Freezing Fog, Freezing Mist[3], or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[4,5]	Light Snow, Snow Grains or Snow Pellets[4,5]	Moderate Snow, Snow Grains or Snow Pellets[4]	Freezing Drizzle[6]	Light Freezing Rain	Rain on Cold-Soaked Wing[7]	Other[8]
-3 °C and above (27 °F and above)	0:11 - 0:17	0:18 - 0:22	0:11 - 0:18	0:06 - 0:11	0:09 - 0:13	0:02 - 0:05	0:02 - 0:05	
below -3 to -6 °C (below 27 to 21 °F)	0:08 - 0:13	0:14 - 0:17	0:08 - 0:14	0:05 - 0:08	0:05 - 0:09	0:02 - 0:05		
below -6 to -10 °C (below 21 to 14 °F)	0:06 - 0:10	0:11 - 0:13	0:06 - 0:11	0:04 - 0:06	0:04 - 0:07	0:02 - 0:05	CAUTION: No holdover time guidelines exist	
below -10 °C (below 14 °F)	0:05 - 0:09	0:07 - 0:08	0:04 - 0:07	0:02 - 0:04				

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Table A2: A typical generic type I holdover time table

NOTE: This table is intended for training only and shall not be used for actual operations.

13.2.4 Type II/III/IV Fluid Generic Holdover Time Table Example (Table A3 and A3.2)

(Tables A3.1 and A3.2) Tables A3.1 and A3.2 show generic Type II/IV HOT tables. The tables provide the expected range of protection times that can be used for all qualified Type II/IV fluids. As for a Type I table, the lesser time value is the estimated time of protection during moderate precipitation, and the greater time value is the estimated time of protection during light precipitation.

The table is read by verifying the outside air temperature, the form of precipitation, and the concentration of the fluid. (Alternatively, the fluid concentration can be selected based upon the amount of HOT desired.) The applicable HOT cell is where these parameters cross. As an example, for a temperature between -3 °C (27 °F) and -8 °C (18 F), for a fluid concentration of 100/0 and a snow conditions, the appropriate HOT range or Type II is 20 to 35 minutes, but for Type IV, the appropriate HOT range for light snow is 55 to 105 minutes, and for moderate snow, the appropriate HOT range is 25 to 55 minutes.

It is **very important to use the HOT for the correct concentration of fluid because using an incorrect one can result in using a dramatically incorrect HOT, thus compromising the safety of the takeoff**.

It is the responsibility of the Pilot in Command to decide on which time is appropriate based upon the rate of the snowfall (if not provided with this information by other means). If the deicing crew is asked to give this information to the flight crew, it is essential to give the time span (e.g., 20 to 35 minutes).

The fluid mixture concentration may depend upon the procedures used by the deicing service provider. Some providers only offer one concentration (e.g., 100/0), while others offer all standard dilutions (e.g., 75/25, 50/50).

All HOT tables contain several notes. The notes shall be observed accordingly. For thickened fluids, the generic HOT table provides times that are valid for **both composite and metallic aircraft surfaces** (the difference between Type I and the thickened fluids is the heat conduction properties afforded by the heated Type I fluid).

GENERIC HOLDOVER TIMES FOR SAE TYPE II FLUIDS

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog, Freezing Mist[2], or Ice Crystals	Snow, Snow Grains or Snow Pellets[3,4]	Freezing Drizzle[5]	Light Freezing Rain	Rain on Cold-Soaked Wing[6]	Other[7]
-3 °C and above (27 °F and above)	100/0	0:55 - 1:50	0:25 - 0:50	0:30 - 1:00	0:20 - 0:35	0:07 - 0:45	
	75/25	0:25 - 0:55	0:15 - 0:25	0:15 - 0:40	0:10 - 0:20	0:04 - 0:25	
	50/50	0:15 - 0:25	0:05 - 0:10	0:08 - 0:15	0:06 - 0:09		
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:30 - 0:45	0:20 - 0:35	0:20 - 0:45	0:15 - 0:20		
	75/25	0:25 - 0:50	0:10 - 0:20	0:15 - 0:25	0:08 - 0:15		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:30 - 0:45	0:15 - 0:30	0:20 - 0:45[8]	0:15 - 0:20[8]		
	75/25	0:25 - 0:50	0:08 - 0:20	0:15 - 0:25[8]	0:08 - 0:15[8]		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:15 - 0:20	0:02 - 0:07				
below -18 to -25 °C[9] (below 0 to -13 °F)	100/0	0:15 - 0:20	0:01 - 0:03				
below -25 °C to LOUT[9] (below -13 °F to LOUT)	100/0	0:15 - 0:20	0:00 - 0:01				

CAUTION No holdover time guidelines exist

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Table A3: Typical type II generic holdover time table

NOTE: This table is intended for training only and shall not be used for actual operations.

GENERIC HOLDOVER TIMES FOR SAE TYPE IV FLUIDS

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog, Freezing Mist[2], or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[3,4]	Light Snow, Snow Grains or Snow Pellets[3,4]	Moderate Snow, Snow Grains or Snow Pellets[3]	Freezing Drizzle[5]	Light Freezing Rain	Rain on Cold-Soaked Wing[6]	Other[7]
-3 °C and above (27 °F and above)	100/0	1:15 - 2:40	1:55 - 2:20	1:00 - 1:55	0:30 - 1:00	0:40 - 1:10	0:20 - 0:35	0:08 - 1:05	
	75/25	1:25 - 2:40	2:05 - 2:25	1:15 - 2:05	0:40 - 1:15	0:50 - 1:20	0:30 - 0:45	0:09 - 1:15	
	50/50	0:30 - 0:55	1:00 - 1:10	0:25 - 1:00	0:10 - 0:25	0:15 - 0:40	0:09 - 0:20		
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:20 - 1:35	1:45 - 2:05	0:55 - 1:45	0:25 - 0:55	0:25 - 1:10	0:20 - 0:25		
	75/25	0:30 - 1:20	1:50 - 2:10	1:00 - 1:50	0:30 - 1:00	0:20 - 1:05	0:15 - 0:25		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:20 - 1:35	1:20 - 1:40	0:45 - 1:20	0:25 - 0:45	0:25 - 1:10[8]	0:20 - 0:25[8]		
	75/25	0:30 - 1:20	1:40 - 2:00	0:45 - 1:40	0:20 - 0:45	0:20 - 1:05[8]	0:15 - 0:25[8]		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:20 - 0:35	0:30 - 0:45	0:09 - 0:30	0:02 - 0:09				
below -18 to -25 °C[9] (below 0 to -13 °F)	100/0	0:20 - 0:35	0:10 - 0:20	0:03 - 0:10	0:01 - 0:03				
below -25 °C to LOUT[9] (below -13 °F to LOUT)	100/0	0:20 - 0:35	0:07 - 0:10	0:02 - 0:07	0:00 - 0:02				

CAUTION No holdover time guidelines exist

FOR TRAINING PURPOSES ONLY

Table A3.2: Typical Type IV generic holdover time table

NOTE: This table is intended for training only and shall not be used for actual operations.

13.2.5 Type I/II/III/IV Holdover Time Table for Frost

There is a separate HOT table to be used in active frost conditions. Table A4 is an example of **a Type I, II, III, and IV fluid holdover time table for frost conditions**. Thus, the table provides the HOTs that can be used for all qualified fluids in frost conditions. The way to read the table is the same as for the other tables. The difference for this table is that all fluid types are represented together. Note that there is no fluid concentration for Type I, only for the thickened fluids. The HOTs provided in this table are valid for **both composite and metallic aircraft surfaces**.

Table A4: Generic frost protection holdover times for all fluid types

Outside Air Temperature[1,2,3]	Type I
-1 °C and above (30 °F and above)	0:45 (0:35)[5]
below -1 to -3 °C (below 30 to 27 °F)	
below -3 to -10 °C (below 27 to 14 °F)	
below -10 to -14 °C (below 14 to 7 °F)	
below -14 to -21 °C (below 7 to -6 °F)	
below -21 to -25 °C (below -6 to -13 °F)	
below -25 °C to LOUT (below -13 °F to LOUT)	

Outside Air Temperature[2,3]	Concentration Fluid/Water By % Volume	Type II	Type III[4]	Type IV
-1 °C and above (30 °F and above)	100/0	8:00	2:00	12:00
	75/25	5:00	1:00	5:00
	50/50	2:00	0:30	3:00
below -1 to -3 °C (below 30 to 27 °F)	100/0	8:00	2:00	12:00
	75/25	5:00	1:00	5:00
	50/50	1:30	0:30	3:00
below -3 to -10 °C (below 27 to 14 °F)	100/0	8:00	2:00	10:00
	75/25	4:00	1:00	5:00
below -10 to -14 °C (below 14 to 7 °F)	100/0	6:00	2:00	6:00
	75/25	1:00	1:00	1:00
below -14 to -21 °C (below 7 to -6 °F)	100/0	3:00	2:00	6:00
below -21 to -25 °C (below -6 to -13 °F)	100/0	2:00	2:00	4:00
below -25 °C (below -13 °F)	100/0	No Holdover Time Guidelines Exist		

FOR TRAINING PURPOSES ONLY

NOTE: This table is intended for training only and shall not be used for actual operations.

13.3 Local Frost Prevention for Cold-Soaked Wing Areas

Local frost is an accumulation or build up of frost on limited ("local") wing areas that are cold-soaked due to cold fuel or large masses of cold metal; this type of frost does not cover the entire wing. Local frost prevention for cold-soaked wing areas is a procedure to treat an aircraft upon its arrival to try to prevent the need for full deicing/anti-icing prior to its departure. Wing surface temperatures can be considerably below the ambient temperature due to contact with cold fuel or close proximity to large masses of cold-soaked metal. When this occurs, frost can accumulate on wing surfaces and may result in the entire wing needing to be deiced/anti-iced prior to its subsequent departure. The local frost prevention procedure is mainly used for cold-soaked wing tank areas during transit stops.

This is a preventive procedure, and it does not replace standard deicing/anti-icing procedures. Checks for clear ice and any other aircraft manufacturer's treatment and requirements may still need to be performed. The requirement that critical aircraft surfaces be clean of frost, slush, snow, and ice accumulation still applies. This local frost prevention procedure shall only be carried out if approved by the operator of the aircraft to be treated, and it shall only be carried out by properly qualified and trained personnel.

The local frost prevention procedure shall be applied to clean wings immediately following arrival of the aircraft. Application of Type II, III, or IV anti-icing fluid is acceptable, at the latest, when frost just starts to build up, and in this case, the fluid shall be applied at a minimum temperature of +50 °C (122 °F). Suitable spray equipment should be used to apply a coating of fluid on the wings in the limited cold-soaked areas where formation of frost may be expected due to contact of the wing skin with cold fuel or masses of cold metal. The fluid must completely cover the treated area. Both wings shall receive the same and symmetrical treatment (e.g., the same area in the same location shall be sprayed), which also applies when contamination conditions would not require the treatment of both wings. Note that aerodynamic problems could result if this requirement is not met. A holdover time shall not be assigned for a local frost prevention treatment since the fluid has not been applied to all critical surfaces of the aircraft. If precipitation occurs between application of the fluid and dispatch of the aircraft, or if precipitation is expected before takeoff, a standard two-step deicing/anti-icing treatment shall be performed.

Since the anti-icing fluid is heated to +50 °C (122 °F) for frost that has just started to build up, no minimum viscosity limits are relevant. Using diluted fluid can cause it to drain off more quickly than undiluted thickened fluid. This can cause the wing to become contaminated in certain areas, and it must be noted when inspecting the aircraft.

14 TE14: DEICING/ANTI-ICING CODES AND COMMUNICATION PROCEDURES

14.1 At the end of this section, the trainee should be able to describe in detail:

- The main contents of the Aerospace Standard WOM 3.3.
- Acceptable and unacceptable methods of communication.
- Releasing and dispatching an aircraft.
- The anti-icing code (when holdover times apply).
- The post-deicing report (deicing treatments only, holdover times do not apply).
- The role of the flight crew.
- Off-gate deicing/anti-icing communication.
- Standard ICAO aircraft spelling and phraseology.

14.1.1 WOM 3.3 Phraseology

For clear communication between the ground crew and the flight crew during deicing/anti-icing operations, it is important that standard phrases and procedures are understood by everyone. The Aerospace Standard WOM 3.3 contains standard scripts to be used for the following situations:

- Prior to deicing/anti-icing operations, including correct configuration of the aircraft.
- Upon concluding the deicing/anti-icing operations.
- Giving the “all clear” signal after the deicing/anti-icing operations.

There are also standardised scripts that can be used in abnormal situations:

- For spray nozzle proximity warning alarms.
- For other aircraft having an emergency in the same area.
- For any interrupted operations (such as running out of fluid).

14.1.2 Post Deicing/Anti-Icing Communication

Proper communication is as important as proper deicing/anti-icing. When communicating and verifying the process between the ground crew and the flight crew, there must not be any doubt about any of the following: the procedure, fluid used, holdover time, areas covered, etc.

As a rule, an aircraft shall not be dispatched for departure after a deicing/anti-icing operation until the flight crew has been notified of the type of deicing/anti-icing operation performed (i.e., the anti-icing code). The anti-icing code (also known as post-deicing/anti-icing report) shall be provided by qualified staff upon completion of the treatment, indicating that the treated surfaces are free of frost, snow, slush, or ice, that deicing/anti-icing is complete, that deicing equipment is cleared from the area, and, in addition, providing the necessary information for the flight crew to determine the appropriate holdover time for the prevailing weather conditions. The person communicating with the flight crew shall have a basic knowledge of the English language in order to communicate properly (refer to WOM 3.2.8.6; an operational level 4 is the preferred minimum).

As important as the communication between the flight crew and the deicing crew is, so too is the communication among the deicing crew members themselves and the Deicing Coordinator. **No misunderstanding can be allowed** when deciding on treatment and verifying operational procedures. If several deicing vehicles are performing the deicing/anti-icing simultaneously on an aircraft, a lead vehicle/person shall be identified. **This team leader shall be the person communicating with the aircraft and the vehicles treating the aircraft**. The procedures and the areas to be treated are divided and settled according to the team leader’s instructions. The team leader will give instructions on fluids and mixtures to use, areas to be treated and by whom, etc. After the procedure has been completed, all vehicles shall report to the team leader their particular information once their operation is concluded.

The team leader shall decide which area to treat first and the time that spraying starts shall be reported to the flight crew. At the time of the final report (the anti-icing code), all vehicles shall be in a safety area or in a position well clear of the aircraft. The procedure should also reflect the local demands.

Communication between the Pilot in Command and the deicing crew will usually be achieved using a combination of printed forms and verbal communication. For treatments carried out after aircraft doors are closed, use of flight interphone (headset) or VHF radio will be the normal method. Electronic message boards may also be used in “off stand” situations. **Use of hand signals is not recommended**, except for the final “all clear” signal.

When a treatment is interrupted for a significant period of time (e.g., truck runs out of fluid), the flight crew shall be informed, stating the reason, the action to be taken, and the estimated time delay. When continuing the treatment,

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the previously treated surfaces must be fully deiced and anti-iced again if the holdover time applicable to the interrupted treatment is no longer sufficient.

14.1.3 Releasing or Dispatching the Aircraft and the Final Walk-Around

The person releasing or dispatching the aircraft immediately before taxi and takeoff shall verify to the flight crew all relevant information regarding the deicing/anti-icing process and communicate any relevant issues. A final check of the aircraft shall be made during the final walk around (or verification of deicing/anti-icing) before push-back or before taxi. This final check should also include a visual check of the engine inlets (fan blades) or the propellers. Any other verification or check should be made at this time. If the deicing crew is unable to communicate with the flight crew, the person "releasing" the aircraft can communicate the anti-icing code and other information to the flight crew. Invoicing or other required information can be exchanged at this point, although the aircraft may be ready to taxi, and paperwork may need to be settled in another way.

14.1.4 The Anti-Icing Code

The following elements comprising the Anti-Icing Code shall be recorded and be communicated to the flight crew by referring to the anti-icing treatment. It shall be provided in the sequence given below:

NOTE: This information shall not be communicated in circumstances where anti-icing holdover times do not apply, e.g., local frost prevention in cold-soaked wing areas, symmetrical local area deicing, or deicing of specific surfaces only (such as leading edges for removal of impact ice), etc.

a) The fluid type (i.e., Type I, II, III, or IV);

b) The fluid name (manufacturer and brand/trade name) of the Type II, III, or IV anti-icing fluid.

   NOTE: Communication of this element is not required for Type I fluid.

c) The concentration of fluid (dilution) within the undiluted fluid/water mixture, expressed as a percentage by volume for Type II, III, or IV (i.e., 100% ("undiluted") = 100% fluid, 75% = 75% fluid and 25% water, 50% = 50% fluid and 50% water).

   NOTE: Communication of this element is not required for Type I fluid.

d) The local time (hours and minutes -hh:mm), either:

   - For a one-step deicing/anti-icing operation: at the start of the final treatment; or
   - For a two-step deicing/anti-icing operation: at the start of the second step (anti-icing).

e) The date in the following format: day, month, year (DDMMMYY format (e.g., 28JAN15 = January 28, 2015));

   NOTE: This element is required for record keeping and is optional for flight crew notification.

f) The statement, "Post deicing/anti-icing check completed."

NOTE 1: For specific aircraft types, additional requirements exist, e.g., tactile checks for clear ice on wing surfaces. Additional confirmation for these checks may be required.

NOTE 2: An alternative means of visual communication of the anti-icing code to the flight crew can be used (e.g., written on paper, MBs, ACARS, EFBs, etc.).

NOTE 3: Aircraft onboard systems, available to assist flight crew to determine holdover time, require a good coordination between service providers and aircraft operators to provide fluid information in advance or to inform the customers of any change of fluids prior to the de/anti-icing operation.

14.1.5 The Post Deicing Report

After the completion of a deicing only procedure, where no anti-icing holdover time is applicable, the company responsible for conducting the post-deicing check shall also provide the flight crew with the post-deicing communication. The following elements shall be recorded and be communicated to the flight crew as part of the post-deicing communication:

a) Deicing fluid type (i.e., Types I, II, III, or IV).

b) Statement that anti-icing holdover times do not apply.

c) The date in the following format: day, month, year (DDMMMYY format) (e.g., 28JAN15 = January 28, 2015).

NOTE: This element is required for record keeping and is optional for flight crew notification.

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d) The statement "post-deicing check completed."

14.1.6 Flight Crew Information

The flight crew shall be notified and approve of both the start and the finish of the deicing/anti-icing procedures with reception of the anti-icing code. The aircraft must be configured before the start of the deicing/anti-icing process, and the flight crew may need to consider when they will be able to depart before allowing the deicing operation to begin. For some aircraft, the auxiliary power unit (APU) or air-conditioning must be shut off, and some flight crews may need to be informed of the deicing of certain parts of the aircraft (e.g., when deicing the tail) before the operation can begin. The main idea is to receive the "go-ahead" from the flight crew; they will then take into account any procedures needed. The flight crew shall receive a confirmation from the ground crew that all deicing/anti-icing operations have been completed and that all personnel and equipment are in safe locations before reconfiguring or moving the aircraft.

The flight crew shall also be notified of any deicing/anti-icing procedures that apply in special circumstances or if preventive anti-icing has been performed. Preventive anti-icing does not rule out the need for any check or the need for additional treatment. This decision lies with the Pilot in Command. The following information shall be provided to the flight crew for a preventive anti-icing procedure: "Local frost prevention was accomplished." Additional information should also be provided, such as if there have been any significant weather elements since the deicing operation was performed and before the arrival of the flight crew. Other additional information might identify areas that were not treated but may need an additional check before departure. The information shall be provided either by direct communication or by in written form. All events shall be recorded so that further information can be provided if necessary.

Off-Gate Deicing/Anti-Icing Communication

The at-gate deicing/anti-icing process is quite straightforward since engines are not running and the aircraft is easier to configure for deicing (if configuring is needed). The procedures that apply to remote deicing areas may need some extra verification of the process before the start of the deicing. The information can include the verification of parking brake setting, aircraft configurations, engines shut down and start up, etc. The procedure is dependent on the aircraft limitations or requirements for deicing. For example, aircraft with four engines may need to shut down the outer engines to allow for a safe deicing operation; if this is not possible, the aft section and tails shall be treated such that the jet blast can be avoided (e.g., approaching from far behind and staying close to the fuselage). Additional communication is needed to verify the procedure for deicing operations with engines running. In some cases, aircraft are unable to shut down the outer engines, and if propeller aircraft are deiced at the remote area, proper communication is essential to verify possible extra procedures, such as which side of the aircraft to treat first, propeller "brakes," etc. This additional communication can be time-consuming, but the safety of the operation is the key element for everyone.

An alternate means of communication may be the use of Electronic Message Boards. In the event of a conflict, verbal communication shall take precedence. **During deicing/anti-icing operations with engines running, both verbal and visual communications shall be used and positive control maintained during the deicing/anti-icing operation in accordance with AS6285 and ARP5660.**

Communication shall be in accordance with AS6285 (latest issue), 8.5 and 8.6.

14.1.7 Radio Telephony Phraseology

Whenever communicating with aircraft, standard ICAO phraseology shall be used. There is always a danger of misunderstanding or miscommunicating when using local language and acronyms. Note that there can be many other communications in progress at the time of your need to communicate. There may be one or several frequencies available for deicing operations on the apron and the remote area. Any other ongoing communication shall not be interrupted so that the ongoing communication will not be compromised. When starting and ending a VHF-communication, remember that there is a delay for the transmission to "open." First press the tangent and then talk. When ending, finish your communication and then release the tangent.

There are some basic rules of communication. First think about what you are going to say, hold the microphone close to your mouth, speak clearly and with a normal speed, avoid disturbing or incoherent sounds ("aaaa," "hmmmm"), always read or repeat back what you have been told, identify yourself (e.g., deicing vehicle number or coordinator), and always address the other party with the same call-sign that has been identified. In many cases, aircraft are identified by registration number when performing deicing. Another process is to communicate using flight numbers.

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Registration numbers are always easier to identify when deicing vehicles are moving around aircraft and on the apron. Flight numbers do not clearly distinguish one aircraft from another for the deicing crew, but this procedure may be used, for example, on a remote deicing pad where there are no other aircraft at one particular place. Verify whenever in doubt. A correct communication procedure shall be used at all times.

An example of a deicing communication between a vehicle (truck No. 2) and an aircraft (OH-LVA) at a gate stand (note that Standard ICAO Alphabet Identifiers are to be used, see Table A5) may be found in AS6285E, 8.5 and 8.6.

Table A5: Standard ICAO alphabet identifiers

A	Alfa	(al-fah)		N	November	(no-vem-ber)
B	Bravo	(brah-voh)		O	Oscar	(oss-cah)
C	Charlie	(char-lee) or (shar-lee)		P	Papa	(pah-pah)
D	Delta	(dell-ta)		Q	Quebec	(keh-beck)
E	Echo	(eck-oh)		R	Romeo	(row-me-oh)
F	Foxtrot	(foks-trot)		S	Sierra	(see-air-rah)
G	Golf	(golf)		T	Tango	(tang-go)
H	Hotel	(hoh-tel)		U	Uniform	(you-nee-form) or (oo-nee-form)
I	India	(in-dee-ah)		V	Victor	(vik-tah)
J	Juliett	(jew-lee-ett)		W	Whiskey	(wis-key)
K	Kilo	(key-loh)		X	X-ray	(ecks-ray)
L	Lima	(lee-mah)		Y	Yankee	(yang-key)
M	Mike	(mike)		Z	Zulu	(zoo-loo)

All communication is based on the assumption that both parties understand the proceedings of a proper deicing/ anti-icing operation. Some aircraft may have other requests, such as wanting the information when deicing the tail area, etc. All communication shall be read or repeated back clearly. If uncertain of the procedure, always ask again to verify the transmission. On many occasions, it is likely that both the deicing operator and the aircraft crew have English as a foreign language. In these cases, it is even more important to verify procedures. Avoid phrases or other non-standard wording that can be misunderstood as information for a final release (e.g., when two deicing trucks are talking to each other over the frequency and verifying procedures, such as "deice No. 2, you're ready?," could be misunderstood to the flight crew as "deice No. 2 is ready." At this point, the aircraft may begin start procedures and/ or push-back while waiting for the holdover time information, etc.

14.1.8 ICAO Phraseology

Some of the basic ICAO phraseology and wordings are shown in this section. Note that numbers can be used in a different way when communicating about deicing items, such as quantity of fluids used. Call signs shall always be used correctly, but any special information can be adapted according to the situation. The main idea is that both parties understand each other clearly. Note that flight crews may communicate with UTC time indications. Even so, deicing events are always communicated as a local time.

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Table A6: ICAO number pronunciation

0	Zero	(zee-ro)
1	One	(wun)
2	Two	(too)
3	Three	(tree)
4	Four	(fow-er)
5	Five	(fife)
6	Six	(six)
7	Seven	(sev-en)
8	Eight	(ait)
9	Nine	(nine-er)
10	One-zero	(wun, zee-ro)
75	Seven-five	(sev-en, fife)
100	Hundred	(hand-red)
1000	Thousand	(tau-send)
Frequency	131900	One three one decimal niner zero
Time	09:20	Zee-ro niner too zee-ro

Table A7: Common phrases and meanings

Acknowledge	Say that you have received and understood the transmission
Affirm	A positive reply
Approved	Permission granted
Check	Inspect/verify something
Confirm	Make sure that something is done
Contact	Take radio contact with someone
Correct	The right way to proceed
Correction	Something said/informed wrongly and continued with the right message
Disregard	Do not note the previous message
Go ahead	Continue with transmission/procedure
How do you read?	Verifying the transmission and readability
Monitor	Listen to the frequency
Report	Inform of the procedure
Request	Ask for something
Roger	Have received and understood the message (not recommended when multiple communication is ongoing, needs a call sign verification)
Say again	Repeat the message
Stand by	Wait for the transmission to continue after a moment
Verify	Confirm/check/inspect something

15 TE15: AIRCRAFT IN GENERAL AND COMMON CRITICAL SURFACES AND INSTRUMENTS

15.1 At the end of this section, the trainee should be able to describe in detail:

- The critical aircraft surfaces to inspect.
- The precautions to take against clear ice.
- Critical areas not to spray.
- Use of the "Deicing/Anti-Icing Diagrams/No Spray Zones" information in Appendix B.

15.2 Check of Critical Surfaces

For each type of aircraft used in their operations, operators should identify the critical surfaces which should be checked for contamination check, post deicing/anti-icing check (see WOM 3.1 subsection 3.1.14 "Ground Equipment"). Information from the aircraft manufacturer should be used to determine the critical surfaces for each aircraft type. Examples of this information are available in WOM 3.2/Appendix 2. Contact the aircraft manufacturer for specific information.

The following is a general list of critical surfaces and requirements:

- Wings, tails, and control surfaces shall be free of frost, snow, slush, or ice. Some coating of frost may be permissible on wing tank lower surfaces caused by cold-soaked fuel. Ice can accumulate on aircraft surfaces during flight through clouds or precipitation. When the ground outside air temperature at the destination is low, it is possible for flaps and other movable surfaces to be retracted with undetected accumulations of ice remaining on or between stationary and movable surfaces. It is, therefore, important that these areas are checked prior to departure and any frozen contamination removed. (Note that some aircraft manufacturers advise checking for such contamination prior to retracting surfaces, to avoid damaging the surfaces.)
- Pitot heads, static ports, airstream direction detector probes, and angle of attack sensors shall be clear of frost, snow, slush, ice, fluid residues, and protective covers.
- Engine inlets shall be clear of internal ice and snow, and the fan shall be free to rotate. In freezing fog and other freezing precipitation conditions, it is necessary for the front and rear sides of the fan blades to be checked for ice prior to engine start-up. Any frozen contamination discovered is to be removed by directing air from a low-flow hot air source or other means recommended by the aircraft and engine manufacturers. Exceptions will be noted in the Engine Manufacturer's Manual. These suction, exhaust blast and propeller wash areas will move due to the effect of local wind speed and direction at the deicing location, so continuous vigilance will be required in gusting conditions. The melting of snow and ice will cause water to drain down the engine inlet. This water must be dried out so as not to let the water refreeze after the treatment.
- Air-conditioning inlets/exits shall be clear of frost, snow, slush, or ice. Outflow valves shall be clear and unobstructed.
- Landing gear and landing gear doors shall be unobstructed and clear of frost, snow, slush, or ice.
- Fuel tank vents shall be clear of frost, snow, slush, or ice.
- Fuselage shall be clear of ice and snow. In accordance with the aircraft manufacturers' manuals, some adhering frost may be allowed. Do not close any door until all ice and snow have been removed from the surrounding area.
- Propellers - Refer to the aircraft manufacturer's information for the maximum temperature and pressure for fluid application, as well as frost and light ice removal.

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15.3 Clear Ice Precautions

Clear ice is extremely difficult to detect visually. Therefore, when the following conditions prevail, or when there is any question whether clear ice may have formed, a close examination shall be made prior to departure to ensure that all adhering frozen contamination has been removed. Clear ice can form on aircraft surfaces below a layer of snow or slush. Significant amounts of clear ice can form in the vicinity of the fuel tanks, both on wing upper and lower surfaces. Aircraft are most vulnerable to clear ice contamination when one or more of the following conditions exist:

a) Wing temperatures remain well below 0 °C (32 °F) during the turnaround transit.

b) Outside air temperatures between -2 and 15 °C (28 and 59 F) are experienced, although clear ice may form at other temperatures if conditions (a), (c), and (d) exist.

c) Precipitation occurs while the aircraft is on the ground.

d) Frost or ice is present on the lower surface of either wing.

NOTE: Low wing temperatures associated with clear ice normally occur when large quantities of cold fuel remain in wing tanks during the turnaround/transit and any subsequent refueling is insufficient to cause a significant increase in fuel temperature.

15.4 Critical Surfaces and Areas Not to Spray

Basically, all surfaces and parts that have an aerodynamic, control, sensing, movement, or measuring function must be clean. All of these surfaces cannot necessarily be cleaned and protected in the same conventional deicing/anti-icing manner, for example, the use of hot air may be required when deicing landing gear or propellers. Some areas require only a cleaning operation, while others need protection against recontamination from active freezing precipitation. Deicing procedures may also vary according to aircraft limitations.

Some critical elements and procedures to follow, common for most aircraft, are:

- Deicing/anti-icing fluids **shall not** be sprayed directly onto wiring harnesses and electrical components (receptacles, junction boxes, etc.), brakes, wheels, exhausts, or thrust reversers.
- Deicing/anti-icing fluid **shall not** be directed into the orifices of Pitot tubes, static ports, nor directly onto airstream direction detector probes/angle of attack airflow sensors.
- All reasonable **precautions shall be taken to minimise fluid entry** into engines, other intakes/outlets, and control-surface cavities.
- Engines: The suction, exhaust blast and propeller wash areas will move due to the effect of local wind speed and direction at the deicing location, so continuous vigilance will be required in gusting conditions.
- Fluids **shall not** be directed onto flight deck or cabin windows, as this can cause crazing of acrylics or penetration of the window seals.
- Prior to the application of deicing/anti-icing fluids, **all doors and windows should be closed** to prevent galley floor areas being contaminated with slippery deicing fluids and upholstery becoming soiled. Note that doors shall not be closed until all ice and snow have been removed from the surrounding area.
- Any forward area from which fluid can blow back onto windows during taxi or subsequent takeoff **shall be free of fluid** prior to departure.
- If Type II, III, or Type IV fluids are used, **all traces of the fluid on flight deck windows should be removed** prior to departure, particular attention being paid to windows fitted with wipers. Rinsing with an approved cleaner and a soft cloth may remove deicing/anti-icing fluid.
- Landing gear and wheel bays **shall be kept free** of slush, ice, and accumulations of blown snow.
- When removing ice, snow, slush, or frost from aircraft surfaces, **care shall be taken** to prevent it from entering and accumulating in auxiliary intakes or control-surface hinge areas. Remove snow from wings, stabilizers, ailerons, rudders, and elevators by spraying from the leading edge to the trailing edge.

NOTE: There is an exception: On aircraft with no leading edge devices (i.e., hard wing and/or propeller driven), deicing/anti-icing fluid may be sprayed from highest point of the wing surface camber to the lowest, flowing forward over the leading edge of the wing ensuring sufficient rollover, and over the trailing edge. Caution must be used to ensure fluid is not sprayed directly into any wing openings.

A flight-control check should be considered according to aircraft type (refer to aircraft manufacturer recommendations). This check should be performed after deicing/anti-icing. The intention is to ensure that flight controls have not become affected by the presence of gel residues from repeated applications of thickened fluid.

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15.5 Deicing/Anti-Icing Diagrams/No-Spray Areas

In WOM 3.2/Appendix 2 provides a comprehensive list of **Deicing/Anti-Icing Diagrams/No Spray Zones** for many different aircraft types. It is recommended that these are consulted by all deicing operators to verify the specific requirements for the aircraft being treated.

15.6 Proximity Sensor Activation Reporting Procedure

Refer to WOM 3.1.6.8.20 "Proximity Sensor Activation Reporting Procedures"

15.6.1 Communication for Proximity Sensor Activation by Physical Contact

Refer to WOM 3.1.9.1; WOM 3.3.4.2.2.1, and ICAO Doc 4444 ATM/501 12.7.2.3.

15.6.2 Training Requirements for Ground Crew

15.6.2.1 Check Requirements

Should contact occur, a trained/qualified individual other than the ground crew member involved in the occurrence, will be required to visually inspect for damage.

The individual shall perform the check from a viewpoint where they can closely and clearly observe the affected area. This may require the use of a raised platform; optical device (i.e., binoculars); and/or additional lighting.

The check will require the proximity sensor to remain in position on the aircraft, and once the affected area is identified, the proximity sensor will be moved away from the aircraft.

The individual will check for the following and report as per WOM 3.1.6.8.

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SECTION D: SPECIAL ASPECTS OF AIRCRAFT DEICING/ANTI-ICING OPERATIONS

16 TE16: SAFETY PRECAUTIONS AND HUMAN FACTORS

16.1 At the end of this section, the trainee should be able to describe in detail:

- The definitions of hazard and risk.
- The sources of hazard during deicing/anti-icing operations and their mitigation.
- The need for personal safety, awareness, and protection.

16.1.1 The Definitions of Hazard and Risk and the Management of Safety

It is important to understand that there are well defined methods for the management of safety at an airport. The key to this is to understand the difference between a hazard and the risk to staff and operations that the hazard may present. The definition of these two terms is given here as:

- Hazard: Anything may cause harm to people (staff) or damage to property (for example, an aircraft).
- Risk: The probability that the hazard will result in this harm or damage.

For example, standing close to a lion may be considered hazardous – the lion may attack and injure you. However, standing close to a lion in a zoo is usually not hazardous, as lions are kept in cages with iron bars to prevent any contact with people. The hazard is present in both cases (the lion is the same in both cases), but in the second case, the risk is very low (the lion is contained in an iron cage). The purpose of any safety management system is to understand and appreciate the hazards of the operations, and then to introduce procedures and protective methods to lower the risk to acceptable levels. Safety management therefore relies upon carrying out risk assessments on identified hazards to reduce the risk for the potential for harm or damage to acceptable levels.

16.1.2 The Sources of Hazard During Deicing/Anti-Icing Operations and Their Mitigation

In addition to all of the normal hazards to be found at an airport, deicing and anti-icing operations present some further hazards that must be managed effectively.

16.2 The Use of Chemicals in Deicing/Anti-Icing Fluids

There are three main types of chemicals used in the manufacture of deicing/anti-icing fluids.

a) PG is available as Industrial and USP/EP (Pharmacopeia) grades. Industrial grade PG is used in the manufacture of fully formulated fluids that meet AMS1424 or AMS1428. When used in accordance with the manufacturer's Safety Data Sheet (SDS), taking the proper precautions and using recommended personal protective equipment, if required, PG presents little to no risk to the user. All handling of PG-based fluids should be done in accordance with the manufacturer's SDS or product information bulletin (PIB).

b) Industrial grade EG is used in the manufacture of fully formulated fluids that meet AMS1424 or AMS1428. Only high-dose EG exposures by ingestion (oral route) have been associated with toxic effects; oral exposure is not likely during deicing operations. When used in accordance with the manufacturer's SDS, taking the proper precautions and using recommended personal protective equipment, if required, EG presents little to no risk to the user. All handling of EG-based fluids should be done in accordance with the manufacturer's SDS or PIB.

c) All deicing/anti-icing fluids contain a range of other chemical additives that help prevent corrosion, allow the fluid to spread evenly and in the case of thickened fluids, to thicken the layer of glycol on the aircraft and create the desired property of a suitable holdover time. These additives will vary in nature from one fluid manufacturer to another and the relevant safety data information must be consulted to understand and manage any potential hazards. It should be recognised that while these additives are only present in minor quantities (1 to 2%) compared to the freezing point depressant, propylene glycol or ethylene glycol, they can contribute to the aquatic toxicity of the deicing/anti-icing fluid. All handling of fluids should be done in accordance with the manufacturer's SDS or PIB.

Most deicing/anti-icing fluids are based on the above chemical types. As they are all mainly mixtures of glycol and water, there is no flammability hazard. There may be some potential for slippery surfaces around an aircraft that has been treated with these materials. However, glycols are not oily substances, and do not give a very slippery surface. Instead, they can be treated similarly to the slipperiness of surfaces wet with water.

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16.3 The Use of Deicing/Anti-Icing Spraying Equipment

Descriptions of the typical types of deicing vehicles is given in section 12 "TE12: Deicing/Anti-Icing Equipment Operating Procedures" on page 30 of this Appendix. The operation of these vehicles presents a number of hazards that must be assessed and managed:

- The vehicle should be checked for complete operational readiness according to the manufacturer's instructions before use.
- These vehicles will be driven in close proximity to aircraft in order to carry out the deicing/anti-icing functions. The potential for the vehicle or its boom to make contact with the aircraft must be minimised. Driving the vehicle around the aircraft with the boom raised should not be done.
- While driving close to the aircraft, there is the potential for jet blast from the aircraft engines. This is a particular hazard for open-basket vehicles.
- The presence of winter conditions means that visibility is likely to be poor due to darkness and any precipitation at the time.
- Vehicles that use a combustion heater to raise the temperature of the fluids cannot be operated in confined or poorly ventilated areas due to the hazard of asphyxiation.

16.4 Hazards for Personnel

The process for deicing/anti-icing aircraft is still very dependent on human operators and involves extensive manual operations outdoors in difficult weather. The use of personal protective equipment (PPE) to reduce the risk of various operational hazards is unavoidable. Such PPE includes:

- For working at heights, fall protection equipment such as harnesses or lanyards.
- To avoid burns from hot fluids or contact with chemicals, the use of suitable gloves, face shields, and protective suits are recommended.
- Protective suits also guard against the cold of winter conditions, and suitable reflective areas should be part of the suit design.
- Hearing protection may be required around the aircraft.
- Protective safety footwear should be used.

If the operator is using an open-basket vehicle for the deicing/anti-icing, then they may be subject to a mist of glycol-based fluid. In addition, operators may be subject to fatigue or cold which may impair their ability to judge situations safely. Procedures should be in place to minimise the potential hazard of such situations.

16.5 Human Factors

The deicing/anti-icing process is constantly subject to the potential danger of human error. Proper training and qualification are not an automatic confirmation of the need for a committed professional approach toward the deicing operation. This requirement is basic for both for flight crew and ground crew. There should be a clear procedure of conduct in case of any incidents or accidents. Records should be kept, even for small incidents, so they could be analyzed and form the basis of better procedures. A professional attitude in all conditions, operation, and weather elements is the key to complement proper training. In addition, operating under winter conditions in a safety-critical role requires suitable breaks in the work carried out to ensure personnel remain capable and alert at all times.

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17 TE17: ENVIRONMENTAL IMPACT AND MITIGATION

17.1 At the end of this section, the trainee should be able to describe in detail:

- The meaning of some of the methods used to gauge environmental impact.
- The potential environmental impact of deicing/anti-icing fluids.
- Some of the methods that are used to manage the environmental impact of deicing/anti-icing fluids.

17.1.1 The Meaning of Some of the Methods used to Gauge Environmental Impact

The use of deicing and anti-icing fluids to provide the safety critical clean aircraft during winter operations does result in quantities of glycol effluent from the operations.

- Type I fluids are typically supplied at 80% or 92% glycol, and diluted to the concentration required but are also available in ready-to-use forms.
- For Type II and Type IV fluids, these fluids are typically 50:50 mixtures of glycol in water as supplied. This 50:50 mixture is called a 100% product. It can then be diluted further to 75:25 with water (a mixture that is then about 37.5% glycol) or to a 50:50 dilution with water (which is then about 25% glycol).

Although these products can be diluted before use, the quantities of glycol used at any airport may be large due to the number of aircraft to be treated. All qualified fluids are assessed for basic environmental impact data during the process of qualification. Aerospace material specifications AMS1424 and AMS1428 Fluid list the tests further discussed in this section.

17.1.2 Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD)

Bacteria and other micro-organisms use carbon-based chemicals as food. Glycols are alcohols, namely diols (two alcohol groups), that are readily utilised by micro-organisms to grow. The consumption of these chemicals in turn also requires oxygen as part of the metabolic process. Therefore the measure of how easily biological organisms turn glycol and oxygen into biochemical energy for the organism is called the **biochemical oxygen demand (BOD)**. The measurement of this number can give a variable value, as the test relies on a biological entity or mixture of entities (which can vary from lab to lab and over time), a sufficient supply of oxygen which may not always be the case, particularly for highly concentrated organic materials and a nutrient mix that can vary in composition. However, the test does give at least a good indication if the material tested is easy or difficult to degrade.

It is also possible to oxidise a test material by chemical means. Potassium dichromate is a very strong chemical oxidizing agent, and will break down most organic chemicals such as glycols very quickly. This is a more complete and predictable way to determine the oxygen required to break down the test chemical, as the reaction is free of the variability of the living systems used for the BOD measurement. This chemical method is used to measure the **chemical oxygen demand (COD)**.

To summarise, the two test methods give the following measure of degradability of test chemicals:

- BOD: the typical biochemical degradability of the test chemical in real world conditions as measured through oxygen uptake.
- COD: the expected oxygen demand if the chemical is completely degraded under forcing conditions.

17.1.3 Biodegradability

The ratio of BOD to COD is normally quoted as a measure of the ready biodegradability of materials which is likely to happen in the real world. Although there is no specification for this measure of ready biodegradability, most deicing/ anti-icing fluids are readily biodegradable to more than 30% over a 5-day period. This ready biodegradability is due to the glycols being nutritious and nontoxic for micro organisms.

17.1.4 Aquatic Toxicity

Fluids are also tested in accordance with EPA 40 CFR 797.1300 and 794.14, revised July 1, 1989, or OECD (Organization for Economic Cooperation and Development Guidelines for Testing of Chemicals), methods 202 and 203 using test species required by regulatory agencies for permitted discharges. Examples include fathead minnows, daphnia magna and rainbow trout. The LC50 concentration (the highest concentration at which 50% of the organisms do not survive the test period) is determined and stated in milligrams per liter. Again, there are no pass/ fail criteria for these measurements, but the method may allow the comparison of one fluid with another.

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17.2 The Potential Environmental Impact of Deicing/Anti-Icing Fluids

17.2.1 Water Courses

The measures of biodegradability in WOM 3.2/17.1.3 are discussed with reference to the use of oxygen to oxidise carbon-based materials into carbon dioxide. Should quantities of glycol-based aircraft deicing/anti-icing fluids find their way untreated into watercourses, then the progression of this biodegradation will lead to oxygen being taken out of the water. In the short term, before the oxygen is replenished, this low oxygen level may cause fish and other aquatic creatures to asphyxiate. In the longer term, the biological species that proliferate as they receive this feedstock may also upset the natural balance of the watercourse.

17.2.2 Aquatic Creatures

The aquatic toxicity described above does give an indication of the potential threat to aquatic creatures. However, as most deicing/anti-icing fluids are mainly propylene or ethylene glycol, the depletion of oxygen from the watercourse (streams, ponds, rivers) is the dominant consideration.

17.3 Mitigating the Environmental Impact of Deicing/Anti-Icing Fluids

As the main chemical component of deicing/anti-icing fluids is the propylene or ethylene glycol, various ways have been adopted to minimise the impact of glycols on the environment. These include:

- Containing the glycol and disposal of this as chemical waste. By setting aside specific areas in which to deice and anti-ice aircraft, these areas allow concentrated streams of glycol waste to be collected. For example, the use of a deicing pad with underground storage tanks allows the gravity fed capture of the glycol waste stream, and also the easy recovery of the material by pumping and transport of this waste for disposal.
- In addition, there is equipment available that is able to vacuum up the spent glycol-based fluid off the airport tarmac or runway to store in suitable tanks for further treatment.
- Allowing the spent fluid to wash into treatment ponds has also been done. These can feature either activated sludge technology or reed bed growth to allow the biochemical oxidation of the fluids with minimal impact on external watercourses. Any water then discharged from this treatment is usually free of any BOD burden.
- The potential for recycling the spent glycol is also being done by various companies. Instead of simply treating the dilute glycol material as a waste stream, it is possible to concentrate the glycol by filtering the material and stripping out water on or near to the airport, followed by distillation of the glycol to achieve a purity comparable to freshly manufactured material. While this can be done, there are a number of complicating factors, including the concentration of the glycol in any waste stream (too little may make the cost of recycling more than the value of the glycol recovered) and the purity of the chemical stream recovered. For example, if ethylene glycol and propylene glycol are both used at an airport, or other runway deicing chemicals, the recovery process may become too complicated to perform adequately. However, regulatory changes have been used in some regions of the world to incentivise the recovery of glycols by the better planning of all operations.

In addition to the general methods above, it is important to realise that as most deicing/anti-icing operations are carried out in winter conditions, then freezing precipitation of any sort combined with freezing point depressants will continually act to produce waste glycol streams that are much more dilute than any concentration of fluids used to treat the aircraft. In addition, some further helpful information on environmental considerations is contained in ARP5660 Section 5.

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18 TE18: DEICING FACILITY OPERATION

18.1 At the end of this section, the trainee should be able to describe in detail:

- The special needs of a designated deicing facility.
- The need for agreed and practical management plans and coordination to ensure safety and effectiveness.

18.1.1 Designated Deicing Facilities (DDF)

ARP5660 establishes the minimum recommended practices for the standardisation of operational procedures at Designated Deicing Facilities (Central Deicing Facilities/Remote Deicing Facilities), to ensure the safe operation of aircraft, equipment and personnel during ground icing conditions. Operating a DDF is in most cases the joint effort of several parties, including facility operators, airport authorities, air traffic control, apron control, etc. To help ensure the safe operation of a DDF it is recommended that parties manage this joint effort in such a way that possible conflicts or misunderstandings that may hamper a safe and efficient operation are reduced. This can be achieved by organizing regular and ad-hoc meetings to harmonise the operational and managerial policy and for information exchange.

18.1.2 Management Plan

Due to the need to coordinate numerous organizations and people, the key requirement for the successful and safe operation of a DDF is the need for a management plan. This management plan should address the following:

- Deicing personnel.
- Pilots and air operators for operation of the aircraft while at the DDF, including basic aircraft operation and complying with the procedures at the location. The Pilot in Command will always have final responsibility for the safety of the flight.
- Facility operators and/or deicers for handling of the aircraft at the location, maintenance of the deicing equipment and facilities.
- Airport authorities for constructing and maintaining the deicing locations including infrastructure for the vehicles.
- Air Traffic Control for guidance of aircraft to and from the DDF.
- Airport deicing management organisation.
- Pre-authorisation for deicing services between carriers and service provider and airport authority.

The responsibilities of all parties can be documented in a memorandum of understanding (MOU) containing an overview of the total operation. This should include items such as a description of the infrastructure, a process model, communication structure, publication strategy, dissemination of information, and logistic support. The following should be addressed and defined in a DDF operations plan:

- General.
- Equipment.
- Approved aircraft types.
- Apron management coordination.
- Movement of aircraft to the pad.
- Aircraft movement.
- Vehicle movement.
- Pad configuration.
- Engines-On deicing operations.
- Procedures – jet powered aircraft.
- Procedures – propeller driven aircraft.

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19 TE19: OPERATIONAL QUALITY MANAGEMENT, AUDIT FINDINGS, AND UPDATING PROCEDURES

19.1 At the end of this section, the trainee should be able to describe in detail:

- The need to continually improve the operational performance for aircraft deicing/anti-icing.
- The principles of Quality Management and the main concepts of WOM 3.4.
- The need for updated procedures and training.

19.1.1 The Need to Continually Improve the Operational Performance for Deicing/Anti-Icing

Deicing and anti-icing operations for aircraft are subject to changes by many different influences, including:

- The time between the end of one deicing season and the start of another, leading to the need to deliver refresher training before the next winter season begins.
- Changes in equipment, fluids or processes that may take place at an airport.
- Changes to local or federal regulatory or industry practices.
- Changes in personnel carrying out the deicing/anti-icing.
- Learning from the previous winter season incidents or accidents locally or globally.

While these bullet points list in a general way some of the changes that may influence the smooth running of deicing/anti-icing operations over time, it is important that there is a systematic approach that **ensures all changes and opportunities for improvement** are captured in updated working procedures. This need to continually improve is the principle behind quality management.

19.1.2 The Principles of Quality Management and the Main Concepts of WOM 3.4

The basic concepts of quality management are set out in ISO 9001 and AS9100, summarised in two main points:

- The need to demonstrate and consistently provide a product or service that meets customer and applicable regulatory requirements.
- Aims to enhance the product or service through effective systems and processes for continual improvement.

For aircraft deicing and anti-icing, the safety critical nature of this work requires complete conformance to the principle of the clean aircraft concept. It involves both conformance to this standard of operation, and continual improvement in line with the principles of quality management plus the current revisions of the SAE standards. ISO 9001 and AS9100 further defines the general areas that should be covered to ensure conformance to the principles of quality and these will be used to define the sections with respect to deicing/anti-icing operations.

These include:

- Quality system, documentation and control of records.
- Management responsibility.
- Resource management.
- Product realisation.
- Measurement, analysis, and improvement.

The details and instruction of how to operate quality management with regard to the ground deicing/anti-icing operations for aircraft will not be described here. They are fully covered in WOM 3.4. It is expected that WOM 3.4 shall be read and understood by the trainer to ensure that the local management commitment, procedures and instructions reflect the content of this document. Although the above description of a quality management system (QMS) outlines the terms and definitions of a quality system, each individual deicing service provider will need to find the right level of accountability, documentation and systems review for the effectiveness of their operations.

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19.1.3 The Need for Updated Procedures and Training

WOM 3.4 sets out the need for the continual improvement of aircraft deicing/anti-icing operations. This is summarised in Figure A15.

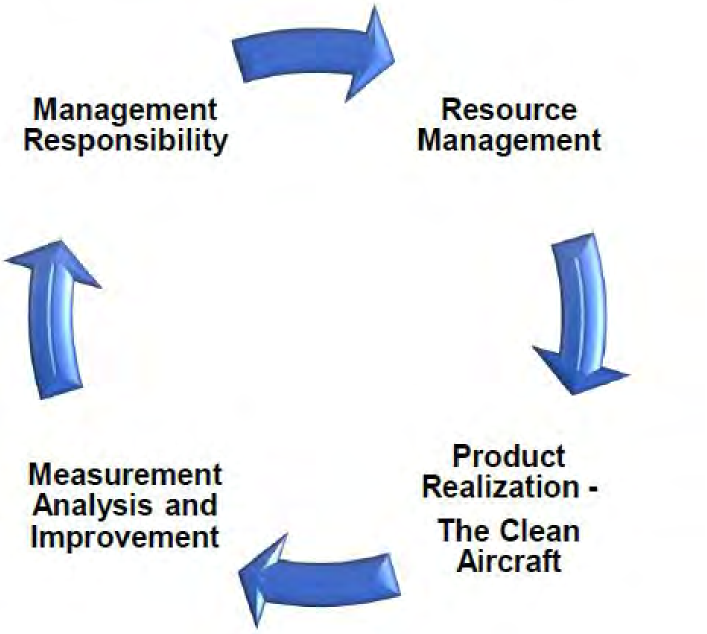

Figure A4. Management of quality as a continual process.

The key parts of this process include:

a) **Management responsibility**: Senior management shall provide evidence of its commitment to the development and implementation of a suitable management system for the effective deicing/anti-icing of aircraft. Senior management shall review the organisation's (QMS) at planned intervals to ensure their continuing suitability, adequacy and effectiveness.

b) **Resource management:** The deicing service provider shall determine and provide the resources needed to implement and maintain the safety of these services, and to continually improve their effectiveness.

c) **The clean aircraft:** The aircraft deicing service provider shall plan and develop the processes needed to deliver the clean aircraft free of any frozen contamination on every occasion.

d) **Measurement, analysis, and improvement**: Due to the safety critical nature of the deicing/anti-icing processes delivering clean aircraft on every occasion, there is a need to demonstrate the correct effectiveness of the service provided, and for the continuous improvement of its effectiveness. The outcome of this step provides the information necessary for senior managers to review the effectiveness of their QMS in (a).

One practice vital to the correct functioning of this process can be achieved by means of an end of season review. The review should be carried out by senior managers, based upon the feedback from the operations during the winter season. The input to this management review shall include information on:

- The results of audits, both internal and external;
- Customer feedback as appropriate;
- Process and product conformity;
- Status of corrective and preventative actions;
- Accident/incident/irregularity, in terms of investigation, corrective action, and continuous improvement;
- Follow up of previous management reviews.
- Recommendations for improvement.

The output of management review shall include any decisions and actions related to:

- Improvement of the effectiveness of the systems and processes;
- Improvement in the delivery of the effectiveness of these processes;
- Any recommendations to the impact of these on resource needs,
- An updated ground deicing program, policies, and procedures.

The end-of-season review provides a means of formally closing out the season, assessing the effectiveness of the operations for the season, determining the need for further resources and training, updating of procedures with the opportunities for enhanced safety and efficiency, and using the process to demonstrate management commitment to improve the operations for the next season.

20 TE20: LOCAL RULES, RESTRICTIONS, AND AIRPORT PROCEDURES

20.1 At the end of this section, the trainee should be able to describe in detail:

- The way in which the local rules, restrictions, and procedures conform to the SAE global deicing standards.
- The special requirements of the local situation that may require local experience and procedures to supplement or assure conformance with the “clean aircraft” concept.

20.1.1 Local Rules and Procedures Confirming to the SAE Global Deicing Standards

It is expected that any airport where aircraft ground deicing procedures are carried out can show their operations can conform to the SAE global aircraft ground deicing standards:

AS6285 Aircraft Ground Deicing/Anti-Icing Processes

AS6286 Training and Qualification Program for Deicing/Anti-icing of Aircraft on the Ground

AS6332 Aircraft Ground Deicing/Anti-Icing Quality Management

ARP1971 Aircraft Deicing Vehicle - Self-Propelled

ARP5660 Deicing Facility Operational Procedures

WOM 3.3 Aircraft Ground De-/Anti-Icing Communication Phraseology for Flight and Ground Crews

WOM 3.1 Aircraft Ground Deicing/Anti-Icing Processes

WOM 3.2 Aircraft Ground Deicing/Anti-icing Training and Qualification Programme

WOM 3.4 Aircraft Ground Deicing/Anti-Icing Quality Management

In addition, the following standards support the information in the global deicing standards:

20.1.2 The Special Requirements for the Local Situation

This WOM 3.2 standard has set out to describe the training and qualification process for personnel involved in various roles concerned with the ground deicing/anti-icing of aircraft. While this training and qualification is supported with guidance in Appendices 1 and 2, there are other instructions and guidance available in other SAE Standards that are mentioned in this text. However, it is not possible to prescribe all possible documentation, systems and processes for any particular airport operation. For example, the extent of the documentation can differ from one organisation to another due to the size of the organisation and types of activities, the types of equipment in place, the complexity of their processes and interactions and the competence of the personnel.

It is ultimately up to the trainer to tailor the required training to the local situation and audience, although it is expected that the local processes and procedures will be congruent with the SAE standards and the best practice guidance that these contain. Conformance to the principle of the “clean aircraft concept” must be the basis of all ground deicing/anti-icing of aircraft in winter conditions.

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APPENDIX 2 AIRCRAFT DIAGRAMS AND NO-SPRAY AREAS

0 ADF APPLICATION – NO-SPRAY-ZONES

0.1 Diagram Symbols

Thin hoarfrost is acceptable on the upper surface of the fuselage proved all vents and ports are clear. Thin hoarfrost is thin enough to distinguish paint lines, markings or lettering.

Coating of frost up to 1/8th inch (3 mm) in thickness on the lower wing surfaces caused by cold fuel in the wing tank areas between the front and rear spar is permissible. However, all leading edge devices, control surfaces, tab surfaces, upper wing surfaces and balance bay cavities **MUST** be free of ice, snow, slush or frost.

Engine intake **MUST** be free of all contaminants and engine fan blades **MUST** freely rotate.

Engine intake **MUST** be free of all contaminants and engine fan blades **MUST** freely rotate. Fuselage **MUST** be inspected prior to engine start when conditions warrant.

Propellers must be free of all contaminants before engine start.

Do not apply undiluted Type II, III or IV fluids forward of the front cabin entry door. Do not apply to windshields or windscreens.

Check upper wing surface to confirm that ice is not present. A physical check (tactile inspection) **MUST** be conducted on the wings upper surfaces at inboard end of wing fuel tank and/or other areas as specified by the aircraft manufacturer. Specific Airworthiness Directive requirements may apply.

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0.2 Diagram Icons

Do not spray into engine openings.

Do not spray into engine exhaust.

Do not apply Type II, Type III or Type IV to radome.

Do not spray directly at flight deck windows/windscreen.

Do not spray directly at main deck cabin windows or doors.

Do not spray directly at or into pitot tubes, TAT probes, angle of attack vanes or other data sensing devices/probes/tubes.

Do not spray directly at static ports.

Do not spray directly at or into aircraft intake or exhaust vents, ram air inlets, scoops, drains, outlets or pressurized outflow valves.

Apply deicing fluids at angles below 45 degrees.

Do not spray into avionics vents.

Do not spray directly at aircraft wheels, brakes, oleo struts, mechanisms and switches.

Do not spray into APU inlet.

Do not spray into APU exhaust.

Do not spray onto heat exchanger ventilation grid located on engine pylons.

Do not spray onto propeller blades.

Clear Ice Check (Tactile Check) required prior to deicing and may be required as part of post deicing Check.

Do not direct fluid spray onto the hinges or bushings of folding wing devices, as this can cause lubricants to be washed away. Overspray is allowed

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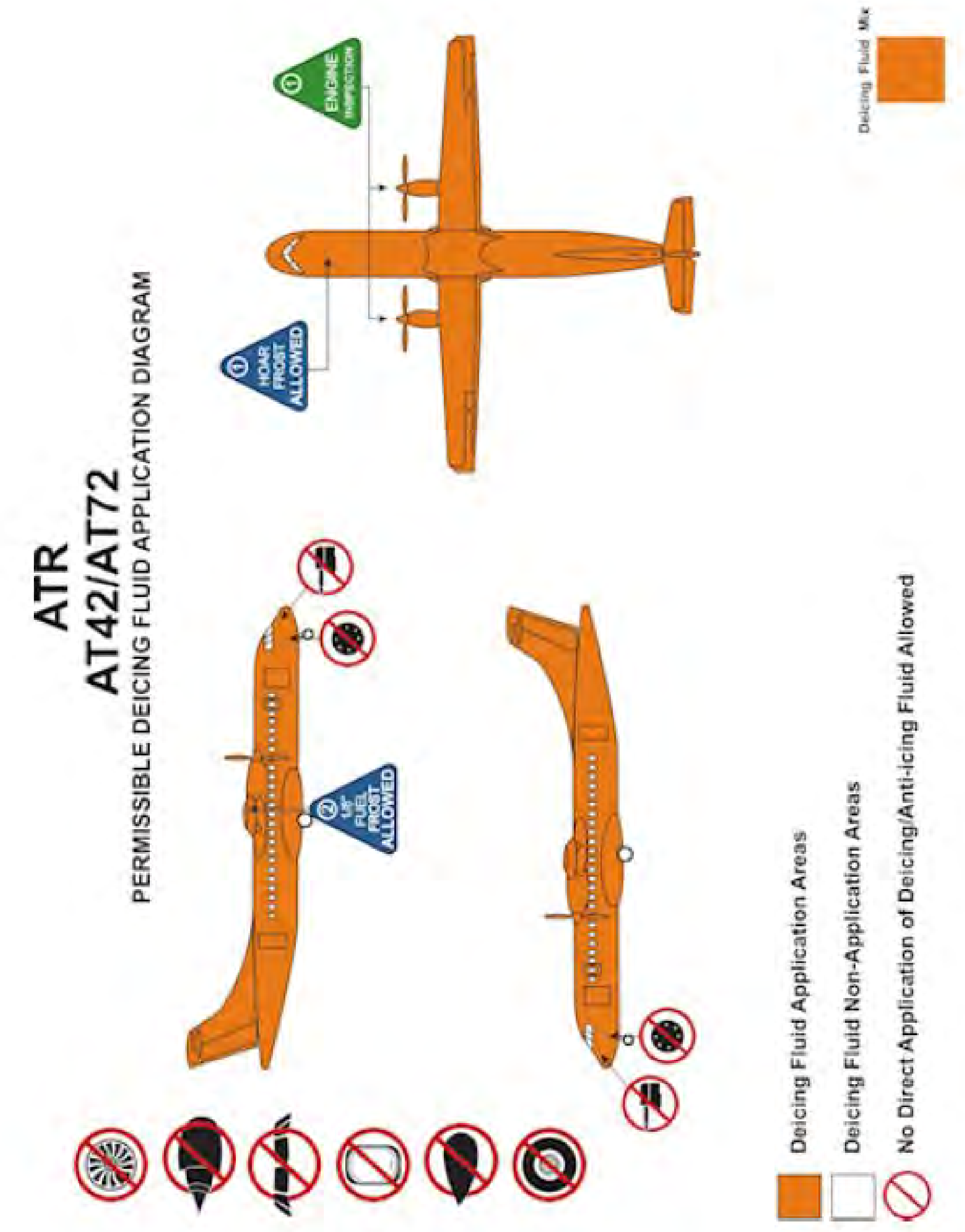
0.3 ATR 42/ATR 72



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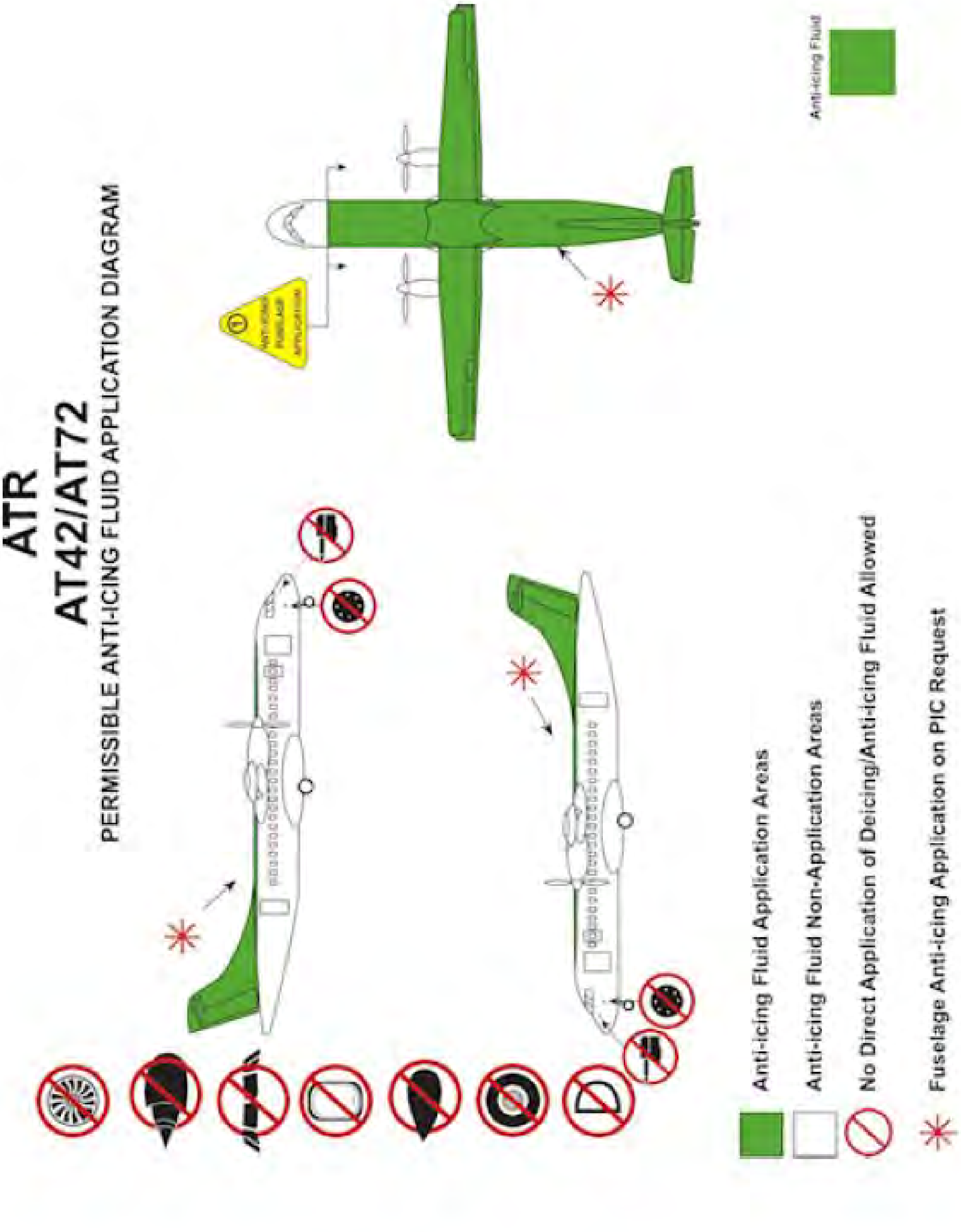
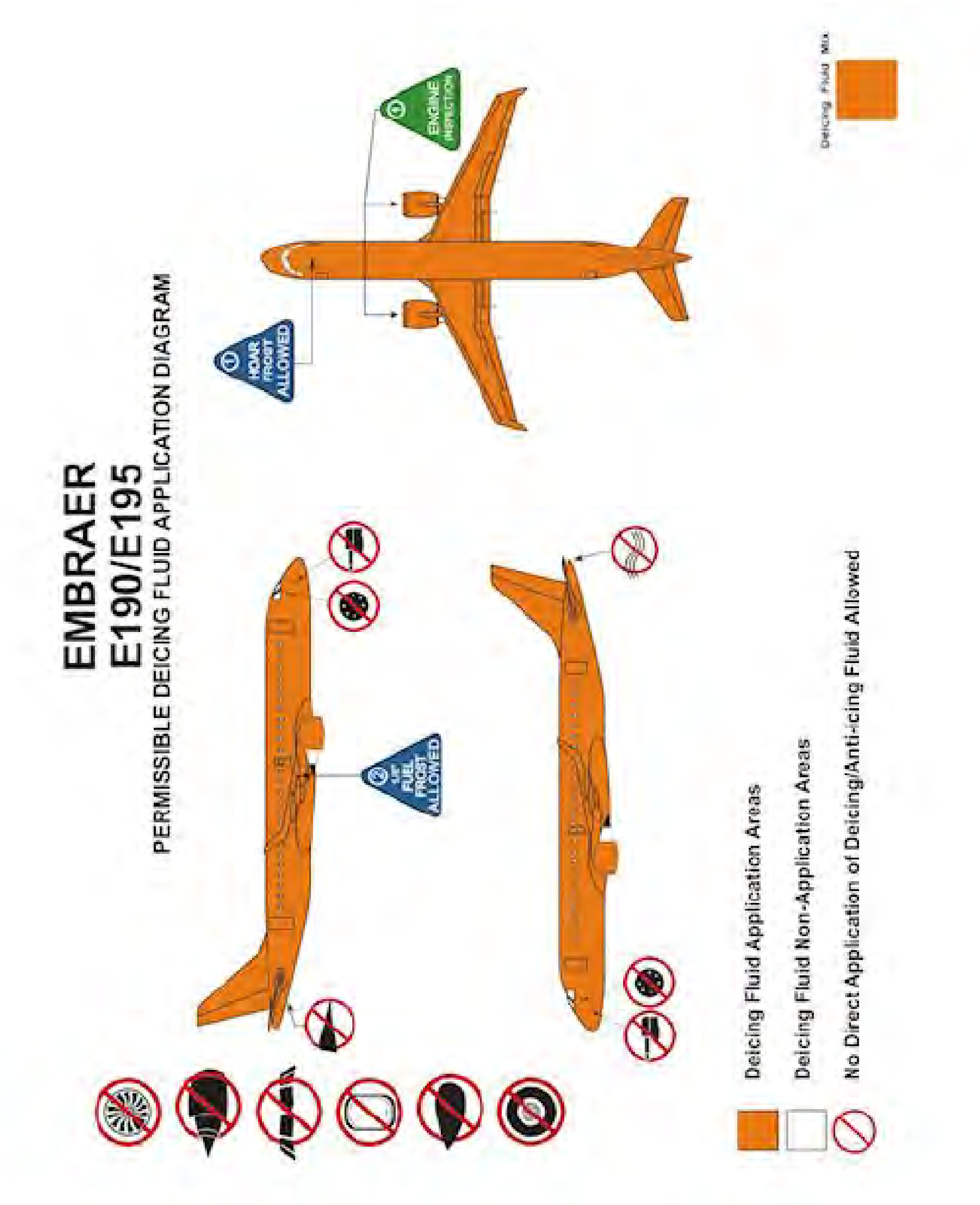
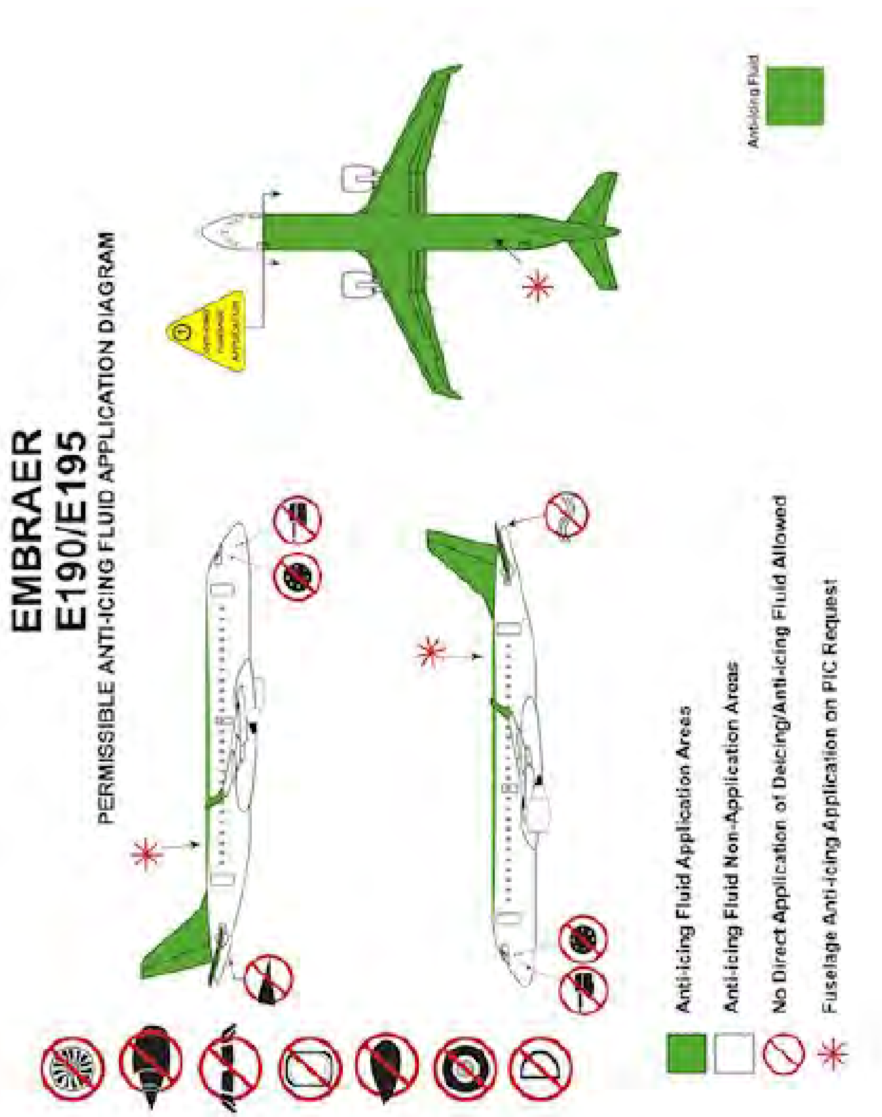

ATR
AT42/AT72
PERMISSIBLE ANTI-ICING FLUID APPLICATION DIAGRAM
Anti-icing Fluid
Anti-icing Fluid Application Areas
Anti-icing Fluid Non-Application Areas
No Direct Application of Deicing/Anti-icing Fluid Allowed
Fuselage Anti-icing Application on PIC Request

0.4 Embraer E190/E195




EMBRAER
E190/E195
PERMISSIBLE ANTI-ICING FLUID APPLICATION DIAGRAM
Anti-icing Fluid
Anti-icing Fluid Application Areas
Anti-icing Fluid Non-Application Areas
No Direct Application of Deicing/Anti-icing Fluid Allowed
Fuselage Anti-icing Application on PIC Request

1 BACKGROUND INFORMATION

1.1 Aircraft Types

1.1.1 Consideration of Aircraft Variations

The deicing/anti-icing procedures can in general be performed according to standard recommendations. However, there are some variations between aircraft, companies, airports and regulations related to a typical A/C scenario. All aircraft related limits shall be taken into account and the differences informed to the deicing crew. The application of deicing/anti-icing fluid shall be in accordance with the requirements of the airframe/engine manufacturers. The winter operation plan should reflect the particular airport and the aircraft it serves (e.g., passenger traffic, cargo, and business). There are also a wide variety of aircraft to consider (e.g., small transport, medium-large transport, business jets, propeller aircraft, etc.) when providing guidelines for the operation. It is impossible to introduce (and remember) each aircraft type and its particular limitations so a more general approach is in place. It is up to the airline to provide special instructions of procedures if they deviate from normal.

1.1.2 Aircraft No-Spray Areas in General

Basic areas of caution when deicing/anti-icing are engine-inlets, APU inlet/exhaust, windows, doors/seals, brakes/ landing gear, vents, probes, sensors, cavities and any opening where sprayed fluid is not allowed. Additionally, composite parts may have their own limitations regarding deicing fluids and temperatures, such as composite propellers. There are many variations but these general areas shall be avoided whenever possible. Some splashes of fluid and fluid drained cannot be avoided but direct spray on these parts is not allowed. Areas where fluid is allowed to be sprayed (e.g., the radome), but from where fluid flow-off can cause some problems (e.g., fluid flowing from the nose section on the windows during takeoff), should be noted and the procedure should be discussed together with the flight crew. The reasons why these areas are restricted and the consequences of what might happen if glycol/ fluid is sprayed should be understood. Such incidents may be that sensors give false readings, engine and APU produce smoke inside the aircraft via the air intake (or break), glycol may stick on heated cockpit windows causing restricted view for the flight crew, etc.

1.1.3 APU

The APU is critical for deicing fluid and no spraying shall be directed towards the inlet or exhaust. There have been a number of cases where the APU has been destroyed due to deicing fluids and some aircraft have restrictions of use during deicing. The procedure for each case must be clear and general avoidance shall be noted. Engines are normally shut down but may remain running at idle during deicing/anti-icing operations. Air conditioning and/or APU air shall be selected OFF, or as recommended by the airframe and engine manufacturer. All the preparations should be performed beforehand so the deicing/anti-icing operation is not interrupted. Proper communication shall be established so the procedure can be performed accordingly. Aircraft in general have their APU situated in the aft tail section. The APU intake can be on either side of the tail as well as the exhaust. Older design (and some eastern production) can have the APU located in the landing gear section under the wing/fuselage and the exhaust directed through the wing or the wing root. The air-conditioning is usually in operation whenever the APU is. This can cause glycol to be sucked in the air system and thus produce smoke inside the cabin. The flight crew shall be informed before the start of the deicing so they can make the appropriate adjustments.

1.1.4 Jet Aircraft Versus Propellers

Normal jet-engine aircraft are perhaps the conventional aircraft to deice/anti-ice. Even so, many propeller aircraft perform a variety of flights and need deicing/anti-icing just as any other aircraft. The procedure in itself does not vary because of engine differences. The wings, tail and fuselage are treated the same way. There may be differences on what sort of anti-icing is allowed (thickened fluid) or how the anti- icing fluid affects performance. The propellers may have some requirements on how to deice or simply to avoid deicing. Note that the deicing check also includes the propellers. Propeller aircraft are generally treated at the stand because rotating propellers cause a hazard. If the procedure is performed at a remote area, appropriate procedures shall be established and engine shutdown/start-up procedures (if performed) shall be well known. Some propeller aircraft have the possibility to stop the rotation of the propeller for a limited time (prop-brake). If the deicing/anti-icing is performed and engines are started, whether it is on a remote or at stand, the correct sequence shall be known and communicated. The aircraft is said to have a left-hand and a right-hand side according to the captain's view forward. The engines are also numbered according to the captain's view starting from left to right (number one on the left-hand side and number two on the right-hand side

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for a twin-engine A/C). The correct communication shall be used when performing this kind of deicing/anti-icing operation.

1.1.5 Aircraft Ice Detection and Prevention Systems

Aircraft have a wide variety of anti-icing or deicing systems while in-flight. The protective systems are, however, not in use during the ground stop. Areas and systems protected by the aircraft can be the wing leading edges, the tail (vertical and horizontal) leading edges, engine inlet leading edges, probes, ports, tubes, antennas, propellers, cockpit windows even upper surfaces of the wing (tank area mainly). The main anti-icing system used is electricity and heated air taken from engines. Propeller aircraft and some equally sized jets use so-called deicing boots. These boots do not prevent the ice from forming but they remove it after it has formed. The systems must be generally understood and the limitations noted.

As an example, the wing leading edge can be heated during flight from the engine outwards but the leading edge between the wing root and the engine may in some cases not be heated. This difference shall be noted when checking the aircraft for ice. The same issue is relevant for the tail section where there may in some case not be any heating at all on the leading edges. The propellers are also not protected for the whole length and it shall be checked accordingly. The engine inlet leading edges are heated during flight but not on ground. This shall be noted when cleaning and checking the aircraft. All static ports and pitot tubes including other probes and sensors shall be free from ice before takeoff. Note that the engine inlet also contains some probes that should be checked. These systems give relevant information for the flight and are in some cases electrically heated (depending on aircraft type and options used), but they do not perform correctly unless clean. Some wings are protected from freezing with a heated cover (usually tank area). This area can, however, be iced up if the melted precipitation has frozen overnight when the system has not been in use. Note that if the wing heating is used during the ground stop/taxi (e.g., some business jets), the viscosity of the thickened fluid used can be degraded due to the excess heating of the fluid.

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1.1.6 Common Aircraft Types and Design

Aircraft can be designed in different ways and in different sizes to serve certain needs for some particular operation. As an example: commuter aircraft have some limitations and requirements on short-haul routes with short runways and turn-arounds, cargo aircraft have requirements on weight carried and thus size of aircraft, airliners have variable requirements and limitations extending from fuel burn, range, noise limitations to passengers carried. Business aircraft have in general speed, cost efficiency and easy access of operation as a requirement. All elements are considered for each customer and the result is a variety of aircraft in operation. Notable variables, other than size, can be low-wing versus high-wing design, wing mounted engines versus fuselage mounted engines, propeller A/C versus jet A/C, etc. Major aircraft manufacturers are currently Airbus and Boeing, dominating the market. Eastern production, containing a variety of Antonov, Tupolev, Ilyushin, and other designs. Smaller sized/mid-sized aircraft vary from, e.g., BAe, Embraer, EADS ATR, Fokker, Bombardier, Saab, etc., and business jets have a large variety of aircraft available.

The aircraft even named differently and of different shape and size, have a general concept of design and function. These parts on the aircraft are named alike and refer to the same controls, etc. Here is an example of an imaginary aircraft, for an airline, of conventional design and medium size. The parts listed here are for reference only and do not mean that each aircraft should have the same systems and controls.

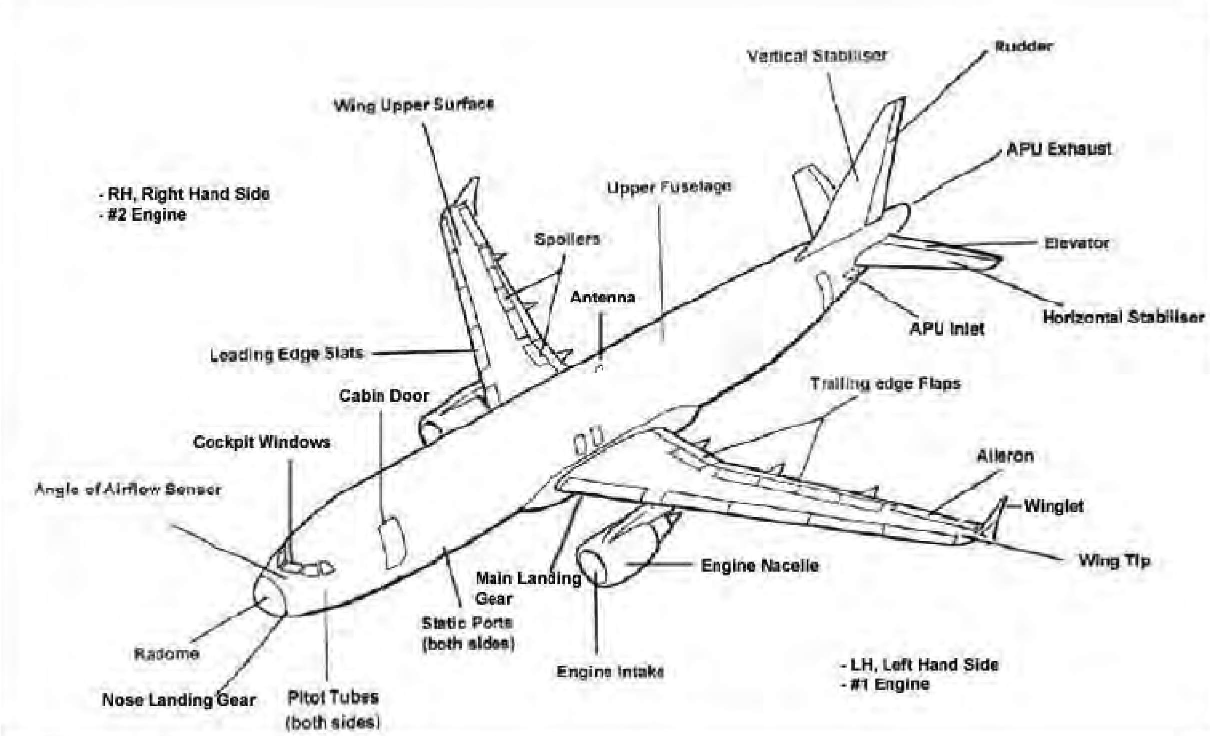


Figure B1 - Aircraft controls and description

1.1.7 Precautions with Aircraft Turn-Around

It must be noted that many airlines and companies have their special requirements on deicing procedures and checks. Many of these requirements are based on mandatory manufacturer or regulator requirements but there are also company-based limitations. The limitations and requirements can be such as a mandatory hands-on check for contamination on wings and leading edges or positioning of elevator before the start of anti-icing. Some companies may have adapted these procedures even if there is no mandatory requirement. Performing preventive deicing/anti-icing on aircraft for a turn-around must be based on mutual understanding and communication. No deicing operation can be performed without permission from the airline and flight crew (commander).

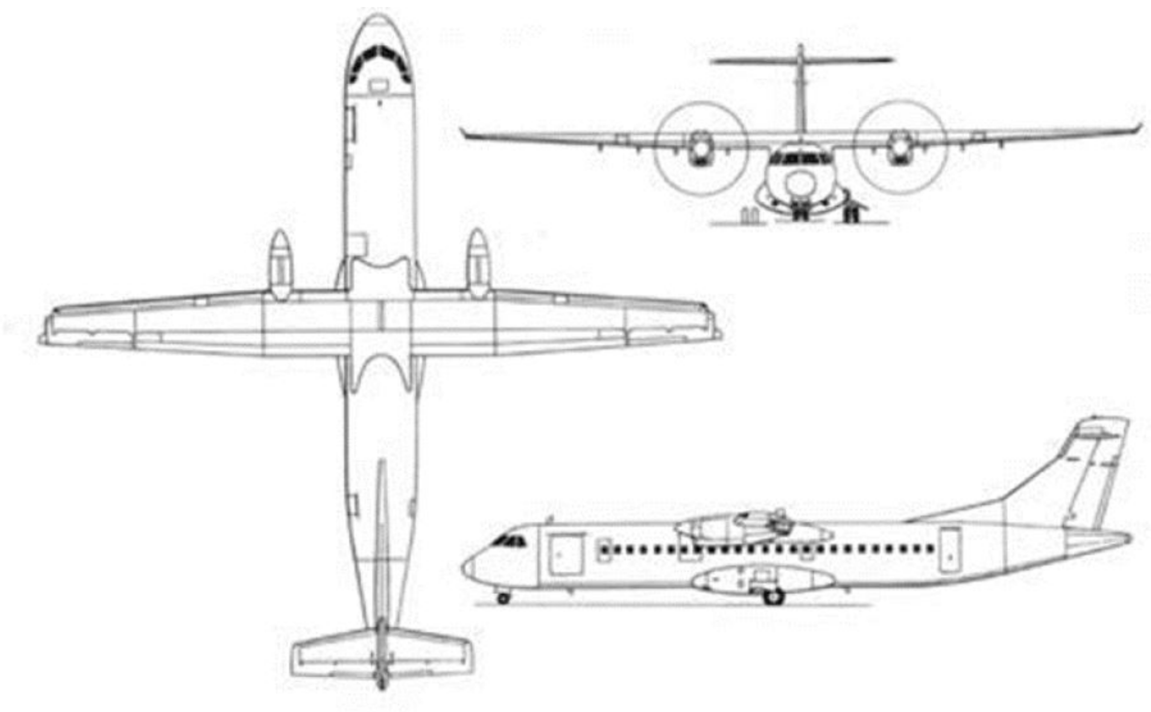
1.2 Aircraft Types

NOTE: The wing and horizontal tail surface areas mentioned are not verified to reflect only the wetted areas (the area that is sprayed with de-anti-icing fluids) for each aircraft type. Some wing and horizontal stabilizer areas may or may not include flight controls, wing-to-fuselage panels, winglets, etc. The figures shall therefore only be used as an indication. Always check with the operator or aircraft manufacture for the correct figure of wetted areas

1.2.1 ATR-42/72

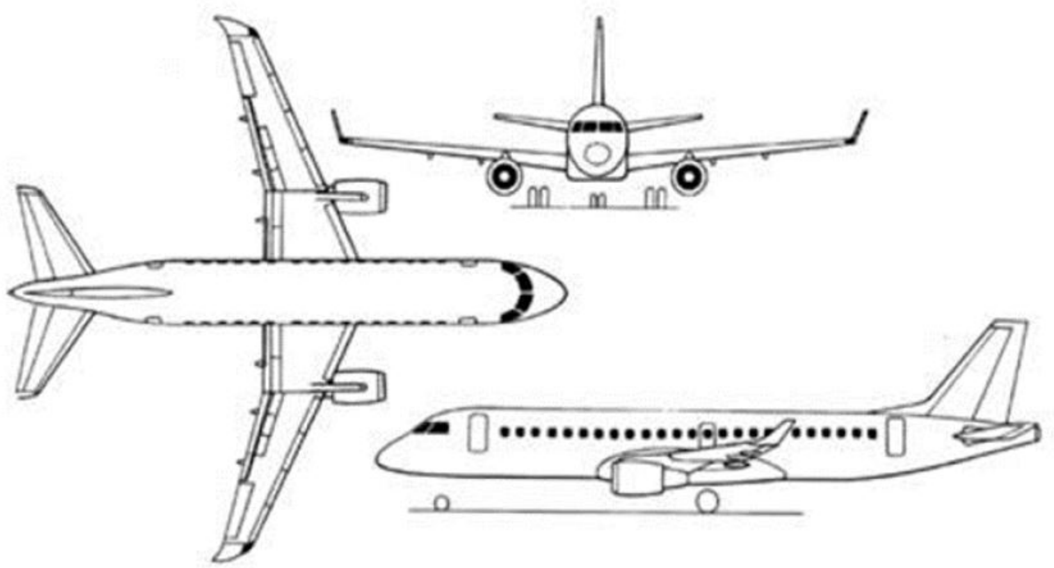
All dimensions are for reference only and are approximate. Latest revision of aircraft data shall be used in operation. The figures given may differ when compared with other manuals and therefore verification must be made if using these figures directly in operation. These numbers are rounded up for easier use in operation. The dimensions for the upper fuselage area and the vertical stabilizer surface area are not mentioned here. Relevant aircraft manufacturer and airline operator manuals should be referenced when treating these areas.

Manufacturer	EADS
Type	ATR-72
Wing area	61 m^2
Horizontal stabilizer area	12 m^2
Total surface area	73 m^2
Height overall	8 m
Wingspan	28 m
Fuselage, 1/3 surface area	66 m^2



1.2.2 Embraer, 190/195

Manufacturer	Embraer
Type	ERJ 190/195
Wing area	93 m²
Horizontal stabilizer area	26 m²
Total surface area	119 m²
Height overall	11 m
Wingspan	29 m
Fuselage, 1/3 surface area	114 m²



1.3 Aircraft code

The aircraft wingspan and code is modified from the ICAO Annex 14 - Aerodrome Design Manual. The dimensions are as a reference only and up to date tables shall be used in operation. The wingspan is a good indication on the distances needed for separation of aircraft. Remote deicing/anti-icing should also consider the safety distance that is needed in between aircraft. These figures are rounded up for easier use in operation and therefore does not necessary reflect the exact category or wingspan.

This table is sorted by category

MANUFACTURER	TYPE	CODE	WINGSPAN (in meters)
Embraer	ERJ 190/195	C	28
EADS	ATR-72	C	28

Table 1B

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APPENDIX 3 EXAMPLE TRAINING TIMES

0 DURATION OF TRAINING TYPICALLY REQUIRED

		Theoretical Training Exam	Practical Training	Remark
10	Deicing Vehicle Driver	7 hours (1 day)		WOM 3.2.5.5
20	Deicing Operator	14 hours (2 days)	21 hours (3 days)	WOM 3.2.5.6 Local settings may demand more/less extensive training.
30	Deicing Supervisor	14 hours (2 days)	21 hours (3 days)	WOM 3.2.5.7
30B	Deicing Inspector	4 hours (1/2 day)	4 hours (1/2 day)	WOM 3.2.5.8
40	Deicing Instructor	14 hours (2 days)	21 hours (3 days)	WOM 3.2.5.9
50	Deicing Coordinator	14 hours (2 days)	21 hours (3 days)	WOM 3.2.5.10

These recommendations are not binding and may require more/less time depending on local settings.

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1 RECOMMENDED TIMING FOR THEORETICAL TRAINING ELEMENTS (WOM 3.2.5.3)

Table C1: Theoretical Elements – Standard Teaching Plan (Sections A, B and C)

Subject	Guidance Content (References)
Course Introduction (WOM 3.2)	
TE1. Introduction	Trainer to introduce themselves. They will explain how they are qualified to train the subject, plus their experience. They will give an overview of the course content, the teaching method, and the requirement for a validation exam and pass mark
A. The requirement for aircraft ground deicing/anti-icing (WOM 3.2 Appendix 1)	
TE2. Basic knowledge of aircraft performance	Four forces that act on an aircraft. Airflow over and under the wings. Why an aircraft can take off. How lift is generated. The critical angle of attack. The aerodynamic window of operation. The biggest contributor to aircraft lift.
TE3. Effects of frozen contamination on aircraft performance	The effect of frozen contamination on lift and drag and the aerodynamic window of operation. The critical component areas for lift and maneuverability of the aircraft. The effect of a small layer of frost. Other effects of frozen contamination.
TE4. The clean aircraft concept, regulations, and recommendations	The "clean aircraft" concept. The regulatory requirements of various national authorities. The role of SAE International and the key global aircraft ground deicing standards. The main purpose of aircraft deicing and anti-icing.
TE5. Meteorological considerations on ice formation	General weather conditions and ice formation. Typical weather types leading to frozen contamination on the aircraft. Weather situations needing special attention. Weather conditions included in/excluded from the holdover time tables. Some forms of weather reporting. Effects of weather on airport operation.
B. The methods for checking the aircraft for contamination	
TE6. Contamination check (to establish the need for deicing)	How to examine the aircraft critical flight surfaces (wings, vertical stabilizer, horizontal stabilizers), top fuselage, undercarriage, nose radome, pitot-static orifices, angle of attack devices, windscreens.
TE7. Post deicing/anti-icing check	How to perform a post deicing/anti-icing check of the aircraft to make sure that no contamination (frozen deposits) remains after deice/anti-ice, the aircraft is clean and in proper condition for flight.
C. The practical methods for aircraft cleaning with deicing/anti-icing fluids (WOM 3.1, WOM 3.3, ARP1971, AS6285)	
TE8. General techniques for removing frozen deposits from aircraft surfaces	The various ways in which deicing can be carried out. The only way in which anti-icing can be carried out. The need to prepare equipment, procedures, and people. The areas of an aircraft to check for frozen contamination. Descriptions of one-step and two-step deicing/anti-icing.
TE9. Deicing/anti-icing by fluids - procedures in general	Critical aspects of deicing and the general process. Special care for composite wing deicing. The general process for using anti-icing fluids effectively. Use of Type I for anti-icing. The general use of Type II, III, and IV fluids.
TE10. Basic characteristics of aircraft deicing/anti-icing fluids	Why deicing/anti-icing fluids are the most usual way of deicing aircraft. The three safety requirements of deicing/anti-icing fluids. The differences between Type I, II, III, and IV fluids, and the colors of these. The unusual characteristics of anti-icing fluids and the precautions needed. The two ways to classify fluid performance. Incompatibility of certain types of fluids, e.g., EG & PG are not compatible with acetate or formate based fluids. Understanding of AMS1424/1 & /2 and AMS1428/1 & /2 and what is allowed to be applied to the aircraft per the manufacturer's Aircraft Maintenance Manual.
TE11. Types of fluid checks required and the equipment for this	The general handling and storage requirements of deicing/anti-icing fluids. The quality control checks to be performed on these fluids. Pumping, heating, and storage tank requirements.
TE12. Deicing/anti-icing equipment operating procedures	The variations of deicing vehicles, and the types of safety precautions to be taken. The operation of filling stations. Clear communications with the flightcrew. Equipment use, spray alternatives, and data collection. Basic vehicle components and safety equipment. **Refer to ARP1971.**
TE13. Fluid application and the use plus the limitations of holdover time tables	Details of the "clean aircraft" concept. The main areas of the aircraft to spray. The key aircraft areas to anti-ice. The purpose of holdover time (HOT) tables and how to read these. The difference between generic and fluid brand HOT tables. The importance of using the correct dilution when reading the appropriate HOT table.
TE14. Deicing/anti-icing codes and communication procedures	The anti-icing code/post deicing report. Communication to flightcrew with reference to **WOM 3.3**. Operator/ driver communication, two-way communication.
TE15. Aircraft in general and common critical surfaces and instruments	The critical aircraft surfaces to inspect. The precautions to take against clear ice. Critical areas not to spray. Understanding the use of the "no spray" diagrams in **WOM 3.2 Appendix 2.**

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Table C1: Theoretical Elements – Standard Teaching Plan (Section D)

Subject	Guidance Content	Reference
D. Special aspects of aircraft deicing/anti-icing operations (ARP5660, AS6332, AS6286B, WOM 3.3, WOM 3.2 Appendix 2)		
TE16. Safety precautions and human factors	Safety assessment by hazard identification and risk management. Personal safety (contamination, working at height, etc.). Safety of others (contamination, struck by vehicle, etc.). Aircraft safety (damage prevention). Personal Protective Equipment (gloves, visors, clothing, etc.).	
TE17. Environmental impact and mitigation	Environmental impact and mitigation.	
TE18. Deicing facility operation	The need for special procedures for central deicing facilities and remote deicing facilities with reference to **ARP5660**.	
TE19. Learning from season operations, audit findings, and updated procedures.	Review of season operational performance with reference to **WOM 3.4**. Review of any incidents, both local and in the industry. Review findings from internal and external audits as appropriate. Consolidate learning with updates to procedures and instructions for next winter season.	
TE20. Local rules and restrictions, airport procedures	Local procedures, permits, requirements, documentation, and operations. Compliance with all SAE Standards referenced.	

These recommendations are not binding and may require more/less time depending on local settings.

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3.3 AIRCRAFT GROUND DE-/ANTI-ICING COMMUNICATION PHRASEOLOGY FOR FLIGHT AND GROUND CREWS

3.3.1 Rationale

Aircraft deicing operations traditionally occurred at the passenger gate or cargo ramp. While this is still predominantly the case, many airports are maximising aircraft parking space efficiency, or have local environmental requirements, that necessitate the use of remote or centralised deicing locations. Deicing services at these locations may be provided by a single airline or third party specialist company, resulting in cross company procedures being implemented for site safety or efficiency purposes. Standardised aircraft deicing communication protocols and phraseology are needed to ensure that important safety, quality, and efficiency information exchange occurs between the participating flight and ground crews.

3.3.2 Foreword

This document contains standardised phraseology for communication between aircraft flight and ground crews during aircraft deicing operations. It is very important that both parties communicate fully about contact requirements, aircraft configuration, de-/anti-icing treatment needed, and post deicing reporting requirements.

3.3.3 Scope

This document establishes standard phraseology for the communication procedures during aircraft ground deicing operations.

NOTE: The minimum requirements to accomplish an aircraft deicing operation are specified in WOM 3.1.

Clear concise standard phraseology between ground personnel and flight crews is an important part of the de-/anti-icing process. It plays a key role in the overall safety of the deicing programme. Historically, flight and ground crews have had to deal with differing communication scripts at multiple airport locations. This has led to unsafe situations, including aircraft moving before the deicing process has been fully completed.

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3.3.4 Phraseology

3.3.4.1 General Comments

Communication (contact) shall be established using the phraseology in this document between the flight crew and the ground crew before initiating services.

Words italicized in parentheses—(xxxx)—indicate that specific information, such as a level, a place, or a time, etc., must be inserted to complete the phrase, or, alternatively, that optional phrases may be used. Words in square brackets—[xxxx]—indicate optional additional words or information that may be necessary in specific instances. Within the phraseologies, where the term "NOTE" is followed by a numeral, a superscript numeral—#—has been placed within the phraseology to indicate the specific element where the note is applicable.

In locations with unique or specific operating requirements and/or technologies, supplemental phraseology or modifications to the phraseology may be required. This may include locations or operations where approved alternative means of communications are utilized. This is permitted, pending the required communication elements are maintained.

3.3.4.2 Ground Crew/Flight Crew Phraseologies for De-/Anti-Icing Operations

3.3.4.2.1 Normal Operations

Table 1

Circumstances	Crew	Phraseologies
1. Prior to deicing/anti-icing, groundcrew will contact the flightcrew to advise:	Groundcrew	a. (*aircraft identification or call sign*) CONFIRM BRAKES SET, AIRCRAFT CONFIGURED, AND TREATMENT REQUIRED
	Flightcrew	b. **[AFFIRM] BRAKES SET, AIRCRAFT CONFIGURED, REQUEST (*Specify treatment requirements including surfaces to be treated, fluid type(s), deicing only, manual deicing methods (i.e., forced air (where available and use is authorized), anti-icing only or deicing/anti-icing (two-step ("HOLDOVER REQUIRED")), etc.*)**
	Groundcrew	c. HOLD POSITION, DEICING STARTS NOW, [MONITOR THE (*visual positive hold control method*)][1] NOTE 1: Required for engines-on deicing only where visual positive hold control is utilized.
	Flightcrew	d. **HOLD POSITION, [MONITOR THE (*visual positive hold control method*)][1]** NOTE 1: Required for engines-on deicing only where visual positive hold control is utilized.

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Table 2

Circumstances	Crew	Phraseologies
2. On completion of the deicing/anti-icing procedure, groundcrew will contact the flightcrew to advise:	Groundcrew	a. (*aircraft identification or call sign*) DEICING COMPLETE (*name of final fluid type applied*)[1] NOTE 1: Omit fluid type information if deicing was solely performed using a manual method. b. (*fluid manufacturer, brand/trade name*) (*mixture ratio (in percent)*)[2] NOTE 2: These components are required for anti-icing with Type II, III, and IV fluids only. Omit if one-step deicing only procedure was performed or if deicing was solely performed using a manual method. c. ANTI-ICING BEGAN AT (*HH:MM (local time)*)[3], POST-DEICING CHECK COMPLETED, DEICING[4] PERSONNEL AND EQUIPMENT ARE SAFELY AWAY NOTE 3: Where a deicing only procedure was performed, replace this element with: "HOLDOVER TIMES DO NOT APPLY." NOTE 4: In locations where deicing takes place exclusively at designated deicing facilities (i.e., CDFs, DDFs, etc.), "DEICING" can be omitted from this element where no other groundcrew personnel or ground support equipment are within the equipment restraint area (ERA) or within the aircraft footprint or expected to be within these areas. d. HOLD POSITION AND CONTACT (departure control/advisory position (i.e., ATC) or groundcrew (as applicable)) FOR (departure method, i.e., taxi, pushback, etc.) **DEICING ONLY PROCEDURE - MANUAL METHOD phraseology example:** *"AIRLINE 123,* DEICING COMPLETE, *HOLDOVER TIMES DO NOT APPLY, POST-DEICING CHECK COMPLETED, DEICING PERSONNEL AND EQUIPMENT ARE SAFELY AWAY, HOLD POSITION AND CONTACT PAD CONTROL ON 131.17 FOR TAXI."* **DEICING ONLY PROCEDURE - ADF METHOD phraseology example:** *"AIRLINE 123,* DEICING *COMPLETE, TYPE I, HOLDOVER TIMES DO NOT APPLY, POST-DEICING CHECK COMPLETED, DEICING PERSONNEL AND EQUIPMENT ARE SAFELY AWAY, HOLD POSITION AND CONTACT GROUNDCREW FOR PUSH AND START."* **DEICING/ANTI-ICING or ANTI-ICING ONLY PROCEDURE phraseology example:** *"AIRLINE 123,* DEICING COMPLETE, *TYPE IV, ACME CLEANGREEN 75%, ANTI-ICING BEGAN AT 14:35, POST-DEICING CHECK COMPLETED, DEICING PERSONNEL AND EQUIPMENT ARE SAFELY AWAY, HOLD POSITION AND CONTACT GROUND ON 121.9 FOR TAXI."*
	Flightcrew	**b. HOLD POSITION AND CONTACT (*departure control/advisory position (i.e., ATC) or groundcrew (as applicable)*) FOR (*departure method, i.e., taxi, pushback, etc.*)**

3.3.4.2.2 Abnormal Operations

3.3.4.2.2.1 Abnormal Occurrences

Table 3

Circumstances	Crew	Phraseologies
1. For a declared emergency, mayday, or pan pan NOTE: When an urgency, distress, or other emergency call has been received or declared by an aircraft or deicing equipment during deicing operations (transmitted to all stations by the groundcrew). Further guidance to be provided after these transmissions have taken place.	Groundcrew	**For aircraft (transmitted by groundcrew):** a. EMERGENCY, EMERGENCY, EMERGENCY, ALL AIRCRAFT STOP, HOLD POSITION **For deicing equipment (transmitted by groundcrew):** b. EMERGENCY, EMERGENCY, EMERGENCY, ALL TRUCKS STOP DEICING, PROCEED TO THE (*identify location based on local operation (i.e., safe zone, predetermined safety area, equipment staging area, etc.)*) AND STANDBY FOR FURTHER INFORMATION
2. For deicing equipment proximity sensor activation (physical)	Groundcrew	a. A SAFETY PROXIMITY SENSOR (*identify location on the deicing equipment*) HAS BEEN ACTIVATED ON THE (*specify specific location on the aircraft*), CONDUCTING INITIAL CHECK, STANDBY FOR FURTHER INFORMATION
	Flightcrew	b. **ROGER, STANDING BY FOR FURTHER INFORMATION**
	Groundcrew	c. (*title of individual (role) that performed check (other than the deicing operator that made contact)*) HAS PERFORMED A VISUAL CHECK ON THE AFFECTED AREA (*provide results of the check (e.g., there is no visual damage detected or damage is suspected or present)*), ADVISE YOUR INTENTIONS
3. Engine inlet contamination has been detected/observed after deicing/anti-icing has commenced NOTE: Applicable to locations where engines-on deicing/anti-icing is performed.	Groundcrew	a. CONTAMINATION HAS BEEN DETECTED IN YOUR ENGINE INLET(S) (*indicate both or specific engine number(s) and describe contamination details*), GROUNDCREW CAN REMOVE THIS CONTAMINATION ONSITE WITH ENGINES SHUTDOWN USING (*advise specific removal method(s)*), ADVISE YOUR INTENTIONS
4. Contamination observed after completion of deicing/anti-icing and release of aircraft NOTE: If unable to contact the flightcrew, contact must be made to Air Traffic Control (ATC) (i.e., ground, tower, etc.) or on the maneuvering frequency (in the absence of ATC services).	Groundcrew	a. CONTAMINATION WAS OBSERVED (*describe area (i.e., within the flaps tracks)*), RECOMMEND YOU RETURN TO (*specify location (i.e., the CDF, deicing pad/bay, stand/gate, etc.)*) FOR RETREATMENT
	Flightcrew	b. **ROGER, WILL RETURN TO (*location specified*) FOR RETREATMENT**

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3.3.4.2.2.2 Interrupted Operations

A deicing/anti-icing treatment should be continuous and as short as possible. If a treatment is interrupted (for example, a truck runs out of fluid), the aircraft commander shall be immediately informed stating:

a) The reason for interruption

b) The actions to be taken (in consultation with the Commander);

c) The expected time of delay.

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Table 4

Circumstances	Crew	Phraseologies
1. Interrupted operations (groundcrew related) NOTE: The deicing operation has stopped and is incomplete.	Groundcrew	a. (*reason for interruption (i.e., truck inoperative, low in fluid, etc.)*) b. (*actions to be taken to resolve (in consultation with the flightcrew)*) c. (*expected time of delay*) d. DEICING IS INCOMPLETE, STANDBY FOR FURTHER TREATMENT
2. Before continuing treatment	Groundcrew	e. (*confirm the treatment to be carried out including any surfaces requiring retreatment*), CONFIRM BRAKES SET AND AIRCRAFT CONFIGURED
	Flightcrew	f. **BRAKES SET, AIRCRAFT CONFIGURED (*specify any deviation from treatment requirements previously requested or any new or supplemental requests*)**
	Groundcrew	g. HOLD POSITION, DEICING STARTS NOW, [MONITOR THE (*visual positive hold control method*)][1] NOTE 1: Required for engines-on deicing only where visual positive hold control is utilized.
	Flightcrew	h. **HOLD POSITION, [MONITOR THE (*visual positive hold control method*)][1]** NOTE 1: Required for engines-on deicing only where visual positive hold control is utilized.
2.a. Interrupted or cancelled operations (flightcrew related)	**Flightcrew**	a. **STOP DEICING (*specify reason*) (*specific intentions (including if relocating elsewhere on the airfield)*), ADVISE WHEN DEICING[1] PERSONNEL AND EQUIPMENT ARE SAFELY AWAY FROM THE AIRCRAFT** NOTE 1: In locations where deicing takes place exclusively at designated deicing facilities (i.e., CDFs, DDFs, etc.), "DEICING" can be omitted from this element where no other groundcrew personnel or ground support equipment are within the equipment restraint area (ERA), within the aircraft footprint, or expected to be within these areas.
	Groundcrew	b. ROGER, STOP DEICING, HOLD POSITION AND STANDBY, EQUIPMENT IS PROCEEDING TO THE (*identify location based on local operation (i.e., safe zone, predetermined safety area, equipment staging area, etc.)*)
	Groundcrew	c. DEICING IS INCOMPLETE (*advise deicing status*), DEICING[1] PERSONNEL AND EQUIPMENT ARE SAFELY AWAY, HOLD POSITION AND CONTACT (*departure control/advisory position (i.e., ATC) or groundcrew (as applicable)*) FOR (*departure method (i.e., taxi, pushback, etc.)*)[2] NOTE 1: In locations where deicing takes place exclusively at designated deicing facilities (i.e., CDFs, DDFs, etc.), "DEICING" can be omitted from this element where no other groundcrew personnel or ground support equipment are within the equipment restraint area (ERA) or within the aircraft footprint or expected to be within these areas. NOTE 2: Omit departure method element if aircraft is remaining in position and not maneuvering elsewhere on the airfield.
	Flightcrew	d. **ROGER, DEICING IS INCOMPLETE, HOLD POSITION AND CONTACT (*departure control/advisory position (i.e., ATC) or groundcrew (as applicable)*) FOR (*departure method (i.e., taxi, pushback, etc.)*)[1]** NOTE 1: Omit departure method element if aircraft is remaining in position and not maneuvering elsewhere on the airfield.

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3.4 AIRCRAFT GROUND DEICING/ANTI-ICING QUALITY MANAGEMENT

3.4.1 Rationale

This document provides industry standards and guidance for the management of quality systems and processes for the effective deicing and anti-icing of aircraft on the ground. It forms one part of three related SAE Aerospace Standards (AS) and should be read in conjunction with WOM 3.1 Aircraft Ground Deicing/Anti-Icing Processes and 3.2 "Aircraft Ground Deicing/Anti-icing Training and Qualification Programme". Collectively WOM 3.1, WOM 3.2, and WOM 3.4 are known to as Norra Deicing instructions and practices.

Exposure to weather conditions conducive to ice formation can cause the accumulation of frost, snow, slush and ice on aircraft surfaces and components. These contaminants can adversely affect aircraft performance, stability and control, plus the operation of mechanical devices such as control surfaces, sensors, flaps and landing gear. If frozen deposits are present other than those considered in the aircraft certification process, the performance and safety of the aircraft may be compromised.

Regulations governing aircraft operations in ground icing conditions shall be followed. ICAO Annex 6, Part I and Annex 14, Vol. I mandate specific rules for the safe operation of aircraft during ground icing conditions, and all member states subsequently are required to have regulations in place to ensure this. Paraphrased, these rules specify that no one may dispatch or take off an aircraft with frozen deposits on components of the aircraft that are critical to safe flight. A critical surface or component is one which could adversely affect the mechanical or aerodynamic function of an aircraft. The intent of these rules is to ensure that no one attempts to dispatch or operate an aircraft with frozen deposits adhering to any aircraft component critical to safe flight. This is known as the clean aircraft concept.

Quality management concerns the establishment, documentation, implementation and maintenance of a system in order to deliver the required process outcome and to continually improve effectiveness. Quality management is therefore a system that allows the effective delivery of the clean aircraft concept. Although no system is perfect, it is necessary to ensure the operation and processes evolve and learn from both non-conforming practice and opportunities for improvement in this critical area of aircraft safety. As individual icing situations or aircraft types and models may require special procedures, this document can never replace the aircraft operator’s judgment. However, it does give guidance on the principles of systematic operation of deicing and the improvements that allow valuable learning from operations to be captured for even greater assurance of safe operations.

3.4.2 Scope

This document establishes the general requirements for the quality management of aircraft ground deicing/anti-icing systems and processes. It covers the areas of:

- Quality system, documentation and control of records;
- Management responsibility;
- Resource management;
- Product realization; and
- Measurement, analysis and improvement.

This document defines these areas and their key aspects so they can be practically managed, and that deicing operations can become safer with time. In alignment with WOM 3.1 and WOM 3.2, the primary focus of this standard is on the deicing/anti-icing of aircraft using deicing and anti-icing fluids.

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3.4.3 References

3.4.3.1 General

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

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3.4.4 Abbreviations and Definitions

3.4.4.1 General

NOTE: For the purposes of this document, the abbreviations, terms and definitions given in WOM 3.1 apply.

3.4.4.2 Abbreviations and Acronyms

AS Aerospace Standard

OEM Original Equipment Manufacturer

QA Quality Assurance

QC Quality Control

QMS Quality Management System

RI Refractive Index

SMS Safety Management System

3.4.4.3 Definitions

NOTE: Throughout the text of this chapter, wherever the term “product” occurs, it can also mean “service”, and vice versa.

For the purposes of this document, the following definitions apply:

A. Advisory Word Definitions:

The following advisory words are to be used as defined:

MAY: This is used to describe that the practice is encouraged and/or optional.

SHALL: This will mean that the practice is mandatory.

SHOULD: This means that the practice is recommended or strongly encouraged.

B. Words and Phrase Definitions: The following words and phrases are to be used as defined:

AUDIT EVIDENCE: Records, statements of fact or other information, which are relevant to the audit criteria and verifiable.

CLEAN AIRCRAFT CONCEPT: During conditions conducive to airplane icing during ground operations, take-off shall not be attempted when ice, snow, slush or frost is present or adhering to the wings, propellers, control surfaces, engine inlets or other critical surfaces. This is known as the “clean aircraft concept”.

Critical Surface or Component is one which could adversely affect the mechanical or aerodynamic function of an aircraft.

CONFORMITY: The fulfillment of a requirement.

CONTAMINATION: Contamination is defined as all forms of frozen or semi-frozen deposits on an aircraft, such as frost, snow, slush or ice.

CONTAMINATION CHECK OR INSPECTION: A check of aircraft surfaces and components for contamination to establish the need for deicing.

CORRECTIVE ACTION: Corrective action is a reactive process to address concerns or issues after they have occurred. It assumes that a non-conformance or problem has been identified and has been reported by employees of the organization or by customers or other interested parties/stakeholders.

DEICING SERVICE PROVIDER: The company responsible for aircraft deicing/anti-icing operations. This may include contracted service providers, or where the air carrier/operator or airport authority performs these services internally.

FINDING: The results of an evaluation of the collected audit evidence against audit criteria. A finding can indicate conformity or nonconformity with audit criteria, or opportunities for improvement.

GROUND ICING CONDITIONS: With due regard to aircraft skin temperature and weather conditions, ground icing conditions exist when frost, ice, or snow is adhering or may adhere to the critical surfaces of an aircraft.

Ground icing conditions also exist when active frost, frozen or freezing precipitation is reported or observed.

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GROUND ICING PROGRAM: A ground icing program consists of a set of procedures, guidelines, and processes, documented in manuals, which ensure that aircraft do not depart with frost, ice, snow or slush adhering to critical surfaces.

HEAD OF DEICING TRAINING: The person responsible for ensuring that their own understanding and competence is sufficient for them to hold this position, and for ensuring the effective delivery of the deicing/ anti-icing training of personnel for the whole organization. By agreement of the senior management team, this may also be the Program Manager/Responsible Person/Accountable Executive.

NONCONFORMITY: The non-fulfilment of a requirement.

OBSERVATION/OPPORTUNITY FOR IMPROVEMENT: A statement of fact made during an audit and substantiated by objective evidence.

PREVENTIVE ACTION: Preventive action is a proactive process and is initiated to stop a potential problem from occurring or from becoming too severe. Preventive action focuses on identifying negative trends and addressing them before they become significant.

PROGRAM MANAGER/RESPONSIBLE PERSON/ACCOUNTABLE EXECUTIVE/ACCOUNTABLE PERSON: The person responsible for ensuring that the process needed to maintain the quality of systems to deliver the clean aircraft concept during winter operations is established and maintained.

QUALITY ASSURANCE: Quality assurance is a way of preventing mistakes or defects in products and avoiding problems when delivering services to customers; which ISO 9000 defines as "part of quality management focused on providing confidence that quality requirements will be fulfilled". This defect prevention in quality assurance differs subtly from defect detection and rejection in quality control, and has been referred to as a shift left as it focuses on quality earlier in the process. Quality assurance is a proactive process (process driven).

QUALITY CONTROL: Quality control is a process by which entities review the quality of all factors involved in production or in the provision of services. ISO 9000 defines quality control as "A part of quality management focused on fulfilling quality requirements". Quality control is a reactive process (identify and correct).

QUALITY IMPROVEMENT: The actions taken throughout an organization to increase the effectiveness of activities and processes to provide added benefits to both the organization and its customers.

QUALITY MANAGEMENT: Quality management ensures that an organization, product or service is consistent. It has four main components: quality planning, quality assurance, quality control and quality improvement. Quality management is focused not only on product and service quality, but also on the means to achieve it. Quality management, therefore, uses quality assurance and control of processes as well as products to achieve more consistent quality.

QUALITY MANAGEMENT SYSTEM: The ability to demonstrate both management commitment to and the organizational ability to deliver the required level of product or service.

QUALITY MANUAL: The central document that brings together all the aspects necessary to demonstrate control, conformance and continual improvement over aircraft deicing and anti-icing.

NOTE: The contents of a Quality Manual may be included as part of a Ground Icing Program.

QUALIFIED PERSONNEL: Trained personnel that have successfully completed theoretical and/or practical training requirements and certification (including examinations, evaluations, etc.). See WOM 3.2 for further requirements as applicable to the specific occupational requirements.

ROOT CAUSE: A root cause is an initiating cause of either a condition or a causal chain that leads to an outcome or effect of interest. Commonly, root cause is used to describe the depth in the causal chain where an intervention could reasonably be implemented to improve performance or prevent an undesirable outcome.

SAFETY MANAGEMENT SYSTEM: A systematic approach to managing safety, including the necessary organizational structures, accountabilities, policies and procedures.

SENIOR MANAGEMENT: A team of individuals at the highest level of management of an organization who are responsible for ensuring the proper delegation and delivery of performance for the day-to-day tasks of managing the winter operation.

WINTER OPERATIONS: An operational period where ground icing conditions are present or could occur, and aircraft deicing/anti-icing services may be required.

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3.4.5 Quality Management System (Appendix Reference: 1 Procedures and Documentation)

3.4.5.1 General Requirements

The deicing service provider shall establish, document, implement and maintain a QMS and continually improve its effectiveness. The deicing service provider shall:

- Determine the processes needed to manage effective aircraft deicing/anti-icing;
- Determine the criteria and methods needed to ensure the operation and control of these processes are effective;
- Ensure the availability of resources necessary to support the operation and monitoring of these processes;
- Monitor, measure where applicable, and analyze these processes; and
- Implement actions necessary to achieve the planned results and to continually improve these processes.

NOTE: The extent of the QMS documentation can differ from one organization to another due to:

- The size of the organization and types of activities;
- The complexity of their processes and interactions; and
- The competence of the personnel.

3.4.5.2 System Requirements

The QMS shall include:

- Documented statements of the quality policy and objectives;
- A quality manual (may be included as part of a ground icing program);
- Documented procedures and records for effective aircraft deicing/anti-icing; and
- Documents necessary to ensure effective winter planning, operation and control of these processes.

3.4.5.3 Document Control

Documents required by the quality management system shall be controlled. A documented procedure shall be established to define the control needed. Documents shall:

- Be approved for use;
- Be reviewed and updated as necessary;
- Be written to ensure that changes in these documents are shown;
- Refer to the relevant versions of applicable documents;
- Ensure that any external reference documents are identified and controlled; and
- Effectively managed to prevent the use of obsolete documents.

3.4.5.4 Control of Records

Records established to provide evidence of conformity to requirements and of the effective operation of the quality of the management system shall be controlled.

3.4.5.5 Documentation Requirements for a Deicing/Anti-Icing QMS

For deicing/anti-icing operations, documentation shall include:

- Ground icing program (may require regulatory approval of such program, where applicable);
- Quality manual (may be included as part of a ground icing program);
- SMS;
- Documented deicing/anti-icing procedures in conformance to the current revision of WOM 3.1, WOM 3.2, other applicable documentation (as required), and local state regulatory requirements;
- Conformance with latest revisions of local state regulatory authority procedures and requirements; and
- Deicing location procedures as applicable (gate, remote apron, central/designated deicing facility, etc.) Aircraft size limits, safe zones, communications, emergency procedures etc.; and
- Procedures for the performance of engines running deicing, where applicable.

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3.4.6 Management Responsibility (Appendix Reference: 2 Management Responsibility)

3.4.6.1 Management Commitment

Senior management shall provide evidence of its commitment to the development and implementation of a suitable management system for the effective deicing/anti-icing of aircraft. This shall include:

- Communicating the need to demonstrate complete conformance to the clean aircraft concept during winter operations through a clear policy statement;
- Establishing the systems and procedures for carrying this out effectively;
- Ensuring the availability of resources;
- Conducting management reviews and documenting recommended actions; and
- Following up actions to ensure completion of these.

NOTE: The formal extent of the detail of this management commitment can differ from one organization to another due to:

- The size of the organization and types of activities;
- The complexity of their processes and interactions; and
- The competence of the personnel.

3.4.6.2 Planning Objectives

Senior management shall ensure that conformance to the clean aircraft concept is carried out, and that the requirements to meet this objective are established for all relevant functions and levels of the organization.

3.4.6.3 Responsibility, Authority and Communication

3.4.6.3.1 Responsibility and Authority

Senior management shall ensure that responsibilities and authorities are defined and communicated within the organization.

3.4.6.3.2 Management Representative

Senior management shall appoint a manager on an annual basis who, irrespective of other responsibilities, shall have the responsibility that includes:

- Ensuring that the process needed to maintain the quality of systems to deliver the clean aircraft concept during winter operations are established and maintained;
- Report to senior management on the performance and effectiveness of these systems and any need for improvement; and
- Ensuring the need to conform to the clean aircraft concept is communicated throughout the organization.

This person may be known by the title Program Manager/Responsible Person/Accountable Executive/Accountable Person or some other title that identifies them as responsible and accountable to senior management for the effective delivery of this service.

3.4.6.3.3 Head of Deicing Training

As required by WOM 3.2, senior management shall appoint a manager on an annual basis who, irrespective of other responsibilities, shall have the responsibility that includes:

- Ensuring that their own understanding and competence is sufficient for them to hold this position; and
- Ensuring the effective delivery of the deicing/anti-icing training of personnel for the whole organization.

If agreed by senior management the Program Manager/Responsible Person/Accountable Executive/Accountable Person and Head of Deicing Training may be the same person.

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3.4.6.4 Management Review

3.4.6.4.1 General

Senior management shall review the organizations QMS at planned intervals to ensure their continuing suitability, adequacy and effectiveness.

3.4.6.4.2 Review Input

The input to management review shall include information on:

- The results of audits, both internal and external;
- Customer feedback as appropriate;
- Process and product conformity;
- Status of corrective and preventative actions;
- Accident/incident/irregularity, in terms of investigation, corrective action, and continuous improvement
- Follow up of previous management reviews; and
- Recommendations for improvement.

3.4.6.4.3 Review Output

The output of management review shall include any decisions and actions related to:

- Improvement of the effectiveness of the systems and processes;
- Improvement in the delivery of the effectiveness of these processes;
- Any recommendations to the impact of these on resource needs; and
- An updated ground icing program, policies and procedures.

3.4.6.5 Documentation Requirements for Management Responsibility

- Clear communication of the policy to deliver the clean aircraft concept.
- Communication of the responsibilities and authorities of those involved in delivering the clean aircraft concept.
- Letter of appointment of the Program Manager/Responsible Person/Accountable Executive/Accountable Person and Head of Deicing Training as appropriate.
- Minutes of meetings of the senior managers to discuss and agree actions to update winter operations.
- Updated ground icing program, policies and procedures.

3.4.6.6 Resource Management (Appendix Reference: 3, 4, 5, and 6)

3.4.6.6.1 General

The deicing service provider shall determine and provide the resources needed to implement and maintain the safety of these services, and to continually improve their effectiveness.

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3.4.6.6.2 Personnel Competence, Training and Awareness (Appendix reference 3 Training and Qualification)

3.4.6.6.2.1 Requirements

The deicing service provider shall:

- Ensure that its personnel are aware of the relevance and importance of the clean aircraft concept;
- Determine the necessary competence for personnel performing services or manufacturing products;
- Provide initial and annual recurrent training (as appropriate) to ensure the necessary competence of such personnel;
- Evaluate the effectiveness of the training given; and
- Maintain appropriate records of education, training, skills and experience.

The standard of training and competency is given in WOM 3.2. The areas covered by this chapter include:

- Levels of qualification for the various roles carried out by personnel (e.g. deicing instructor, deicing operator, etc.);
- The content of the training sessions and their relevance to the appropriate roles as standard teaching plans;
- The running and delivery of training sessions;
- The examination/evaluation process for theoretical and practical components; and
- How such training and qualification is carried out by deicing service providers.

3.4.6.6.2.2 Documentation Requirements for Competence, Training and Awareness

Personnel involved in carrying out the functions necessary to obtain the clean aircraft concept shall be able to provide documentation that confirms:

- Documented deicing/anti-icing training programs in conformance to the current revision of WOM 3.1, WOM 3.2, other applicable SAE documentation (as required), and local state regulatory requirements;
- Documented passing rates, in accordance with WOM 3.2 or local state regulatory requirements;
- Training and qualification requirements applicable to each role;
- Initial and annual recurrent training records, including theoretical examinations, practical evaluations (where required), and certificates (where require) as applicable to the roles qualification requirements;
- Trainer certification;
- Confirmation training and evaluation has been performed by qualified personnel; and
- Training and qualification for the performance of engines running deicing, where applicable.

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3.4.6.7 Facilities Infrastructure and Deicing/Anti-Icing Equipment (Appendix Reference: 4 Deicing Facilities and 5 Deicing/Anti-Icing Equipment)

3.4.6.7.1 General

The deicing service provider shall ensure and maintain the infrastructure needed to achieve the required performance of deicing/anti-icing, including:

- Deicing/anti-icing fluid storage, handling, transfer lines and dilution as appropriate;
- Preventative maintenance and calibration/accuracy testing of equipment, as required;
- Fluid spraying equipment such as equipment, hoses and spray nozzles; and
- Supporting equipment, such as transport, communication and information systems.

The appropriate guidance for the effective use of equipment is normally described in the OEM User's Manuals. The contents may include the following and some guidance checks are shown in WOM 3.4 Appendix 1:

- Technical requirements;
- Acceptance inspection;
- Maintenance manuals; and
- Product support.

3.4.6.7.2 Documentation for Facilities and Deicing/Anti-Icing Equipment

- Approved locations where de/anti-icing operations are performed.
- Storage vessels, filling ports and connecting hoses are marked with the appropriate fluid manufacturer and brand name, type of fluid (SAE Type I, II, III, or IV) and concentration as appropriate.
- Hazard identification labelling on storage vessels (as required per local state regulations).
- Inspection and maintenance records are available and up to date. Inspection and maintenance frequency is per those as prescribed by applicable SAE, local state regulatory authority or manufacturers requirements/ recommendations.
- Checks have been carried out on fluids and analysis (appearance, RI, pH and viscosity as appropriate) shows these fluids are within the specifications required.
- Equipment is marked with the appropriate fluid manufacturer and brand name, type of fluid (SAE Type I, II, III, or IV) and concentration as appropriate. Tanks, tank lids and/or fill ports are identified. Spray nozzles are identified.
- Hazard identification labelling on equipment (as required per local state regulations)
- Inspection and maintenance records of equipment are available and up to date. Inspection and maintenance frequency is per those as prescribed by applicable SAE, local state regulatory authority or manufacturers requirements/recommendations.
- Equipment walk around checks are performed and documented prior to operation.
- Equipment has the capability to heat deicing fluids within the prescribed temperature ranges.
- Equipment is free from discrepancies, both those that could negatively affect its safety, and those that could affect the operation (not necessarily safety related).
- Aerial device inspection and maintenance is performed, up-to-date and records available.
- Fire extinguisher/suppression system inspection and maintenance is performed, up-to-date and records available.
- Fall protection equipment is available (as required), inspected frequently (as required), and records available.
- Personal protective equipment (as required) is available and used by personnel during operation.
- Equipment that has an onboard blending system and/or onboard manufacturing system, records to demonstrate the accuracy of the mixing and/or production.
- Equipment maintenance issue reporting process and "out of service" (lockout/tag-out) process is documented and in place.
- Calibration and/or accuracy testing of flow meters, temperature sensors and pressure gauges (where required).

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3.4.6.8 Deicing/Anti-icing Fluids Quality Control (Appendix reference 6 Deicing/Anti-icing Fluids)

3.4.6.8.1 Requirements

Deicing/anti-icing fluids are designed to deliver the clean aircraft concept during times of freezing precipitation with three characteristics:

- Use of heated deicing fluid to remove frozen contamination from the aircraft;
- Use of unthickened or thickened deicing/anti-icing fluids to maintain the aircraft free of frozen precipitation for a limited time (holdover time) to allow the aircraft to taxi to its takeoff position; and
- The shedding of remaining fluid from the aircraft during takeoff.

The correct storage and handling of these fluids in line with the manufacturer's recommendations are essential to preserve the performance characteristics of these fluids. Quality control checks (see WOM 3.1) shall be carried out to ensure the suitability of the fluid for use.

3.4.6.8.2 Documentation Requirements for Deicing/Anti-Icing Fluids

- Authorizations of specific fluids used by the deicing service provider;
- Certificates of conformance/analysis (or equivalent documentation) with each fluid delivery;
- Acceptance checks carried out on the fluid as appropriate;
- Refractive index checks are carried out and records maintained for when equipment is in use, and at other times as required;
- Procedure for fluid sampling;
- Laboratory testing results for SAE Type I, II, III, and IV fluids within the specifications set by the appropriate fluid manufacturer, as applicable;
- Field testing results for sprayed thickened SAE Type II, III, and IV fluids within the specifications set by the appropriate fluid manufacturer, as applicable; and
- Calibration and accuracy testing (as applicable) records for refractometers, pH meters and viscometers.

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3.4.7 Clean Aircraft Concept (Appendix Reference 7 Aircraft Ground Deicing/Anti-icing Operations)

3.4.7.1 Planning of Aircraft Ground Deicing/Anti-Icing Operations

The aircraft Deicing Service Provider shall plan and develop the processes needed to deliver the clean aircraft concept. This shall include:

- The need to establish or check current processes and documents;
- The verification and validation of the specific test activities used; and
- The records needed to provide evidence that the service is effective and safe.

3.4.7.2 Aircraft Deicing/Anti-Icing Methods and Processes

The Deicing Service Provider shall plan and carry out the deicing/anti-icing of aircraft under controlled conditions, to include:

- The availability of work instructions as necessary;
- The availability of suitably qualified personnel;
- The use of suitable deicing/anti-icing application equipment;
- The use of suitable deicing/anti-icing fluids; and
- The availability and use of suitable fluid testing equipment (for field and laboratory testing).

3.4.7.3 Aircraft Deicing/Anti-Icing Processes

Best practice guidance for aircraft deicing/anti-icing is given in WOM 3.1. This document describes the following process areas:

- Roles and responsibilities;
- Quality (including quality control of fluids);
- Communications (Ground Crew to Flight Crew), delays, accident notification;
- Aircraft requirements after deicing/anti-icing;
- Checks (the need for deicing and associated contamination check/inspection after deicing/anti-icing);
- Methods of aircraft deicing/anti-icing;
- Ground equipment; and
- Fluids.

3.4.7.4 Documentation Requirements for Aircraft Ground Deicing/Anti-Icing Operations

- Clear definition of roles and their responsibilities shall be included in the quality manual and/or ground icing program described in WOM 3.4.5.5;
- Quality systems shall be defined in the quality manual and/or ground icing program. Quality control of fluids shall be as described in WOM 3.4.6.8;
- Communications procedure shall conform to the requirements in WOM 3.3;
- Random and periodic QC checks and audits during live deicing operations;
- Procedures for the tasks and responsibilities for the post deicing check;
- Procedures for the communications between Flight Crew and the Deicing Service Provider Ground Crew; and
- Record of required deicing/anti-icing data elements (either on a paper log and/or by an equivalent electronic method).

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3.4.8 Measurement, Analysis And Improvement (Appendix Reference 8 Documentation for Measurement, Analysis and Improvement)

3.4.8.1 General

Due to the safety critical nature of the deicing/anti-icing processes delivering the clean aircraft concept on every occasion, there is a need to demonstrate the correct effectiveness of the service provided, and for the continuous improvement of its effectiveness.

3.4.8.2 Internal Auditing

The deicing service provider shall conduct internal audits at planned and random intervals to determine whether the QMS:

- Conforms to the planned arrangements of this international standard and of those of WOM 3.3 and WOM 3.2; and
- Is effectively implemented and maintained.

The auditing arrangements shall take into account the following requirements:

- A documented procedure shall be established to define the responsibilities and requirements for planning and conducting audits, establishing records and for reporting results;
- The audit criteria, scope frequency and methods shall be defined, and shall take into account the results of previous audits;
- Auditors shall be selected to ensure objectivity and impartiality of the audit process, and auditors shall not audit their own work;
- Management responsible for the deicing/anti-icing area being audited shall ensure that any necessary corrective actions are taken without undue delay to eliminate non-conformances and their causes; and
- Follow up activities shall include the verification of the actions taken and the reporting of the verification results.

The information arising from the last two points shall be discussed in the management review (WOM 3.4.6.3)

3.4.8.3 External Auditing by Air Carriers/Air Operators/Customers and Third-Party Organizations/Groups

External auditing shall follow the general requirements of internal auditing (WOM 3.4.8.2). Once again, the output of the external audit shall be discussed and actioned by senior management in the management review (WOM 3.4.6.3).

3.4.8.4 Review for Compliance and Improvement

3.4.8.4.1 General

The deicing service provider shall continually improve the effectiveness of aircraft ground deicing/anti-icing through the use of its quality policy, quality objectives, audit results, analysis of data corrective and preventative actions and management review.

3.4.8.4.2 Corrective Actions

The organization shall take action to eliminate the cause of non-conformances in order to prevent reoccurrence. A documented procedure shall be established to define the requirements for:

- Reviewing and determining the cause of non-conformances;
- Determining the need for and implementing actions to ensure that non-conformances do not reoccur;
- Record the results of the action taken; and
- Reviewing the effectiveness of the actions taken.

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3.4.8.4.3 Preventative Action/Opportunities for Improvement

The deicing service provider shall take action in order to prevent non-conformances or to improve the operations as appropriate. A documented procedure shall be established to define the requirements for:

- Determining potential non-conformances and their effects;
- Determining potential improvements in the methods and control of aircraft deicing/anti-icing;
- Evaluating the need to take action, and implementing these as appropriate; and
- Reviewing the effectiveness of the actions taken.

3.4.8.5 Documentation Requirements for Measurement, Analysis and Improvement

- The schedule for internal audits as appropriate.
- The documented result of each audit, including any findings/observations/opportunities for improvement, root causes, corrective actions and preventive actions.
- Accident/incident/irregularity, in terms of investigation, corrective action, and continuous improvement
- Minutes of meetings of the senior managers to discuss and agree actions to update winter operations (WOM 3.4.6.4).
- Updated ground icing program, policies and procedures (WOM 3.4.6.4).

See WOM 3.4 Appendix 1 for the direction and guidelines to build a check list for auditable areas and documentation requirements.

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APPENDIX 1 AIRCRAFT GROUND DEICING/ANTI-ICING QUALITY MANAGEMENT – DEICING SERVICE PROVIDER DOCUMENTATION REQUIREMENTS AND INSPECTION AREAS

1 PROCEDURES AND DOCUMENTATION (WOM 3.4.5 QUALITY MANAGEMENT SYSTEM)

- Ground icing programme (may require regulatory approval of such programmes, where applicable).
- Quality Manual (may be included as part of a Ground Icing Programme).
- SMS (Safety Management System).
- Documented deicing/anti-icing procedures in conformance with the latest editions of WOM 3.3, WOM 3.2, other applicable SAE documentation (as required), and local state regulatory requirements.
- Conformance with the latest revisions of local state regulatory authority procedures and requirements.
- Procedures for the performance of engines running deicing, where applicable.

2 MANAGEMENT RESPONSIBILITY (WOM 3.4.6. MANAGEMENT RESPONSIBILITY)

- Clear communication of the policy to deliver the clean aircraft concept.
- Communication of the responsibilities and authorities of those involved in delivering the clean aircraft concept.
- Letter of appointment of the Program Manager/Responsible Person/Accountable Executive/Accountable Person and Head of Deicing Training as appropriate.
- Minutes of meetings of the Senior Managers to discuss and agree actions to update winter operations.
- Updated ground icing programme, policies and procedures.

3 TRAINING AND QUALIFICATION (WOM 3.4.6.6 RESOURCE MANAGEMENT)

- Documented deicing/anti-icing training programmes in conformance with the latest editions of WOM 3.3, WOM 3.2, other applicable SAE documentation (as required), and local state regulatory requirements.
- Documented passing rates, in accordance with WOM 3.2 or local state regulatory requirements.
- Training and qualification requirements applicable to each role.
- Initial and annual recurrent training records, including theoretical examinations, practical evaluations (where required), and certificates (where require) as applicable to the roles qualification requirements.
- Trainer certification.
- Confirmation training and evaluation has been performed by a qualified individual.
- Training and qualification for the performance of Engines Running Deicing, where applicable.

4 DEICING FACILITIES (WOM 3.4.6.7 FACILITIES INFRASTRUCTURE AND DEICING/ANTI-ICING EQUIPMENT)

- Approved locations where de-/anti-icing operations are performed.
- Storage vessels, filling ports and connecting hoses are marked with the appropriate fluid manufacturer and brand name, type of fluid (SAE Type I, II, III, or IV) and concentration as appropriate.
- Hazard identification labelling on storage vessels (as required per local state regulations).
- Inspection and maintenance records are available and up to date. Inspection and maintenance frequency is per those as prescribed by applicable SAE, local state regulatory authority or manufacturers' requirements/recommendations.
- Checks have been carried out on fluids and analysis (appearance, RI, pH and viscosity as appropriate) shows these fluids are within the specifications required.

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5 DEICING/ANTI-ICING EQUIPMENT (WOM 3.4.6.7 FACILITIES INFRASTRUCTURE AND DEICING/ANTI-ICING EQUIPMENT)

- Equipment is marked with the appropriate fluid manufacturer and brand name, type of fluid (SAE Type I, II, III, or IV) and concentration as appropriate. Tanks, tank lids and/or fill ports are identified. Spray nozzles are identified.
- Hazard identification labelling on equipment (as required per local state regulations).
- Inspection and maintenance records of equipment are available and up to date. Inspection and maintenance frequency is per those as prescribed by applicable SAE, local state regulatory authority or manufacturers' requirements/recommendations.
- Equipment walk-around checks are performed and documented prior to operation.
- Equipment has the capability to heat deicing fluids within the prescribed temperature ranges.
- Equipment is free from discrepancies, both those that could negatively affect its safety, and those that could affect the operation (not necessarily safety related).
- Aerial device inspection and maintenance is performed, up to date, and records available.
- Fire extinguisher/suppression system inspection and maintenance is performed, up to date, and records available.
- Fall protection equipment is available (as required), inspected frequently (as required), and records available.
- Personal protective equipment (as required) is available and used by personnel during operation.
- Checks have been carried out on fluids and analysis (appearance, RI, pH and viscosity as appropriate) shows these fluids are within the specifications required.
- Equipment that has an onboard blending system and/or onboard manufacturing system, records to demonstrate the accuracy of the mixing and/or production.
- Equipment maintenance issue reporting process and "out of service" (lockout/tag-out) process is documented and in place.
- Calibration and/or accuracy testing of flow meters, temperature sensors and pressure gauges (where required).

6 DEICING/ANTI-ICING FLUIDS (WOM 3.4.6.8 DEICING/ANTI-ICING FLUIDS QUALITY CONTROL)

- Authorisations of specific fluids by the Deicing Service Provider.
- Certificates of conformance/Certificates of analysis with each fluid delivery.
- Acceptance checks carried out on the fluid as appropriate.
- Refractive index checks are carried out and records maintained for when equipment is in use, and at other times as required.
- Procedure for fluid sampling.
- Laboratory testing results for SAE Type I, II, III, and IV fluids within the specifications set by the appropriate fluid manufacturer, as applicable.
- Field testing results for sprayed thickened SAE Type II, III, and IV fluids within the specifications set by the appropriate fluid manufacturer, as applicable.
- Calibration and accuracy testing (as applicable) records for Refractometers, pH meters and Viscometers.

7 AIRCRAFT GROUND DEICING/ANTI-ICING OPERATIONS (WOM 3.4.7 CLEAN AIRCRAFT CONCEPT)

- Clear definition of roles and their responsibilities shall be included in the Quality Manual or Ground Icing Programme described in WOM 3.4.5.5.
- Quality systems shall be defined in the Quality Manual. Quality Control of fluids shall be as described in WOM 3.4.6.8.
- Communications procedure shall conform to the requirements in WOM 3.3.
- Random and periodic QC checks and audits during live deicing operations.
- Procedures for the tasks and responsibilities for the post deicing check.
- Procedures for the communications between Flight Crew and the Deicing Service Provider Ground Crew.
- Record of required deicing/anti-icing data elements (either on a paper log and/or by an equivalent electronic method).

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8 DOCUMENTATION FOR MEASUREMENT, ANALYSIS AND IMPROVEMENT (9. MEASUREMENT, ANALYSIS AND IMPROVEMENT)

- The schedule for internal audits as appropriate.
- The documented result of each audit, including any findings/observations/opportunities for improvement, root causes, corrective actions and preventive actions.
- Accident/incident/irregularity, in terms of investigation, corrective action, and continuous improvement.
- Minutes of meetings of the Senior Managers to discuss and agree actions to update winter operations (WOM 3.4.6.4).
- Updated ground icing programme, policies and procedures (WOM 3.4.6.4).

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4 FORCED (COLD) AIR FOR REMOVAL OF FROZEN CONTAMINANTS

4.1 FORCED AIR PRECAUTIONS

Forced Air may not remove adhering contaminants and therefore will not eliminate the need for deicing processes in accordance with SAE Standards.

Consult Company Head of Ground Operations limitations for maximum air pressures.

Forced Air / forced air with fluid injections shall not be directed into engines, auxiliary intakes/exhausts or the orifices of pitot heads, static vents or directly onto air stream direction detectors (e.g., probes or angle of attack airflow sensors).

When removing ice, snow or slush from the landing gear and wheel well areas care should be taken as debris may cause damage to components.

NOTE: Landing gear and wheel well areas shall not be treated with forced air with fluid injections.

When removing ice, snow, or slush from aircraft surfaces, care should be taken to prevent it from entering and accumulating in aerodynamically quiet areas—such as control surface hinge areas—or from entering engine inlets as special inspections may then be required.

Care should be taken to prevent loose debris from impacting personnel or other aircraft surfaces.

Forced Air applications may not eliminate the need for deicing/anti-icing processes in accordance with SAE Standards.

When anti-icing is not necessary this process must be followed by a Post Deicing/Anti-icing Check complying with SAE Standards.

NOTE 1: Published Holdover Time guidelines shall not be used when using forced air unless followed by the application of deicing and anti-icing fluid, without forced air (SAE Standards).

NOTE 2: Do not use jet exhaust to remove snow or ice from the airframe. The high pressure and high temperature of jet exhaust can cause damage to the aircraft.

4.2 FORCED AIR (WARM)

Above processes are not allowed procedures for Company aircraft.

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5 NORRA SPECIAL REQUIREMENTS

5.1 ATR 72

5.1.1 Approved De-/Anti-icing Fluids

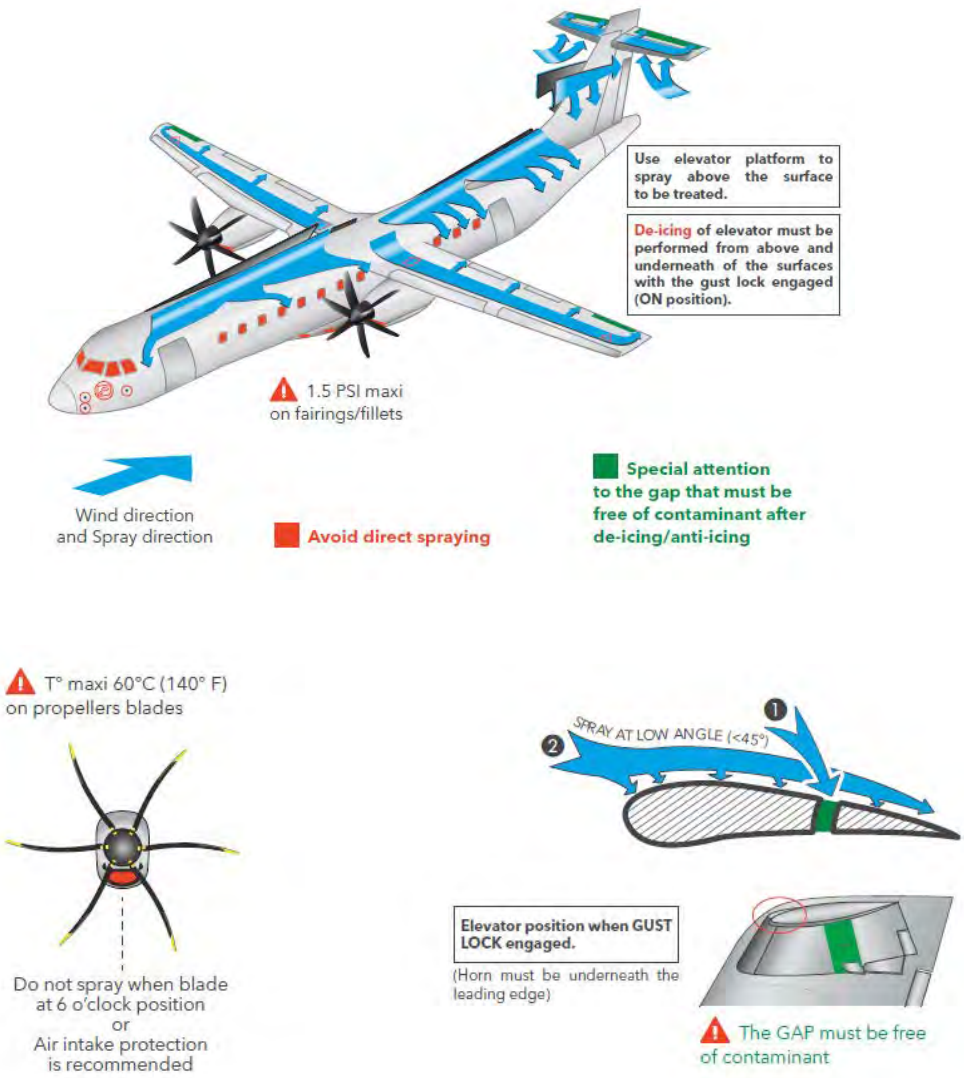
- Type I deicing fluids (in accordance with SAE AMS1424 standard).
- Type II or type IV anti-icing fluid (in accordance with SAE AMS1428 standard).

5.1.2 ATR Deicing

Deicing procedure with PURE WATER is allowed only when the temperature is zero (0) or above zero (0) Celsius degrees, and if the one step or two step procedure is performed immediately after PURE WATER deicing. (Large amount of contamination removed e.g. pre-deicing.)

The temperature of the wing fuel tanks must be confirmed from pilots if only water is used for deicing the wings in order to prevent freezing on the lower tank area.

It is prohibited to taxi to CDF or remote deicing location if deicing is performed with only PURE WATER at gate.



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5.1.3 ATR Deicing/Anti-Icing With Engine Running

5.1.3.1 General

From the perspective of environment protection and fluency of operations, the deicing/anti-icing operations of aircraft at airports shall increasingly be performed at remote deicing/anti-icing stands and Norra has approved deicing operations with ATR engines running.

In the evaluation of approved safety level, the other ground operations, which are performed on the aircraft with engines running have been taken into account among other things. On the basis of risk analysis, it can be stated that deicing/anti-icing is possible to be performed with engines running by maintaining the approved safety level with the following protections:

- Operational procedure.
- Conditions and requirements.
- Instructions for pilots and deicers.
- Communication procedure.
- Training.
- Supervision.

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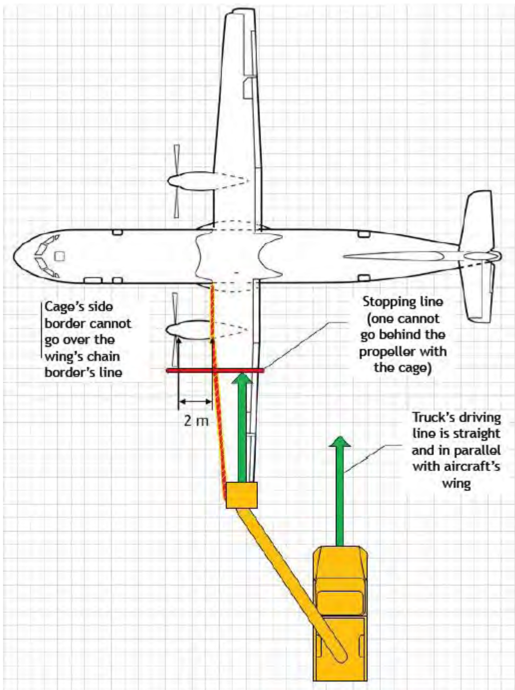
5.1.4 Operational Procedure

5.1.4.1 Option 1

A situation where the deicing truck's cage safety distance is too short can be avoided with a driving line that is in parallel with the wing of the aircraft. The deicer in the truck's cage does not move the cage: the necessary moving is performed from the deicing truck. The location of the deicing cage is, seen from the above, in the middle line of the wing, which is easily estimated from the deicer's eye level. As the deicing/anti-icing proceeds the truck's movement's stopping place is at the stopping line (see picture 1). This ensures the deicing cage's minimum distance (2 m) to the propeller. The driver of the truck is responsible for the driving line being in parallel with the wing, and the deicer sets the cage to the wing's middle line. In case the deicing cage is driven aside from the wing's middle line during deicing/anti-icing, the deicer must require the driver to stop the truck. In case the deicing cage is driven below the accepted minimum safety distance from the propeller, the deicer must require the pilots to stop the engine (see communication method). For deicing/anti-icing propellers' flaps are placed to resting position, when the rotational speed is lowest and the propeller does not produce expulsive force.

Picture 1



NOTE: Air intake and propeller deicing/anti-icing must be performed prior to the deicing/anti-icing with engine running or Hotel Mode activation.

Picture 2

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5.1.4.2 Option 2

The safety distance from the wing can be achieved with wing parallel boom movements.

The deicer does not move the boom sideways, only back and forth. Truck will not be able to drive at the same time as spraying. Truck positioning on the wing (see picture 1.) Deicer is responsible for ensuring that the safety distance to the propeller (2m) is not exceeded when spraying.

Picture 1

When deicing / anti - icing the fuselage, the truck is driven in front of the aircraft so that the boom movement is in the same direction as fuselage (see picture 2). Deicer is responsible for ensuring that the safety distance to the propeller (2m) is not exceeded when spraying.

Picture 2

If the propeller air flow prevents spraying the wing area between the engines, the truck is driven in front of the stabilizer where the boom is extended and the nozzle is above the wing. The spray direction must be from the leading edge to the trailing edge. Deicer is responsible for ensuring that the safety distance to the propeller (2m) is not exceeded when spraying.

Picture 3

5.1.4.3 Conditions and Requirements

Conditions and requirements:

- Pilots and deicers must be trained to the method.
- If it cannot be made sure that all necessary areas are handled, the deicing has to be conducted with Hotel Mode or engine shut down from the side that is being deiced.
- Deicing from below the wing is prohibited.
- Deicing / anti -icing aircraft's fuselage (the front of the engines) is prohibited **option 1** process (with deicing cage).
- Deicing truck's lighting must function when dark.
- The system related to deicing cage's movement has to be operational.
- There must be an intercommunication connection between the driver and the deicer.
- There must be a bilateral radio connection between the deicing personnel and the pilots.
- The method can be adjusted when the wind is less than 14 m/s (27 kt, wind information from the pilot via radio).

5.1.4.4 Instructions for Pilots

Pilots' instructions include the right kind of communication method, restrictions and the method for shutting down an engine in case the minimum safety distance is fallen below. Pilots' instructions are described in the aircraft type's OM-B.

5.1.4.5 Communication Procedure

There must be an intercommunication connection between the driver and the deicer. There must be a bilateral radio connection between the deicing personnel and the pilots. For communication, phraseology is being determined, which secures that all parties are in agreement with what is going to happen and also fast reaction speed is ensured in abnormal cases.

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5.1.4.6 Determined Phraseology

Phraseology is determined in the following situations:

- Aircraft is being taxied to the deice removal stand and it stops (pilot) "PARKING BRAKE SET".
- Commencing deicing (pilot) "DEICING OF WINGS AND STABILISERS WITH ENGINES RUNNING, WIND XX KNOTS".

NOTE: Pilot informs the latest METAR information including the breeze information to the deicer. In case the wind limit of 27 knots is exceeded, engines must be shut down for deicing or the deicing shall be conducted with Hotel Mode.

Commencing deicing (Deicer) "DEICING OF WINGS AND STABILISERS WITH ENGINES RUNNING…"

or

"DEICING WITH ENGINES RUNNING NOT POSSIBLE DUE TO (reason) INFORM WHEN READY TO CONDUCT DEICING WITH HOTEL MODE."

or

"INFORM WHEN READY TO CONDUCT DEICING WITH RIGHT/LEFT ENGINE SHUT DOWN, I WILL INFORM WHEN THE SHUT DOWN SIDE IS READY FOR START-UP AND ALSO WHEN THE LEFT/RIGHT SIDE CAN BE SHUT DOWN FOR DEICING."

EMERGENCY SHUT-DOWN COMMUNICATION:

- Under-swinging the safety destination (Deicer) "SHUT DOWN THE LEFT/RIGHT ENGINE"
- Under-swinging the safety destination (Pilot) "LEFT/RIGHT ENGINE BEING SHUT DOWN"

5.1.4.7 Training

Risks, how to be protected from the risks, as well as, things affecting to the effectiveness of protection shall be trained to the personnel involved in deicing.

Training shall be given in three steps:

1) Theoretical training.
2) Practical training.
3) Demonstration of skill.

The 3-step training program shall be documented by the deicing company.

5.1.4.8 Supervision

The Head of Ground Operations is responsible that instructions are documented in the Winter Operations Manual. The Head of Flight Operations is in charge of instructing the method to the pilots.

NOTE: All deviations shall be reported, see GOM 3.2.6 "Reporting of Accidents, Incidents and Occurrences".

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5.2 E-JET 190

5.2.1 Approved De-/Anti-icing Fluids

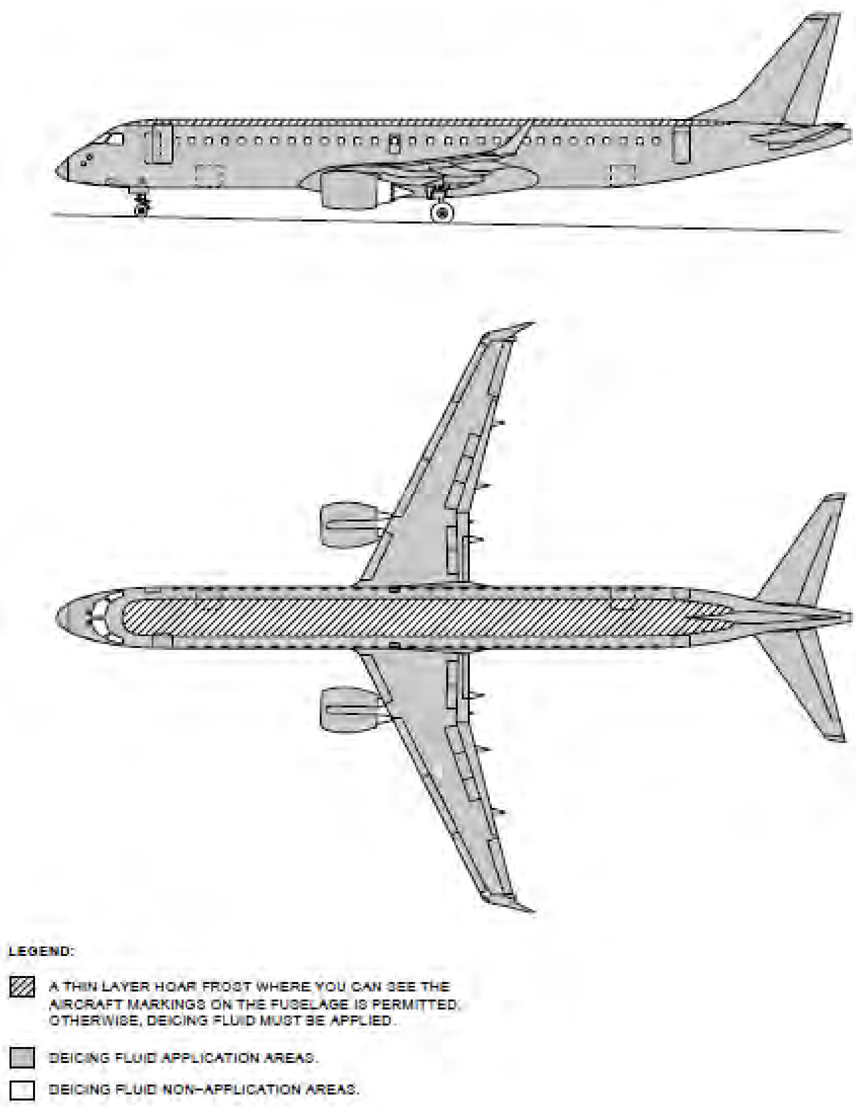
- Type I deicing fluids (in accordance with SAE AMS1424 standard).
- Type II or type IV anti-icing fluid (in accordance with SAE AMS1428 standard).

5.2.2 Deicing E190

Deicing procedure with PURE WATER is allowed only when the temperature is zero (0) or above zero (0) Celsius degrees, and if the one step or two step procedure is performed immediately after PURE WATER deicing. (Large amount of contamination removed e.g. pre-deicing.)

The temperature of the wing fuel tanks must be confirmed from pilots if only water is used for deicing the wings in order to prevent freezing on the lower tank area.

It is prohibited to taxi to CDF or remote deicing location if deicing is performed with only PURE WATER at gate.



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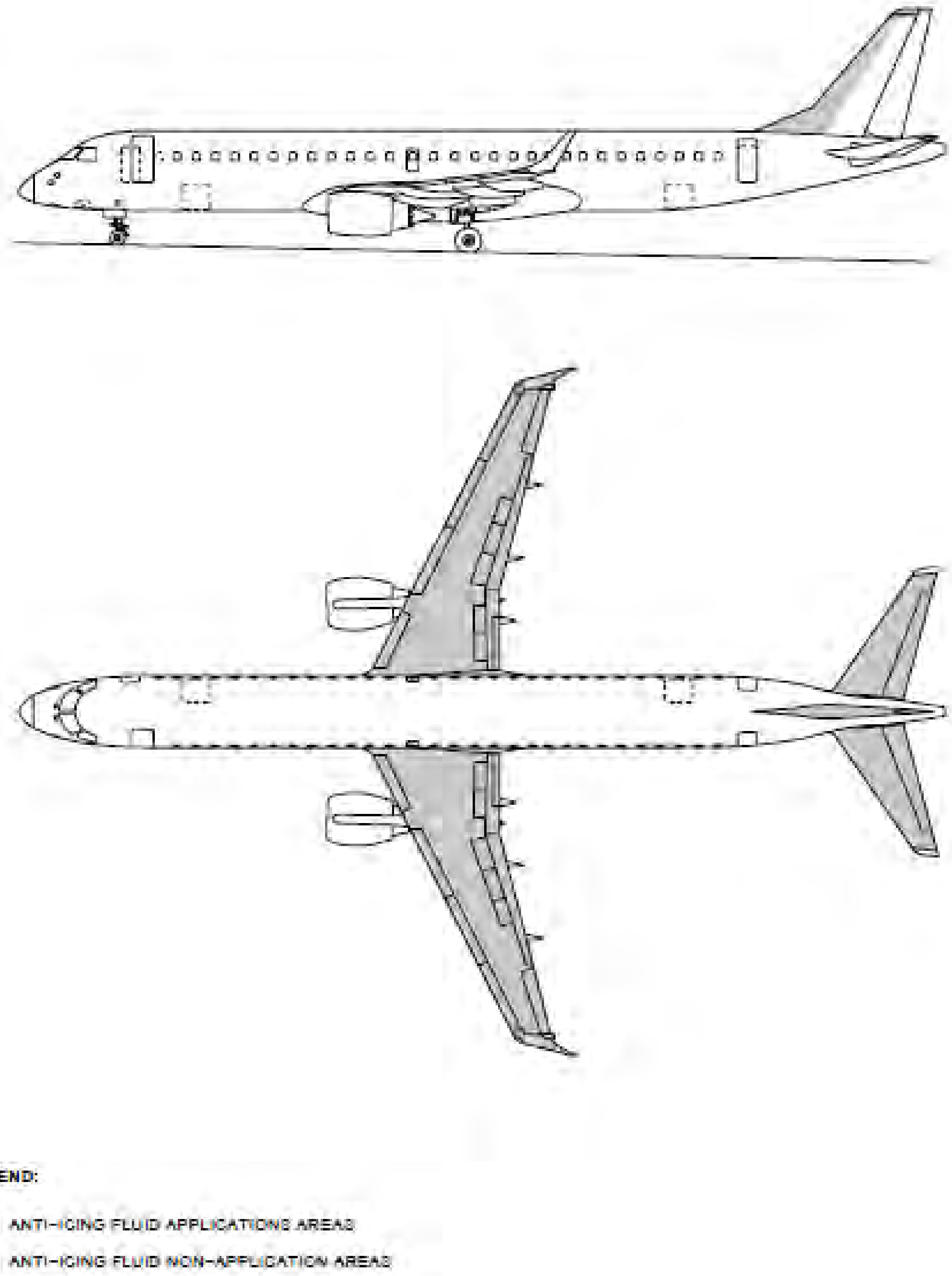
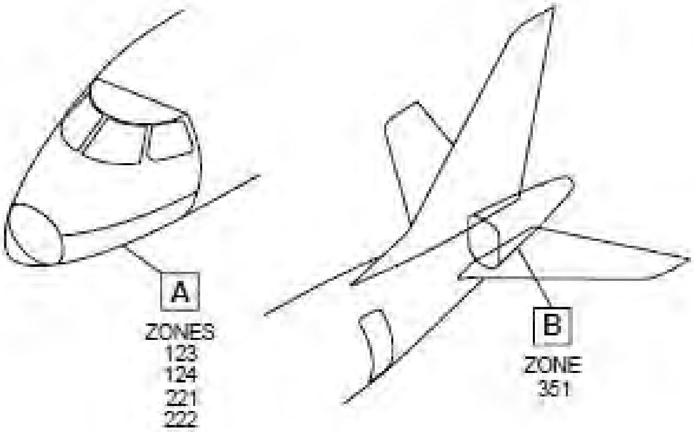
5.2.3 Anti-icing E190

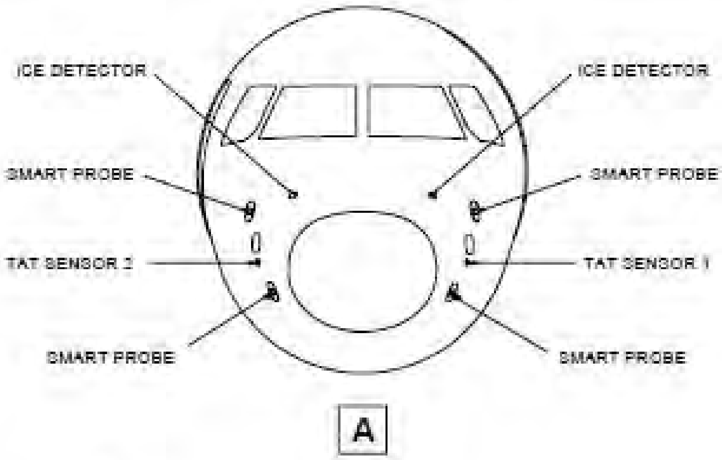


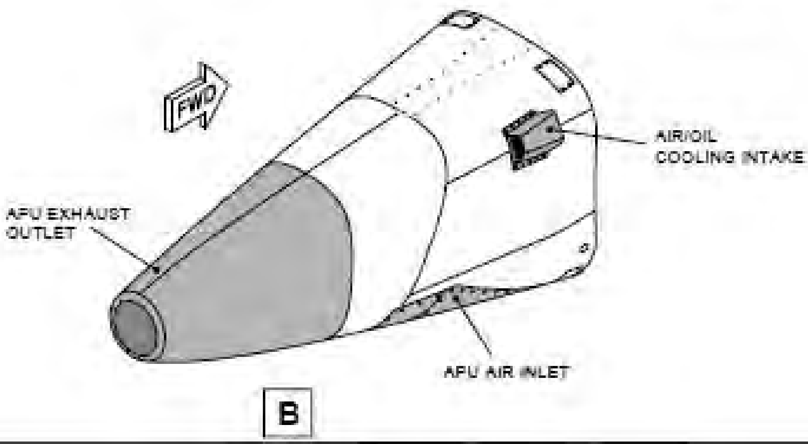
5.2.4 Post Deicing / Anti-Icing Checks

Perform the following checks:

- Make sure that the nose radome and adjacent area are clear of ice and snow.
- Make sure that the flight control surfaces are clear from icing contamination.
- Make sure that the engine, APU, air conditioning, vent, and NACA air inlets are clear.
- Make sure that the landing gear doors and locks, the proximity sensors, the free-fall device, the brakes and the auxiliary brace structure are free from ice or snow accumulation.
- Make sure that the Smart Probes, Pressurization Static Ports, TAT Sensors and Ice Detectors have no ice or snow collection or obstructions or deicing/anti-icing fluid or fluid residues.
- Make sure that the FWD passenger door, aft passenger door and escape hatches have no ice or snow collected.
- Make sure that all drains are clear.

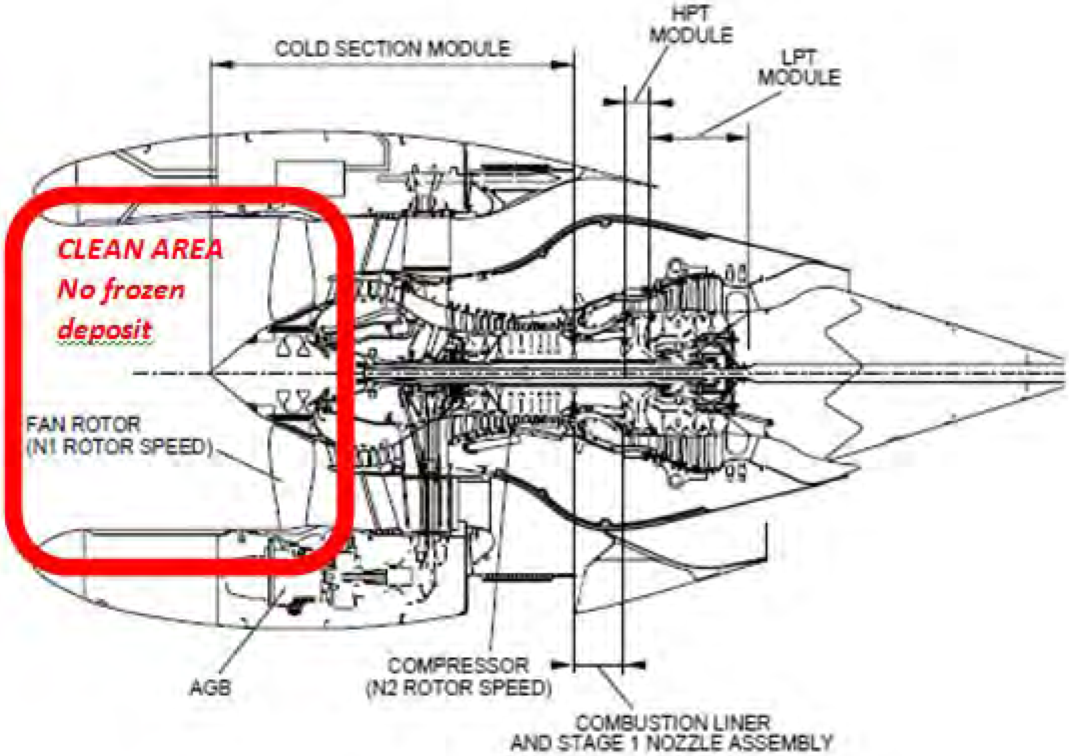




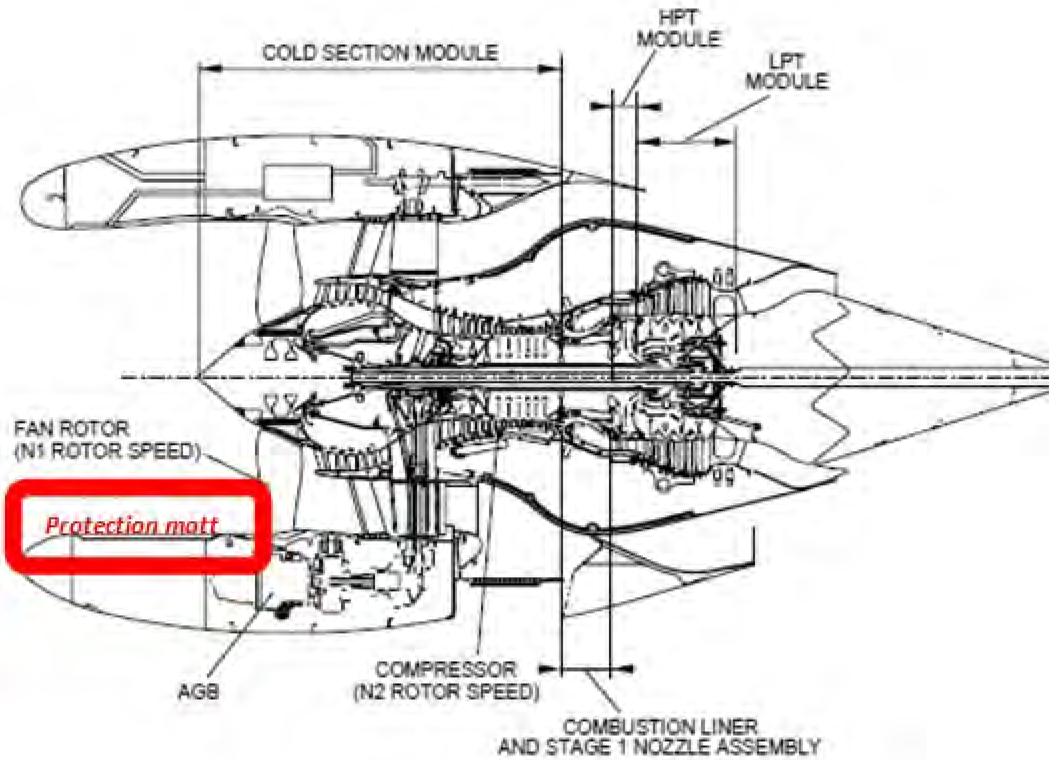


5.2.5 E-Jet Engines

Deposits of snow shall be removed mechanically from engine intakes prior to departure. Any frozen deposits that have bonded to either the lower surface of the intake, the fan blades including the rear side, shall be removed by hot air or brush.

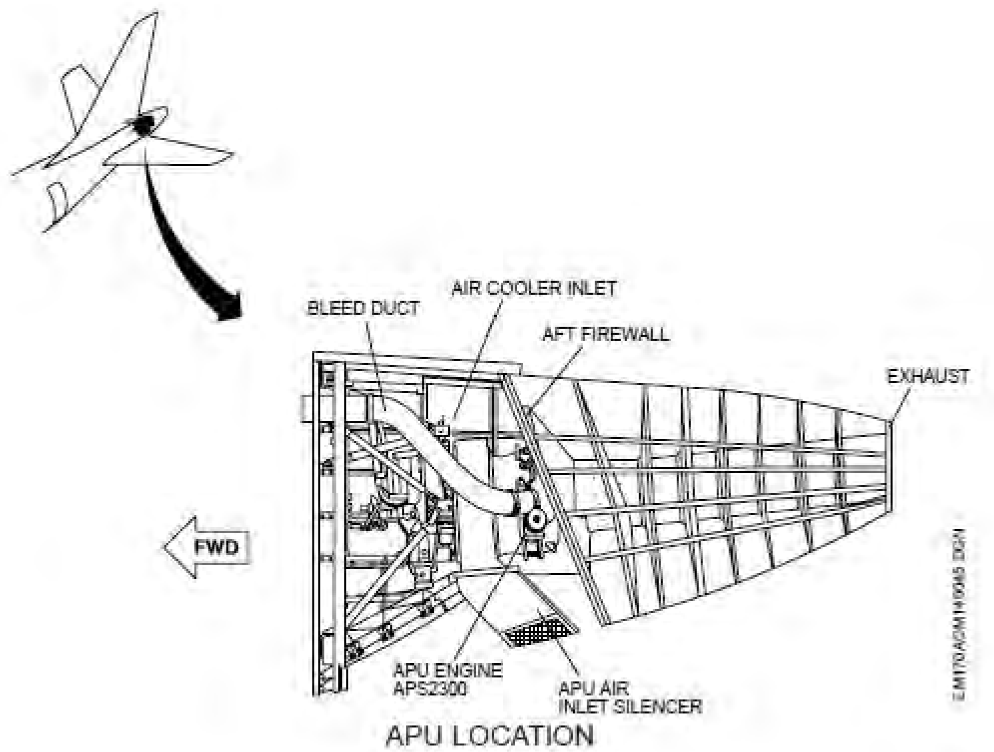


Always use protection matt when deicing the engine



5.2.6 APU (E-Jet)

Deicing fluid shall not be sprayed towards the inlet or exhaust of the APU. Engines are normally shut down but may remain running at idle during deicing/anti-icing operations. All reasonable precautions shall be taken to minimize fluid entry or near APU – inlet/outlet area.



5.3 DEICING FLUID (ATR AND E-JET)

The correct fluid concentration shall be chosen with regard to desired holdover time and is dictated by outside air temperature and weather conditions. The second step shall be performed before first step fluid freezes, if necessary area by area.

Where fluid with a negative buffer is used for the first step and/or when treating composite surfaces, freezing may happen quickly. A two step procedure is common during freezing precipitation. The second step shall be applied in such a way that it gives a complete, sufficient and an even layer of anti-icing fluid on the treated surfaces. It is the responsibility of the Deicing Operator to ensure that all frozen deposits have been removed from the treated surfaces, before applying the second step fluid.

When Type I used for anti-icing, minimum of 1 litre/m2 is required. Fluid mixture shall be heated to at least 60°C.

6 HOLDOVER TIME (HOT) AND FLUID TABLES

6.1 GENERAL

Norra primarily uses holdover time determination systems (HOTDS) to determine holdover times based on liquid water equivalent (LWE) and OAT. These holdover times may differ from those published in the Winter Operations Manual.

6.2 ACTIVE FROST HOLDOVER GUIDELINES

ATR and E-Jet Fleet

Norra uses FAA Holdover time guidelines for holdover times anticipated for Type I, II, III and IV fluid mixtures in Active Frost Conditions as a function of OAT.

TABLE 1: ACTIVE FROST HOLDOVER TIMES FOR SAE TYPE I, TYPE II, TYPE III, AND TYPE IV FLUIDS[1]

Outside Air Temperature[2,3,4]	Type I Aluminum	Type I Composite
-1 °C and above (30 °F and above)	0:45	0:35
below -1 to -3 °C (below 30 to 27 °F)		
below -3 to -10 °C (below 27 to 14 °F)		
below -10 to -14 °C (below 14 to 7 °F)		
below -14 to -21 °C (below 7 to -6 °F)		
below -21 to -25 °C (below -6 to -13 °F)		
below -25 °C to LOUT (below -13 °F to LOUT)		

Outside Air Temperature[3,4]	Concentration Fluid/Water By % Volume	Type II	Type III[5]	Type IV
-1 °C and above (30 °F and above)	100/0	8:00	2:00	12:00
	75/25	5:00	1:00	5:00
	50/50	2:00	0:30	3:00
below -1 to -3 °C (below 30 to 27 °F)	100/0	8:00	2:00	12:00
	75/25	5:00	1:00	5:00
	50/50	1:30	0:30	3:00
below -3 to -10 °C (below 27 to 14 °F)	100/0	8:00	2:00	10:00
	75/25	4:00	1:00	5:00
below -10 to -14 °C (below 14 to 7 °F)	100/0	6:00	2:00	6:00
	75/25	1:00	1:00	1:00
below -14 to -21 °C (below 7 to -6 °F)	100/0	3:00	2:00	6:00
below -21 to -25 °C (below -6 to -13 °F)	100/0	2:00	2:00	4:00
below -25 °C (below -13 °F)	100/0	No Holdover Time Guidelines Exist		

NOTES

1 To use the HOTs in this table, ensure that the fluid and dilution being used is listed in the List of Qualified Fluids Tested for Anti-Icing Performance and Aerodynamic Acceptance table (Table 49 - Table 52). Any restrictions on the use of the fluid have to be identified and applied.
2 Type I Fluid / Water Mixture must be selected so that the freezing point of the mixture is at least 10 °C (18 °F) below outside air temperature.
3 Ensure that the lowest operational use temperature (LOUT) is respected.
4 Changes in outside air temperature (OAT) over the course of longer frost events can be significant; the appropriate holdover time to use is the one provided for the coldest OAT that has occurred in the time between the de/anti-icing fluid application and takeoff.
5 To use the Type III fluid frost holdover times, the fluid brand being used must be known. AllClear AeroClear MAX must be applied unheated.

CAUTIONS

- The cautions that apply to the holdover times in the table above can be found on page 9.

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6.3 TYPE I FLUID HOLDOVER GUIDELINES ON ALUMINUM WING SURFACES

E-JET Fleet

Norra uses FAA Holdover time guidelines for Type I as below:

TABLE 2: HOLDOVER TIMES FOR SAE TYPE I FLUID ON CRITICAL AIRCRAFT SURFACES COMPOSED PREDOMINANTLY OF ALUMINUM

Outside Air Temperature[1,2]	Freezing Fog, Freezing Mist[3], or Ice Crystals[4]	Snow mixed with Freezing Fog[5]	Very Light Snow, Snow Grains or Snow Pellets[6,7,8]	Light Snow, Snow Grains or Snow Pellets[6,7,8]	Moderate Snow, Snow Grains or Snow Pellets[6,8]	Freezing Drizzle[9]	Light Freezing Rain	Rain on Cold-Soaked Wing[10]	Other[11]
-3 °C and above (27 °F and above)	0:11 - 0:17	0:05 - 0:08	0:18 - 0:22	0:11 - 0:18	0:06 - 0:11	0:09 - 0:13	0:02 - 0:05	0:02 - 0:05	CAUTION: No holdover time guidelines exist
below -3 to -6 °C (below 27 to 21 °F)	0:08 - 0:13	0:04 - 0:06	0:14 - 0:17	0:08 - 0:14	0:05 - 0:08	0:05 - 0:09	0:02 - 0:05	CAUTION: No holdover time guidelines exist	CAUTION: No holdover time guidelines exist
below -6 to -10 °C (below 21 to 14 °F)	0:06 - 0:10	0:03 - 0:05	0:11 - 0:13	0:06 - 0:11	0:04 - 0:06	0:04 - 0:07	0:02 - 0:05	CAUTION: No holdover time guidelines exist	CAUTION: No holdover time guidelines exist
below -10 °C (below 14 °F)	0:05 - 0:09	0:02 - 0:03	0:07 - 0:08	0:04 - 0:07	0:02 - 0:04	CAUTION: No holdover time guidelines exist	CAUTION: No holdover time guidelines exist	CAUTION: No holdover time guidelines exist	CAUTION: No holdover time guidelines exist

NOTES

1 Type I fluid / water mixture must be selected so that the freezing point of the mixture is at least 10 °C (18 °F) below outside air temperature.
2 Ensure that the lowest operational use temperature (LOUT) is respected.
3 Freezing mist is best confirmed by observation. It is never reported by METAR however it can occur when mist is present at 0 °C (32 °F) and below.
4 Use freezing fog holdover times in conditions of ice crystals mixed with freezing fog or mist.
5 These holdover times are for use in -SNFZFG and SNFZFG. The Snowfall Intensities as a Function of Prevailing Visibility table (Table 48) is required to confirm the precipitation intensity is no greater than "moderate". No holdover times exist if the reported visibility correlates to a "heavy" precipitation intensity.
6 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 48) is required.
7 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain or drizzle. The Snowfall Intensities as a Function of Prevailing Visibility table (Table 48) is required to confirm the precipitation intensity is no greater than "light". No holdover times exist if the reported visibility correlates to a "moderate" or "heavy" precipitation intensity.
8 Use snow holdover times in conditions of very light, light, or moderate snow mixed with ice crystals.
9 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
10 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
11 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.

CAUTIONS

- The cautions that apply to the holdover times in the table above can be found on page 11.

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6.4 TYPE I FLUID HOLDOVER GUIDELINES ON COMPOSITE WING SURFACES

ATR Fleet

Norra uses FAA holdover time guidelines for Type I as below:

FAA Holdover Time Guidelines **Winter 2024-2025**

TABLE 3: HOLDOVER TIMES FOR SAE TYPE I FLUID ON CRITICAL AIRCRAFT SURFACES COMPOSED PREDOMINANTLY OF COMPOSITES

Outside Air Temperature[1,2]	Freezing Fog, Freezing Mist[3], or Ice Crystals[4]	Snow mixed with Freezing Fog[5]	Very Light Snow, Snow Grains or Snow Pellets[6,7,8]	Light Snow, Snow Grains or Snow Pellets[6,7,8]	Moderate Snow, Snow Grains or Snow Pellets[6,8]	Freezing Drizzle[9]	Light Freezing Rain	Rain on Cold-Soaked Wing[10]	Other[11]
-3 °C and above (27 °F and above)	0:09 - 0:16	0:02 - 0:04	0:12 - 0:15	0:06 - 0:12	0:03 - 0:06	0:08 - 0:13	0:02 - 0:05	0:01 - 0:05	
below -3 to -6 °C (below 27 to 21 °F)	0:06 - 0:08	0:02 - 0:04	0:11 - 0:13	0:05 - 0:11	0:02 - 0:05	0:05 - 0:09	0:02 - 0:05		
below -6 to -10 °C (below 21 to 14 °F)	0:04 - 0:08	0:02 - 0:04	0:09 - 0:12	0:05 - 0:09	0:02 - 0:05	0:04 - 0:07	0:02 - 0:05	CAUTION: No holdover time guidelines exist	
below -10 °C (below 14 °F)	0:04 - 0:07	0:02 - 0:03	0:07 - 0:08	0:04 - 0:07	0:02 - 0:04				

NOTES

1 Type I fluid / water mixture must be selected so that the freezing point of the mixture is at least 10 °C (18 °F) below outside air temperature.
2 Ensure that the lowest operational use temperature (LOUT) is respected.
3 Freezing mist is best confirmed by observation. It is never reported by METAR however it can occur when mist is present at 0 °C (32 °F) and below.
4 Use freezing fog holdover times in conditions of ice crystals mixed with freezing fog or mist.
5 These holdover times are for use in -SNFZFG and SNFZFG. The Snowfall Intensities as a Function of Prevailing Visibility table (Table 48) is required to confirm the precipitation intensity is no greater than "moderate". No holdover times exist if the reported visibility correlates to a "heavy" precipitation intensity.
6 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 48) is required.
7 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain or drizzle. The Snowfall Intensities as a Function of Prevailing Visibility table (Table 48) is required to confirm the precipitation intensity is no greater than "light". No holdover times exist if the reported visibility correlates to a "moderate" or "heavy" precipitation intensity.
8 Use snow holdover times in conditions of very light, light, or moderate snow mixed with ice crystals.
9 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
10 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
11 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.

CAUTIONS

- The cautions that apply to the holdover times in the table above can be found on page 11.

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6.5 TYPE II FLUID HOLDOVER GUIDELINES

ATR and E-Jet Fleet

Norra uses FAA holdover time guidelines anticipated for Type II fluid mixtures as a function of weather conditions and OAT.

FAA Holdover Time Guidelines **Winter 2024-2025**

TABLE 4: GENERIC HOLDOVER TIMES FOR SAE TYPE II FLUIDS[1]

Outside Air Temperature[2]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog, Freezing Mist[3], or Ice Crystals[4]	Snow mixed with Freezing Fog[5]	Snow, Snow Grains or Snow Pellets[6,7,8]	Freezing Drizzle[9]	Light Freezing Rain	Rain on Cold-Soaked Wing[10]	Other[11]
-3 °C and above (27 °F and above)	100/0	0:55 - 1:50	0:20 - 0:40	0:30 - 0:55	0:35 - 1:05	0:25 - 0:35	0:07 - 0:45	CAUTION: No holdover time guidelines exist
	75/25	0:40 - 1:10	0:15 - 0:25	0:15 - 0:30	0:25 - 0:40	0:15 - 0:25	0:04 - 0:25	
	50/50	0:15 - 0:30	0:05 - 0:10	0:07 - 0:15	0:09 - 0:15	0:06 - 0:09		
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:30 - 0:45	0:15 - 0:30	0:20 - 0:40	0:20 - 0:45	0:15 - 0:20		
	75/25	0:25 - 0:55	0:09 - 0:15	0:10 - 0:25	0:15 - 0:30	0:08 - 0:15		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:30 - 0:45	0:10 - 0:25	0:15 - 0:30	0:20 - 0:45[12]	0:15 - 0:20[12]		
	75/25	0:25 - 0:55	0:07 - 0:15	0:09 - 0:20	0:15 - 0:30[12]	0:08 - 0:15[12]		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:15 - 0:20	0:01 - 0:05	0:02 - 0:07				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:15 - 0:20	0:00 - 0:02	0:01 - 0:03				
below -25 °C to LOUT[13] (below -13 °F to LOUT)	100/0	0:15 - 0:20	0:00 - 0:00	0:00 - 0:01				

NOTES

1 To use the HOTs in this table, ensure that the fluid and dilution being used is listed in the Type II Fluids Tested for Anti-Icing Performance and Aerodynamic Acceptance table (Table 50). Any restrictions on the use of the fluid have to be identified and applied.
2 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
3 Freezing mist is best confirmed by observation. It is never reported by METAR however it can occur when mist is present at 0 °C (32 °F) and below.
4 Use freezing fog holdover times in conditions of ice crystals mixed with freezing fog or mist.
5 These holdover times are for use in -SNFZFG and SNFZFG. The Snowfall Intensities as a Function of Prevailing Visibility table (Table 48) is required to confirm the precipitation intensity is no greater than “moderate”. No holdover times exist if the reported visibility correlates to a “heavy” precipitation intensity.
6 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 48) is required.
7 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain or drizzle. The Snowfall Intensities as a Function of Prevailing Visibility table (Table 48) is required to confirm the precipitation intensity is no greater than “light”. No holdover times exist if the reported visibility correlates to a “moderate” or “heavy” precipitation intensity.
8 Use snow holdover times in conditions of very light, light, or moderate snow mixed with ice crystals.
9 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
10 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
11 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
12 No holdover time guidelines exist for this condition below -10 °C (14 °F).
13 If the LOUT is unknown, no holdover time guidelines exist below -25 °C (-13 °F).

CAUTIONS

- The cautions that apply to the holdover times in the table above can be found on page 14.

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6.6 TYPE IV FLUID HOLDOVER GUIDELINES

ATR and E-JET Fleet

Norra uses FAA holdover time guidelines for holdover times anticipated for Type IV fluid mixtures as a function of weather conditions and OAT.

FAA Holdover Time Guidelines **Winter 2024-2025**

TABLE 18: GENERIC HOLDOVER TIMES FOR SAE TYPE IV FLUIDS[1]

Outside Air Temperature[2]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog, Freezing Mist[3], or Ice Crystals[4]	Snow mixed with Freezing Fog[5]	Very Light Snow, Snow Grains or Snow Pellets[6,7,8]	Light Snow, Snow Grains or Snow Pellets[6,7,8]	Moderate Snow, Snow Grains or Snow Pellets[6,8]	Freezing Drizzle[9]	Light Freezing Rain	Rain on Cold-Soaked Wing[10]	Other[11]
-3 °C and above (27 °F and above)	100/0	1:15 - 2:15	0:25 - 0:45	1:55 - 2:20	1:00 - 1:55	0:30 - 1:00	0:40 - 1:10	0:20 - 0:35	0:08 - 1:05	
	75/25	1:25 - 2:40	0:30 - 0:55	2:05 - 2:25	1:15 - 2:05	0:40 - 1:15	1:00 - 1:20	0:30 - 0:50	0:09 - 1:20	
	50/50	0:30 - 0:55	0:07 - 0:20	1:00 - 1:10	0:25 - 1:00	0:10 - 0:25	0:15 - 0:40	0:09 - 0:20		
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:15 - 0:35	0:20 - 0:40	1:45 - 2:05	0:55 - 1:45	0:25 - 0:55	0:25 - 1:10	0:20 - 0:25		
	75/25	0:40 - 1:20	0:25 - 0:50	1:50 - 2:10	1:05 - 1:50	0:30 - 1:05	0:20 - 1:05	0:15 - 0:25		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:15 - 0:35	0:15 - 0:35	1:30 - 1:50	0:45 - 1:30	0:20 - 0:45	0:25 - 1:10[12]	0:20 - 0:25[12]	CAUTION: No holdover time guidelines exist	
	75/25	0:40 - 1:20	0:20 - 0:45	1:45 - 2:00	0:55 - 1:45	0:25 - 0:55	0:20 - 1:05[12]	0:15 - 0:25[12]		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:15 - 0:30	0:01 - 0:06	0:30 - 0:45	0:09 - 0:30	0:02 - 0:09				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:15 - 0:30	0:00 - 0:02	0:10 - 0:20	0:03 - 0:10	0:01 - 0:03				
below -25 °C to LOUT[13] (below -13 °F to LOUT)	100/0	0:15 - 0:30	0:00 - 0:01	0:07 - 0:10	0:02 - 0:07	0:00 - 0:02				

NOTES

1 To use the HOTs in this table, ensure that the fluid and dilution being used is listed in the Type IV Fluids Tested for Anti-Icing Performance and Aerodynamic Acceptance table (Table 52). Any restrictions on the use of the fluid have to be identified and applied.
2 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
3 Freezing mist is best confirmed by observation. It is never reported by METAR however it can occur when mist is present at 0 °C (32 °F) and below.
4 Use freezing fog holdover times in conditions of ice crystals mixed with freezing fog or mist.
5 These holdover times are for use in -SNFZFG and SNFZFG. The Snowfall Intensities as a Function of Prevailing Visibility table (Table 48) is required to confirm the precipitation intensity is no greater than “moderate”. No holdover times exist if the reported visibility correlates to a “heavy” precipitation intensity.
6 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 48) is required.
7 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain or drizzle. The Snowfall Intensities as a Function of Prevailing Visibility table (Table 48) is required to confirm the precipitation intensity is no greater than “light”. No holdover times exist if the reported visibility correlates to a “moderate” or “heavy” precipitation intensity.
8 Use snow holdover times in conditions of very light, light, or moderate snow mixed with ice crystals.
9 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
10 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
11 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table 46 provides allowance times for Type IV EG fluids and Table 47 provides allowance times for Type IV PG fluids in ice pellets and small hail. If the glycol type is unknown, the allowance times for SAE Type IV PG fluids should be used).
12 No holdover time guidelines exist for this condition below -10 °C (14 °F).
13 If the LOUT is unknown, no holdover time guidelines exist below -25.5 °C (-14 °F).

CAUTIONS

- The cautions that apply to the holdover times in the table above can be found on page 30.

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6.7 ALLOWANCE TIMES FOR TYPE IV FLUIDS

FAA Holdover Time Guidelines **Winter 2024-2025**

TABLE 47: ALLOWANCE TIMES FOR SAE TYPE IV PROPYLENE GLYCOL (PG) FLUIDS[1,2]

Precipitation Types or Combinations and Applicable METAR Codes[6]	Outside Air Temperature				
	Above 0 °C[3] (32 °F and above)	0 to -5 °C[3] (32 to 23 °F)	Below -5 to -10 °C[3] (Below 23 to 14 °F)	Below -10 to -16 °C[4] (Below 14 to 3 °F)	Below -16 to -22 °C[4,5] (Below 3 to -8 °F)
Light Ice Pellets -PL, -GS	50 minutes	50 minutes	30 minutes	30 minutes	20 minutes
Light Ice Pellets Mixed with Light Snow -PLSN, -SNPL, -GSSN, -SNGS	40 minutes	40 minutes	15 minutes	15 minutes	
Light Ice Pellets Mixed with Light or Moderate Freezing Drizzle -PLFZDZ, -FZDZPL, FZDZPL, -GSFZDZ -FZDZGS, FZDZGS		25 minutes	10 minutes		
Light Ice Pellets Mixed with Light or Moderate Drizzle -PLDZ, -DZPL, DZPL, -GSDZ, -DZGS, DZGS	25 minutes				
Light Ice Pellets Mixed with Light Freezing Rain -PLFZRA, -FZRAPL, -GSFZRA, -FZRAGS		25 minutes	10 minutes	**Caution: No allowance times currently exist**	
Light Ice Pellets Mixed with Light Rain -PLRA, -RAPL, -GSRA, -RAGS	25 minutes				
Light Ice Pellets Mixed with Light Rain and Light Snow -PLRASN, -PLSNRA, -RAPLSN, -RASNPL, -SNPLRA, -SNRAPL, -GSRASN, -GSSNRA, -RAGSSN, -RASNGS, -SNGSRA, -SNRAGS	20 minutes				
Light Ice Pellets Mixed with Light Freezing Rain and Light Snow -PLFZRASN, -PLSNFZRA, -FZRAPLSN, -FZRASNPL, -SNPLFZRA, -SNFZRAPL, -GSFZRASN, -GSSNFZRA, -FZRAGSSN, -FZRASNGS, -SNGSFZRA, -SNFZRAGS		20 minutes			
Moderate Ice Pellets (or Small Hail) PL, GS	15 minutes	15 minutes	10 minutes	10 minutes	
Moderate Ice Pellets (or Small Hail) Mixed with Moderate Snow PLSN, SNPL, GSSN, SNGS	15 minutes	5 minutes	5 minutes		
Moderate Ice Pellets (or Small Hail) Mixed with Moderate Freezing Drizzle PLFZDZ, GSFZDZ		10 minutes	7 minutes		
Moderate Ice Pellets (or Small Hail) Mixed with Moderate Drizzle PLDZ, GSDZ	10 minutes		**Caution: No allowance times currently exist**		
Moderate Ice Pellets (or Small Hail) Mixed with Moderate Rain PLRA, GSRA, RAPL, RAGS	10 minutes				

NOTES

- The notes that apply to the allowance times in the table above can be found on page 63.

CAUTIONS

- The cautions that apply to the allowance times in the table above can be found on page 57.

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TABLE 47 (CONT'D): ALLOWANCE TIMES FOR SAE TYPE IV PROPYLENE GLYCOL (PG) FLUIDS

NOTES

1 These allowance times are for use with undiluted (100/0) PG based fluids applied on aircraft with rotation speeds of 100 knots or greater. If the glycol type is unknown, the allowance times for SAE Type IV PG fluids should be used. To use the allowance times in this table, ensure the fluid being used is listed in the List of Fluids Validated for the Use of Allowance Times Table (Table 44).

2 Takeoff is allowed up to 90 minutes after start of fluid application if the precipitation stops at or before the allowance time expires and does not restart. Takeoff is not permitted if the OAT decreases during the 90 minutes in conditions of light ice pellets mixed with either: light or moderate freezing drizzle, light or moderate drizzle, light freezing rain, light rain, light rain and light snow, or light freezing rain and light snow..

3 No allowance times exist for PG based fluids when used on aircraft with rotation speeds less than 100 knots.

4 No allowance times exist for PG based fluids when used on aircraft with rotation speeds less than 115 knots.

5 Ensure that the lowest operational use temperature (LOUT) is respected.

6 In the US, small hail is reported as GR with the remark "GR LESS THAN ¼". Outside of the US , small hail is reported as GS. If the METAR does not report an intensity for small hail, use the "moderate ice pellets or small hail" allowance times. If the METAR reports an intensity with small hail, the ice pellet condition with the equivalent intensity can be used. This also applies in mixed conditions.

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6.8 SNOWFALL INTENSITIES AS A FUNCTION OF PREVAILING VISIBILITY

TABLE 48: SNOWFALL INTENSITIES AS A FUNCTION OF PREVAILING VISIBILITY

Visibility		Day		Night	
Statute Miles	Meters	-1°C and below 30 °F and below	Above -1°C Above 30 °F	-1°C and Below 30 °F and below	Above -1°C Above 30 °F
≤1/4 (≤3/8)	**≤400** (≤600)	Heavy	Heavy	Heavy	Heavy
1/2 (>3/8 to ≤5/8)	**800** (>600 to ≤1000)	Moderate	Heavy	Heavy	Heavy
3/4 (>5/8 to ≤7/8)	**1200** (>1000 to ≤1400)	Moderate	Moderate	Moderate	Heavy
1 (>7/8 to ≤1 1/8)	**1600** (>1400 to ≤1800)	Light	Light	Moderate	Moderate
1 ¼ (>1 1/8 to ≤1 3/8)	**2000** (>1800 to ≤2200)	Light	Light	Moderate	Moderate
1 ½ (>1 3/8 to ≤1 5/8)	**2400** (>2200 to ≤2600)	Light	Light	Moderate	Moderate
1 ¾ (>1 5/8 to ≤1 7/8)	**2800** (>2600 to ≤3000)	Very Light	Light	Light	Light
2 (>1 7/8 to ≤2 ¼)	**3200** (>3000 to ≤3600)	Very Light	Very Light	Light	Light
2 ½ (>2 ¼ to ≤2 ¾)	**4000** (>3600 to ≤4400)	Very Light	Very Light	Very Light	Very Light
3 (>2 ¾ to ≤3 ¼)	**4800** (>4400 to ≤5200)	Very Light	Very Light	Very Light	Very Light
≥3 ½ (>3 ¼)	**≥5600** (>5200)	Very Light	Very Light	Very Light	Very Light

NOTES

- The METAR/SPECI reported visibility or flight crew observed visibility will be used with this visibility table to establish snowfall intensity for Type I, II, III and IV holdover time guidelines, during snow, snow grain, or snow pellet precipitation conditions. This visibility table will also be used when snow, snow grains, or snow pellets are accompanied by blowing or drifting snow, or when snow is mixed with ice crystals or freezing fog in the METAR/SPECI.
- The use of Runway Visual Range (RVR) is not permitted for determining visibility used with the holdover tables.
- Some METARs contain tower visibility as well as surface visibility. Whenever surface visibility is available from an official source, such as a METAR, in either the main body of the METAR or in the Remarks (“RMK”) section, the preferred action is to use the surface visibility value.
- If the visibility is being reduced by snow along with form(s) of obscuration such as fog, haze, smoke, etc., use of the table above may overestimate the actual snowfall intensity. However, use of the snowfall intensity being reported by the weather observer or automated surface observing system (ASOS), from the FMH-1 Table, may underestimate the actual snowfall intensity as it does not directly correlate to the snowfall intensities used when determining holdover times. Use of the visibility table in all snow conditions with or without obscurations is recommended.

Example for how to read and use the table: `CYVO 160200Z 15011G17KT 1SM -SN DRSN OVC009 M06/M08 A2948`

In the above METAR the snowfall intensity is reported as light. However, based upon the “Snowfall Intensities as a Function of Prevailing Visibility” table, with a visibility of 1 statute mile, at night and a temperature of -6°C, the snowfall intensity is classified as moderate. The snowfall intensity of moderate - not the METAR reported intensity of light - will be used to determine which holdover time guideline value is appropriate for the fluid in use.

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6.9 GUIDELINES FOR THE APPLICATION OF SAE TYPE I FLUID

TABLE 54: GUIDELINES FOR THE APPLICATION OF SAE TYPE I FLUID

Outside Air Temperature (OAT)[1]	One-Step Procedure De/Anti-icing[2]	Two-Step Procedure	
		First Step: Deicing	Second Step: Anti-icing[3]
0 °C (32 °F) and above	Fluid/water mixture heated to at least 60°C (140°F) at the nozzle with a freezing point of at least 10°C (18°F) below OAT	Heated water or a heated fluid/water mixture	Fluid/water mixture heated to at least 60°C (140°F) at the nozzle with a freezing point of at least 10°C (18°F) below OAT
Below 0 °C (32 °F) to LOUT		Heated fluid/water mixture with a freezing point at OAT or below	

NOTES

1 Fluids must not be used at temperatures below their lowest operational use temperature (LOUT).

2 When anti-icing using the one-step procedure, a minimum quantity of 1 liter/m² (~2 gal./100 sq. ft.) of Type I fluid mixture heated to at least 60°C (140°F) is required after all frozen contamination is removed. This is achieved using a continuous process. This application is necessary to heat the surfaces, as heat contributes significantly to the Type I fluid holdover times.

3 To be applied before first-step fluid freezes, typically within 3 minutes. This time may be higher than 3 minutes in some conditions, but potentially lower in heavy precipitation, colder temperatures, or for critical surfaces constructed of composite materials. If necessary, the second step shall be applied area by area (sectionally).

CAUTIONS

- This table is applicable for the use of Type I holdover time guidelines in all conditions, including active frost. If holdover times are not required, a temperature of 60 °C (140 °F) at the nozzle is desirable.
- If holdover times are required, the temperature of water or fluid/water mixtures shall be at least 60 °C (140 °F) at the nozzle. Upper temperature limit shall not exceed fluid and aircraft manufacturers' recommendations.
- To use Type I Holdover Times Guidelines in all conditions including active frost, an additional minimum of 1 liter/m² (~2 gal./100 sq. ft.) of heated Type I fluid mixture must be applied to the surfaces after all frozen contamination is removed. This application is necessary to heat the surfaces, as heat contributes significantly to the Type I fluid holdover times. The required protection can be provided using a 1-step method by applying more fluid than is strictly needed to just remove all of the frozen contamination (the same additional amount stated above is required).
- The lowest operational use temperature (LOUT) for a given Type I fluid is the higher (warmer) of:
  - a) The lowest temperature at which the fluid meets the aerodynamic acceptance test for a given aircraft type; or
  - b) The actual freezing point of the fluid plus a freezing point buffer of 10 °C (18 °F).
- Wing skin temperatures may be colder or warmer than the OAT. Causes can include: radiation cooling, cold-soaked wing, or hangar storage. Consult the appropriate guidance (HOT Tables and FAA Ground Deicing General Information Document, Winter 2024-2025") for the contaminant in question.
- When conducting aircraft deicing using a Type I fluid and not using the 10 °C/18 °F buffer, procedures must be developed and approved to ensure refreezing does not occur prior to takeoff.

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6.10 GUIDELINES FOR THE APPLICATION OF SAE TYPE II AND IV FLUID

TABLE 55: GUIDELINES FOR THE APPLICATION OF SAE TYPE II AND IV FLUID

(FLUID CONCENTRATIONS IN % VOLUME)

Outside Air Temperature (OAT)[1]	One-Step Procedure De/Anti-icing	Two-Step Procedure	
		First Step: Deicing	Second Step: Anti-icing[2]
0 °C (32 °F) and above	100/0, 75/25 or 50/50 Heated[3] Type II or IV fluid/water mixture	Heated water or a heated Type I, II, III, or IV fluid/water mixture	100/0, 75/25 or 50/50 Heated or unheated Type II or IV fluid/water mixture
Below 0 °C (32 °F) to -3 °C (27 °F)	100/0, 75/25 or 50/50 Heated[3] Type II or IV fluid/water mixture	Heated Type I, II, III, or IV fluid/water mixture with a freezing point at OAT or below	100/0, 75/25 or 50/50 Heated or unheated Type II or IV fluid/water mixture
Below -3 °C (27 °F) to -14 °C (7 °F)	100/0 or 75/25 Heated[3] Type II or IV fluid/water mixture	Heated Type I, II, III, or IV fluid/water mixture with a freezing point at OAT or below	100/0 or 75/25 Heated or unheated Type II or IV fluid/water mixture
Below -14 °C (7 °F) to LOUT	100/0 Heated[3] Type II or IV fluid	Heated Type I, II, III, or IV fluid/water mixture with a freezing point at OAT or below	100/0 Heated or unheated Type II or IV fluid

NOTES

1 Fluids used for the anti-icing procedure must not be used at temperatures below their lowest operational use temperature (LOUT). First step fluids must not be used below their freezing points. Consideration should be given to the use of Type I/III fluid when Type II/IV fluid cannot be used due to LOUT limitations (see Tables 55 and 57). The LOUT for a given Type II/IV fluid is the higher (warmer) of:
   a) The lowest temperature at which the fluid meets the aerodynamic acceptance test for a given aircraft type; or
   b) The actual freezing point of the fluid plus its freezing point buffer of 7 °C (13 °F).

   Although some LOUTs are lower than the temperatures stated in the HOT table, holdover times do not apply when anti-icing below the lowest temperature stated in the band.

2 To be applied before first step fluid freezes, typically within 3 minutes. Time may be longer than 3 minutes in some conditions, but potentially shorter in heavy precipitation, colder temperatures, or for critical surfaces constructed of composite materials. If necessary, the second step shall be applied area by area (sectionally).

3 Clean aircraft may be anti-iced with unheated fluid.

CAUTIONS

- For heated fluids, a fluid temperature not less than 60 °C (140 °F) at the nozzle is desirable.
- Upper temperature limit shall not exceed fluid and aircraft manufacturers' recommendations.
- Wing skin temperatures may be colder or warmer than the OAT. Causes can include: radiation cooling, cold-soaked wing, or hangar storage. Consult the appropriate guidance (HOT Tables and FAA Ground Deicing General Information Document, Winter 2024-2025") for the contaminant in question.
- Whenever frost or ice occurs on the lower surface of the wing in the area of the fuel tank, indicating a cold-soaked wing, the 50/50 dilutions of Type II or IV shall not be used for the anti-icing step because fluid freezing may occur.
- An insufficient amount of anti-icing fluid may cause a substantial loss of holdover time. This is particularly true when using a Type I fluid mixture for the first step in a two-step procedure.
- When conducting aircraft deicing using a Type I fluid and not using the 10 °C/18 °F buffer, procedures must be developed and approved to ensure refreezing does not occur prior to takeoff.

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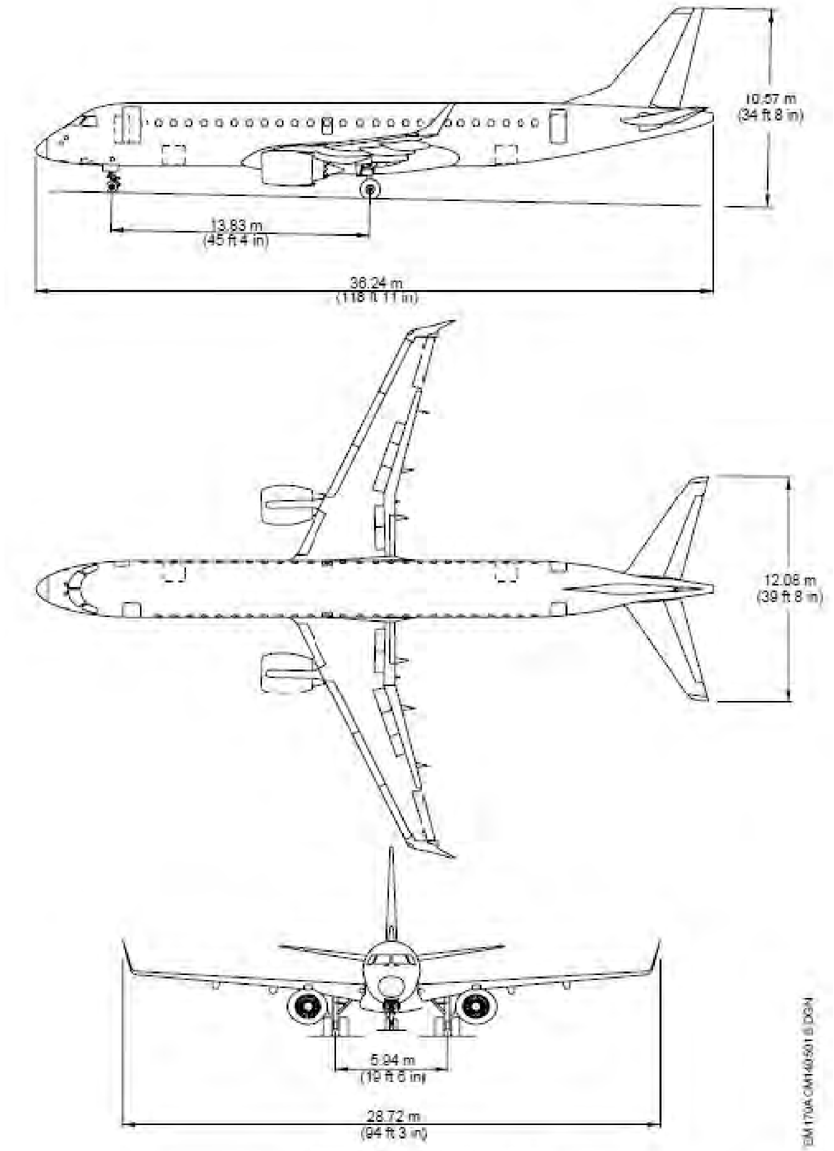
7 NORRA AIRCRAFT FLEET

Embraer 190



THREE VIEW DRAWING

Manufacturer:	Embraer
Type	ERJ 190
Wing area	93 m^2
Horizontal stabilizer area	26 m^2
Total surface area	119 m^2
Height overall	11 m
Wingspan	29 m
Fuselage, 1/3 surface area	114 m^2

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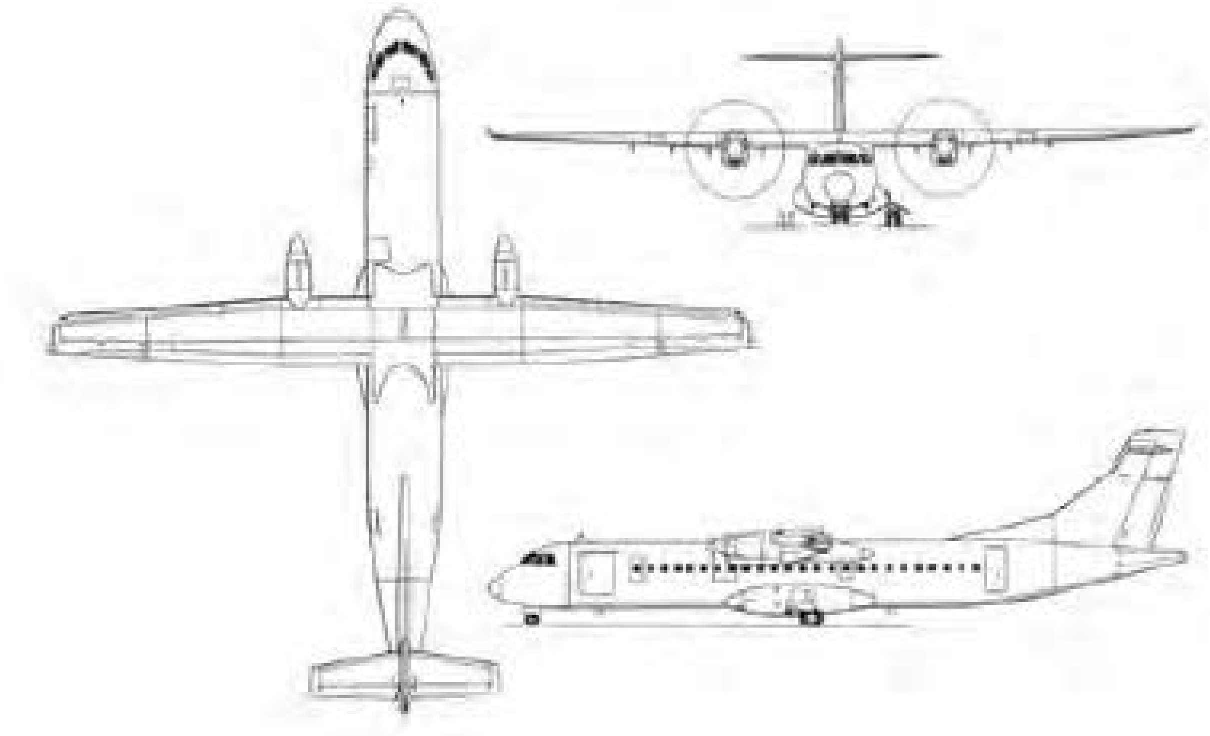
ATR 72



Type	ATR-72
Wing area	61 m^2
Horizontal stabilizer area	12 m^2
Total surface area	73 m^2
Height overall	8 m
Wingspan	28 m
Fuselage, 1/3 surface area	66 m^2

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8 CABIN HEATING WINTER TIME

See:

GOM 12A, Air Conditioning, Ground Connection

GOM 12B; 12B.4 Servicing Points

Aircraft parked either overnight or otherwise long time at the airport shall be heated as needed for the sake of the passengers and crews' comfort.

ATR72

A ground air conditioning source can be connected to the airplane to supply warm air directly into the cabin.

Open airplane forward cargo door vent flap and keep it open when operating the ground conditioned-air source. This is to prevent an increase in cabin pressure during the ground source operation.

On the ATRs the aircraft electrical heater must be placed close to the cabin side's front cargo door, so that the heated air can move to the cabin. In order for the cockpit and toilet areas to also get heated the cockpit and toilet doors must be left open. One must obey the instructions attached to the heater. The heating time of the aircraft depends on the outside temperature. Please, see the table below:

Aircraft parking time	Outside temperature / Hangar temperature	Heating time using electrical heater	Heating time using external heater
Overnight	+10°C » +5 °C	all night	1 h before departure
Overnight	+4°C » -5 °C	all night	2 h before departure
Overnight	-6°C » -15 °C	all night	3 h before departure
Overnight	-16°C <	all night	all night
parking time 1h – 5h	+10°C » +5 °C	parking time	1 h before departure
parking time 1h – 5h	+4°C » -5 °C	parking time	2 h before departure
parking time 1h – 5h	-6°C » -15 °C	parking time	parking time
parking time 1h – 5h	-16°C <	parking time	parking time
parking time 35min – 1h	-10°C <	parking time	parking time

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E-JET

A ground air conditioning source can be connected to the airplane to supply warm air directly into the cabin.

Open airplane rear cargo door vent flap, and keep it open when operating the ground conditioned-air source. This is to prevent an increase in cabin pressure during the ground source operation.

When the APU is running, there is no need for the ground conditioned-air source.

Please, see the table below:

Aircraft parking time	Outside temperature	Heating time using external heater
Overnight and long turnarounds	+10°C » +5 °C	1 h before departure
Overnight and long turnarounds	+4°C » -5 °C	2 h before departure
Overnight and long turnarounds	-6°C » -15 °C	3 h before departure
Overnight and long turnarounds	-16°C <	all night / turnaround
Turnarounds		
parking time 30 - 90 minutes	+10°C » +5 °C	no need for heating
parking time 30 - 90 minutes	+4°C » -5 °C	1 h before departure
parking time 30 - 90 minutes	-6°C » -15 °C	parking time
parking time 30 - 90 minutes	-16°C <	parking time

See also GOM 12C.7.2 Instructions.

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