AEROSPACE STANDARD

AS6286™	REV. B

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Superseding AS6286A

Aircraft Ground Deicing/Anti-Icing Training and Qualification Program

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 AS6285 and AS6332. Collectively, AS6285, AS6286, and AS6332 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” 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 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 program for the deicing and anti-icing of aircraft on the ground. Although references are made to the other two globalized standards, some background information to support a training program 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 organization 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 B represents a completion of the work performed in Revision A. Some work was undefined or under discussion so for the sake of clarity, Revision A was completed with some items outstanding with the intention of following up quickly with Revision B. All changes are marked with a black line on the left of the page.

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Changes made are:

1. Inclusion of outstanding comments/corrections from Revision A.

2. “Inspection” is replaced with “Check.”

3. New diagrams for new aircraft.

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1. SCOPE

1.1 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.

1.2 Agreements and Contracts

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

1.3 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 all necessary precautionary measures to ensure the health and safety of all personnel involved.

2. REFERENCES

2.1 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.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +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
ARP6257	Aircraft Ground De/Anti-Icing Communication Phraseology for Flight and Ground Crews

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AS6285 Aircraft Ground Deicing/Anti-Icing Processes

AS6332 Aircraft Ground Deicing/Anti-Icing Quality Management

2.1.2 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

2.2 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

2.3 Definitions and Abbreviations

2.3.1 Definitions

HEAD OF DEICING TRAINING: The person responsible for ensuring the effective delivery of the deicing/anti-icing training of personnel for the whole organization. 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 Program Manager/Responsible Person/Accountable Executive.

POSTHOLDER 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 organizational 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 organization who are responsible for ensuring the proper delegation and delivery of performance for the day-to-day tasks of managing winter operations.

WINTER PROGRAM 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 during winter operations.

PREFLIGHT CONTAMINATION CHECK: A check performed by ground crew to determine if the aircraft requires deicing and/or anti-icing, or if anti-icing has failed and the aircraft needs re-treatment. Pre-takeoff is not used because this can be confused with the pilot pre-takeoff checks. Maintenance or on-aircraft activity up to the pilot handover is generally termed preflight, activity after pilot handover is normally performed by flight crew and generally termed pre-takeoff.

2.3.2 Abbreviations

ATC Air Traffic Control

ATCT Air Traffic Control Tower

CBDS Computer-Based Deicing Simulator

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CBT Computer-Based Training

QMS Quality Management System

Refer to AS6285 for other definitions and abbreviations that are not listed within this section.

3. THE REQUIREMENTS FOR CLEAN AIRCRAFT IN WINTER - ORGANIZATION AND TRAINING

3.1 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 optimization 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 Organization 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 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 takeoff.*

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. These fluids are usually diluted with water and applied heated to at least 60 °C (140 °F). The spraying of these hot solutions efficiently breaks the bond between the frozen contaminant and the aircraft structure, allowing for ice and snow to be flushed off from the surfaces. Type I fluids are commonly used to de-ice aircraft surfaces. 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.

- Anti-icing fluids are designed and used to protect treated surfaces from active precipitation for a specified period of time (the “Holdover Time”). Fluid Types II, III, and IV are usually applied cold. 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 short 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 takeoff, which is referred to as the aerodynamic performance requirement. The SAE standards AS6286, AS6285, and AS6332 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.

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3.2 Organizational Requirements

The organizational requirements for the effective and safe deicing/anti-icing of aircraft during winter weather are described in more detail in AS6332. A short summary is provided here as an introduction to these requirements. The main concepts contained in AS6332 are based on the quality management methods set out in ISO:9001 and can be summarized 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 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.

3.3 The Essential Elements of a Deicing Training Program

3.3.1 Organization

An organization shall have in place within their management plan and organizational structure descriptions of key personnel (e.g., Head of Deicing Training, Program 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 organization shall specify the individuals who are responsible for the deicing/anti-icing training program. 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 organization’s management plan and organizational structure.

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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 familiarization, 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 program. Individuals designated to conduct deicing/anti-icing training within an organization's management plan and organizational 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 organization by an individual responsible for this function as specified within the organization's management plan and organizational structure (e.g., Training Manager/Head Trainer) or other personnel as designated, or by a third party organization (e.g., air carrier, contracted deicing/anti-icing training vendor, etc.).

3.3.2 Training of Deicing Personnel

Only trained and qualified personnel shall perform aircraft ground deicing/anti-icing procedures. A deicing training program shall be maintained and executed by the organization that performs the deicing. The training program 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 program 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 program shall be reviewed at least annually to ensure that it covers all current aspects of deicing/anti-icing operations.

The Head of Deicing Training is responsible for developing the training program. 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.

3.3.3 Computer-Based Training (CBT)

Computer-Based Training (CBT), e-Learning/distance learning, and Computer-Based Deicing Simulators (CBDS) may be utilized in place of traditional instructor-facilitated training for theoretical training components and limited practical training components (dependent on the CBDS Level utilized). 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.

3.4 The Complementary Fit between AS6286, AS6285, and AS6332

While the AS6286 standard 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:

- 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

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.

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4. AUTHORITY AND ROLES IN DEICING/ANTI-ICING

4.1 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 organization.
- Appoint a manager on an annual basis who may be known by a title such as Program 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 Program 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 Program Manager and the Head of Deicing Training, refer to the appropriate section of AS6332.

4.2 Winter Program Manager and Head of Deicing Training

4.2.1 Program Manager

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

- 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; and
- Ensuring that the need to conform to the clean aircraft concept is communicated throughout the organization.

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 this service.

4.2.2 Head of Deicing Training (see also DI-L70, 4.11 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 his/her own understanding and competence is sufficient to hold this position; and
- Ensuring the effective delivery of the training program for the organization.

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

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4.3 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-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]

DI-L80B Cabin Crew (icing awareness)

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 program 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.

4.3.1 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 (5.2).

Guidance for course content to use in theoretical training is provided in Tables 2 and 3 (6.2). A written exam for theoretical training must be completed in accordance with the process described in 6.3. 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 6.5.

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4.4 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 to 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 emphasized more than others.

Recommended times are in Table C1 in Appendix C 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.

4.5 Deicing Operator, DI-L20

The deicing operator qualification (DI-L20) includes the 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 C1 in Appendix C 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.

4.6 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 emphasized more than others where relevant.

Recommended times are in Table C1 in Appendix C of this document. 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.

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

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Recommended times are in Table C1 in Appendix C 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.

4.8 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 emphasized 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 C1 in Appendix C 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).

4.9 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 centralized 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 emphasized more than others where relevant.

Recommended times are in Table C1 in Appendix C 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).

4.10 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 shall be taken into account. Fluid-specific procedures shall be noted. In some cases, this qualification can be included in DI-L10 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.

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Info: 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.

4.11 Head of Deicing Training, DI-L70

The Head of Deicing Training is responsible for the deicing training program. 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 program (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.

4.12 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 Postholder Training. The Postholder Training 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.

4.13 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.

5. TRAINING SUBJECTS AND THEIR FIT WITH DEICING ROLES

5.1 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.

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

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- 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 by 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.

5.2 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 shall be involved with the process.

- 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 programs.
- 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 organization.

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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

6. TRAINING AND QUALIFICATION PROCESS

6.1 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 personnel 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.

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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 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 authorized air carrier 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 program.

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

- Theoretical
- Practical
- Annual Recurrent

For initial qualification, the qualification of personnel shall be accomplished on live aircraft during live deicing/anti-icing operations. Alternatively, the qualification of personnel can also be accomplished by spraying on a mock-up surface, or aircraft, or deicing simulators, that would simulate an actual live deicing/anti-icing operation.

However, if these individuals have satisfactorily completed all simulated practical evaluations and demonstrations of skills required as part of the training and qualification program, 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 programs must include a detailed description of initial and annual recurrent training and qualification concerning the specific requirements of the program and the duties, responsibilities, and functions detailed in the program. There shall be a Quality Management System (QMS) to monitor and maintain a high level of competence. An ongoing review plan is advisable to evaluate the effectiveness of the deicing/anti-icing training received. The program 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. Training success shall be proven by an exam that shall cover all training subjects contained in this document. Each part shall have a test to verify the correct procedures. The theoretical parts shall have a written examination, with a passing score of 75% minimum, and the practical part shall have a demonstration of skill. Only persons who pass the exam can be qualified. Where an individual has passed an examination but has not achieved a perfect grade, it is 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.

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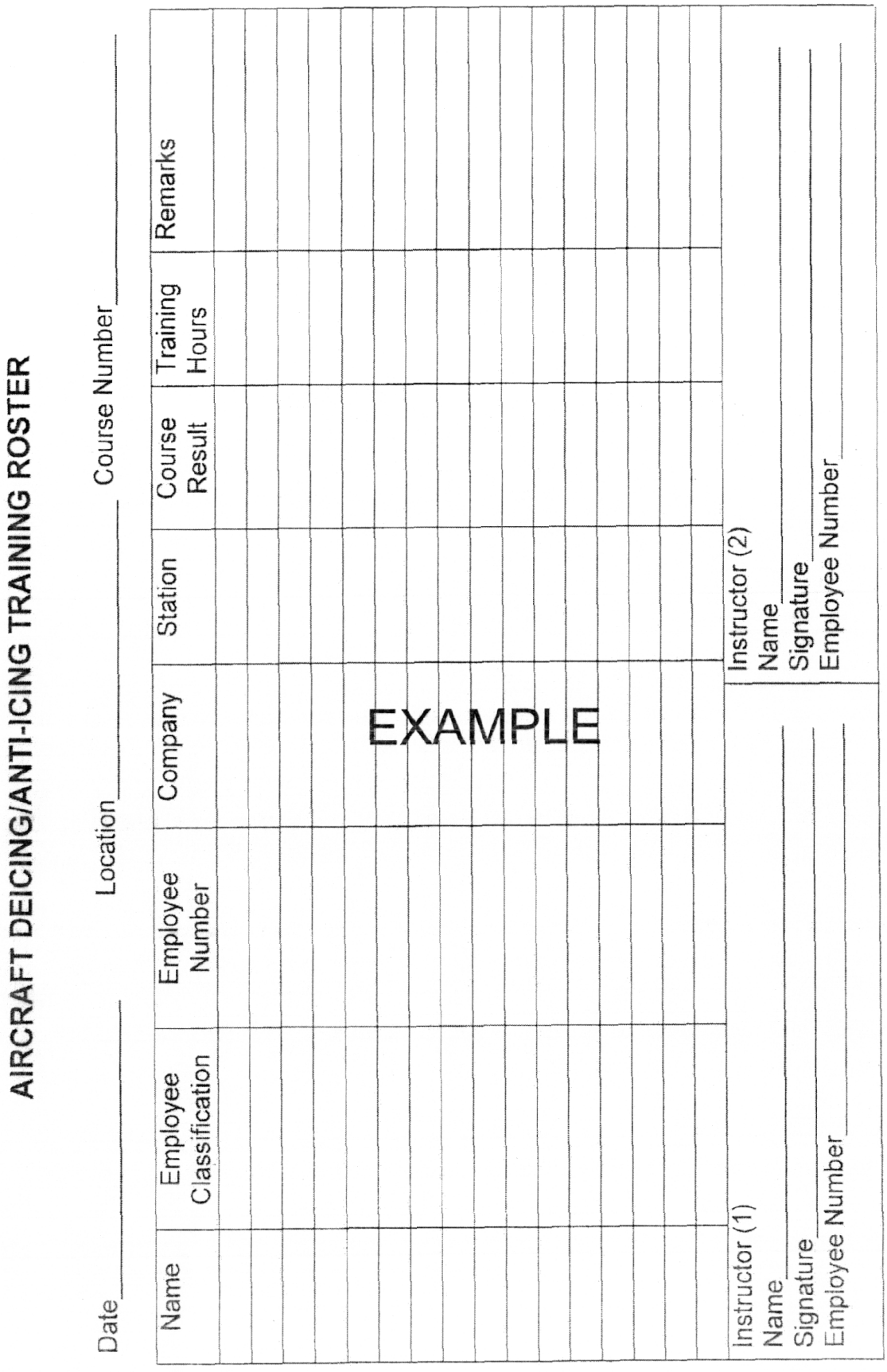


Figure 1 - Aircraft deicing/anti-icing training roster

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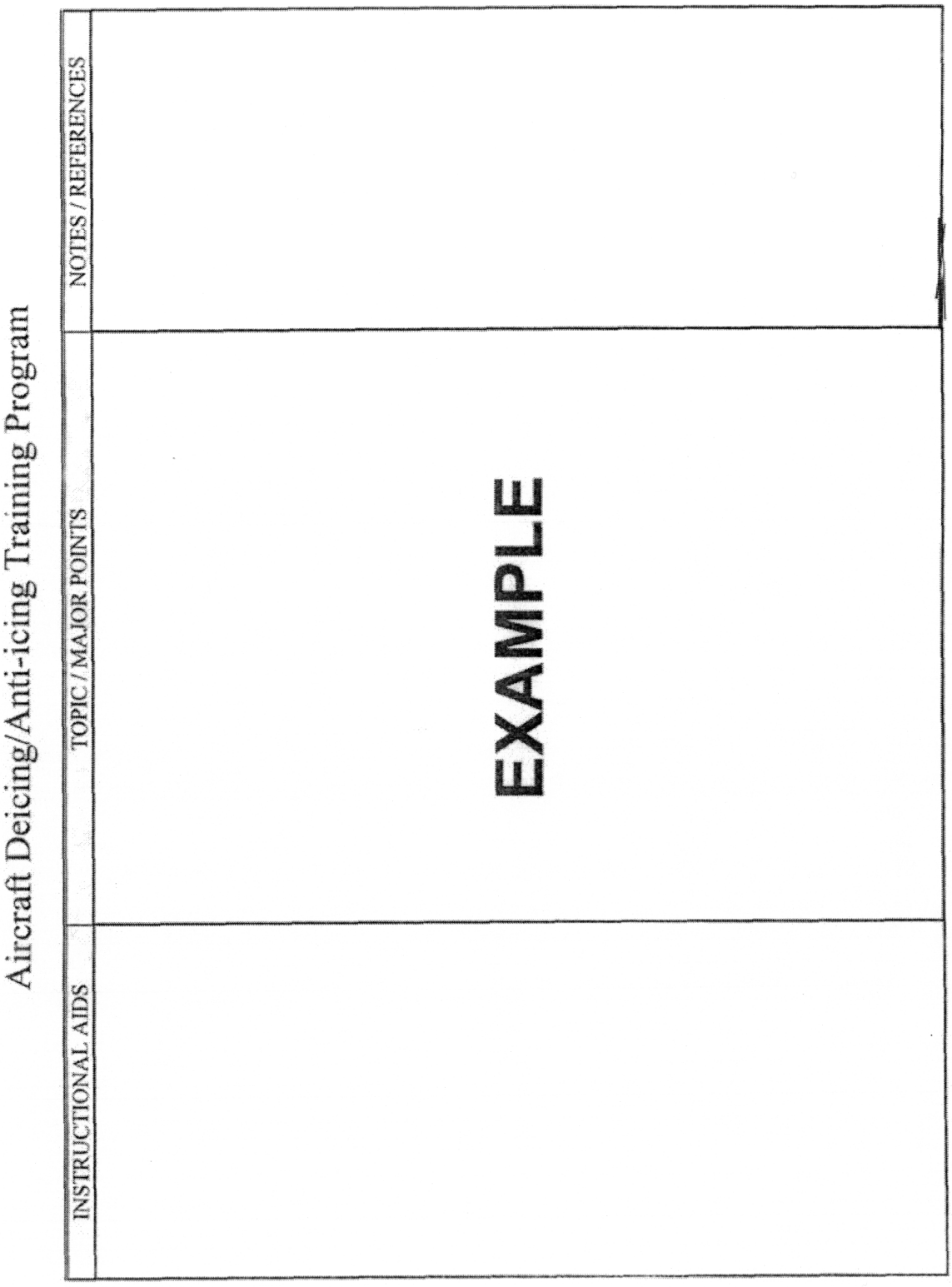


Figure 2 - Aircraft deicing/anti-icing training program

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6.2 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 below 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 must be clean and have no ice ridges, pitot-static orifices, angle of attack devices, windscreens.
TE7. Preflight Contamination Check	How to perform a preflight contamination check of the aircraft to make sure that no contamination (frozen deposits) remain 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 (AS6285, ARP1971, ARP6257)	
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 Aircraft Manufacturer’s Airplane 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 flight crew. 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-specific 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. Communication to flight crew with reference to **ARP6257**. 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 **Appendix B**.

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Table 3 - Theoretical elements - standard teaching plan (section D)

Subject	Guidance Content	Reference
D. Special aspects of aircraft deicing/anti-icing operations (ARP5660, AS6332, AS6286 Appendix B)		
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 considerations. Spill reporting. Waste control (excessive fluid use).	
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 **AS6332**. 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.	

6.3 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 amount 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 these elements in the training program. 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). Practical evaluation should include oral quizzing where practical items are covered (e.g., reading Holdover Time tables and/or refractive index limits, etc.).

6.4 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.

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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. 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-l30 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.

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6.5 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
- Pre/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 6.4 describes the practical training in more detail, and the assessment shall reflect those parts that were trained.

6.6 Training System and Records

6.6.1 Training System and Renewal

All training should be performed according to a pre-established training program. This program should include all levels of training and their relevant requirements. The theoretical part should be categorized according to the qualification, thus dividing the training sessions from each other. This training program 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.

6.6.2 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

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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 successful training and qualification. 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 available (or retrievable) at all stations as proof of qualification.

6.6.3 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 program. Training subjects shall include those presented in Section 6. 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 program shall be conducted and a training-quality program 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 6.6.2 should be maintained in a manner that ensures that they are easily retrievable by persons responsible for executing these program-quality reviews.

6.7 Computer-Based Deicing Simulator (CBDS) Standards

As Computer-Based Deicing Simulator (CBDS) systems are commonly used as part of deicing/anti-icing training programs, 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 categorized 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 utilized to determine the components of a training program 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 utilized to complement some elements of training where other equipment types may be utilized, 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.

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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 bucket/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 (i.e., “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 1-man 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/Bucket 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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7. 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

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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).

8. CONTRACT DEICING/ANTI-ICING

8.1 General Training Recommendation

Many air carriers use other contracted parties to perform their deicing/anti-icing operations. Training for contractor deicing/anti-icing services should include at least one of the following criteria in 8.2 through 8.4.

8.2 Approved Training

An approved contract training program meeting the requirements of this document can be implemented. Flight crews must be advised of local differences.

8.3 Train the Trainer

If the contractor's training program does not meet the requirements of this document, a "Train the Trainer" program can be utilized. Where it has been determined that the contractor must be trained to meet the carriers' approved program requirements, the air carrier or air carrier's approved training vendor shall provide training to the contract deicing/anti-icing personnel and/or designated trainer (in order for the designated contract trainer to facilitate training for the contractor's deicing/anti-icing personnel).

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8.4 Management Plan

The airline will develop, coordinate with other affected parties, implement, and use a management plan to ensure proper execution of its approved deicing/anti-icing program. The air carrier's management plan shall identify the manager responsible for the overall deicing/anti-icing program and each subordinate manager. It shall describe each manager's functions and responsibilities, relative to properly managing the airline's deicing/anti-icing program. A plan encompassing the elements discussed in the following paragraphs is acceptable.

8.4.1 Flight Operations Plan

The flight operations plan shall identify the management position responsible for ensuring that all elements of the management plan and the deicing/anti-icing program have been developed, properly integrated, and coordinated; that the plan and program have been disseminated to all those persons who have duties, responsibilities, and functions to perform in accordance with them; and that adequate management oversight of the program continues to be maintained. The following should be considered. At each airport where operations are expected to be conducted in conditions conducive to ground icing, the plan should identify the person responsible for deciding when ground deicing/anti-icing operational procedures are to be implemented.

The plan should specify the functions, duties, responsibilities, instructions, and procedures to be used by flight crew members, aircraft dispatchers, and management personnel for safely dispatching or releasing each aircraft type used in its operations while ground deicing/anti-icing operational procedures are in effect. A plan should include a detailed description of how the air carrier determines that conditions at an airport are such that frost, ice, or snow may reasonably be expected to adhere to the aircraft, and when ground deicing/anti-icing operational procedures must be in effect. The plan should identify the person responsible for coordinating the applicable portions of the management plan and the deicing/anti-icing program affecting dispatch of the aircraft with the appropriate air traffic control tower (ATCT) personnel and other appropriate airport authorities, including:

- Identifying the person who will be authorized to enter into agreements with the manager of the ATCT at each airport regarding air traffic control (ATC) procedures affecting dispatch during ground icing conditions, and with each airport's manager regarding where aircraft may conduct preflight contamination checks; and

- Ensuring that a detailed description of the deicing/anti-icing program is incorporated in the air carrier's manuals for flight crew members, dispatchers or flight followers, and management personnel to use in conducting operations in ground-icing conditions.

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8.4.2 Ground Operations Plan

A ground operations plan should identify the management position responsible for ensuring that all the elements of the management plan and the deicing/anti-icing program have been developed, properly integrated, and coordinated; that the plan and program have been disseminated to all those persons who have duties, responsibilities, and functions to perform in accordance with them; and that adequate management oversight of the program continues to be maintained. The following should be considered:

- The plan should detail the functions, duties, responsibilities, instructions, and procedures to be used by ground personnel, maintenance personnel, and management personnel for safely dispatching or releasing aircraft while ground deicing/anti-icing operational procedures are in effect.

- At each airport where deicing/anti-icing will take place, the plan should identify the person responsible for deciding when ground deicing/anti-icing operational procedures are to be implemented.

- The plan should identify the person responsible for ensuring that enough trained and qualified personnel, as well as adequate facilities and equipment, are available at each airport where the air carrier will deice/anti-ice aircraft.

- The plan should identify the person responsible for coordinating the applicable portions of the management plan and the deicing/anti-icing program with the appropriate air traffic control tower (ATCT) personnel and other appropriate airport authorities, including:

    - Determine who will be authorized to enter into agreements with the manager of the ATCT at each airport regarding air traffic control (ATC) procedures related to deicing/anti-icing of aircraft, and with each airport's manager regarding aircraft primary and secondary deicing/anti-icing locations.

    - Ensure that a detailed description of the deicing/anti-icing program is incorporated in the operator’s manuals for ground operations personnel and management personnel to use in conducting operations under ground-icing conditions.

9. GUIDANCE FOR RUNNING DEICING TRAINING SESSIONS

9.1 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 program established that all instructors follow. Deicing operations as a ground service may seem less important to emphasize 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.

9.2 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.

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There is no room for trial and error in practical deicing operations. It is therefore a major responsibility for the instructor to organize 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.

9.3 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 is 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 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 he/she does 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 programs, 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).

9.4 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 organized with an introduction, development, and conclusion. The trainees must be made aware of their responsibility and develop a receptive attitude towards the subject. The appearance and attitude of the instructor towards 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 organize 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.

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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.

9.5 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 programs are not available everywhere. Computer-based instruction must be presented in a manner that is understandable for the trainee. If “self-study” programs 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 program 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-programs, etc., it must be made clear what the current procedures are and what information is only for reference.

9.6 Evaluation

The training program must contain procedures of training and evaluation. The evaluation process must be taken into account 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 towards 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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10. NOTES

10.1 Revision Indicator

A change bar (I) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.

PREPARED BY SAE SUBCOMMITTEE G-12T, TRAINING AND QUALITY PROGRAM OF COMMITTEE G-12, AIRCRAFT GROUND DEICING

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APPENDIX A - THEORETICAL ELEMENTS GUIDANCE CONTENT

A.0 TE0: AN INTRODUCTION TO THIS APPENDIX

The purpose of this AS6286 Appendix A 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 AS6286 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:

ARP1971 Aircraft Deicing Vehicle - Self-Propelled

ARP5660 Deicing Facility Operational Procedures

ARP6257 Aircraft Ground De/Anti-Icing Communication Phraseology for Flight and Ground Crews

AS6285 Aircraft Ground Deicing/Anti-Icing Processes

AS6332 Aircraft Ground Deicing/Anti-Icing Quality Management

NOTE: As this AS6286 Appendix A 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.

A.1 TE1: TRAINER AND COURSE INTRODUCTION

A.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

A.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 AS6286 document in Section 9. A suggested schedule of training is shown in Tables 2 and 3 of AS6286. The rest of this AS6286 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.

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

A.2 TE2: BASIC KNOWLEDGE OF AIRCRAFT PERFORMANCE

A.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

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- 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

A.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.

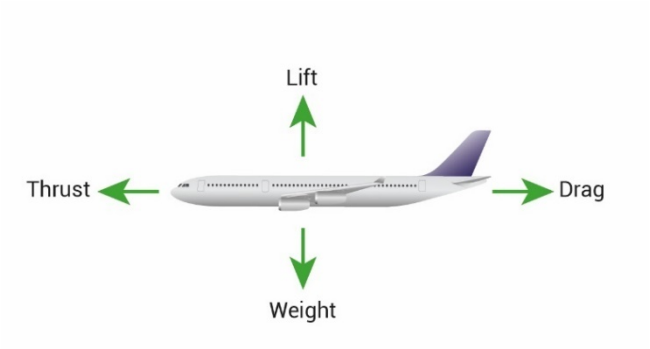


Figure A1 - The four forces that act on an airplane

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 upwards. 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.

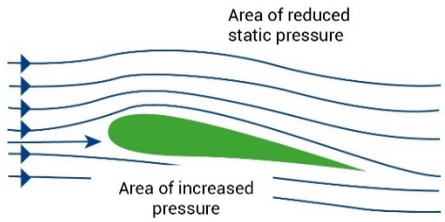


Figure A2 - Flow of air over an airfoil

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

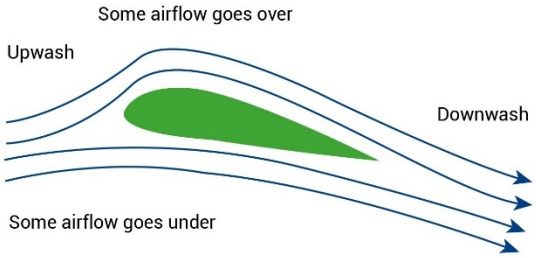


Figure A3 - Airflow around a wing

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.

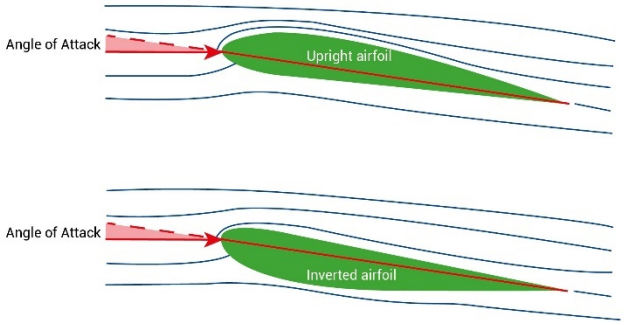


Figure A4 - Lift can be achieved with an airfoil in either orientation

A.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.

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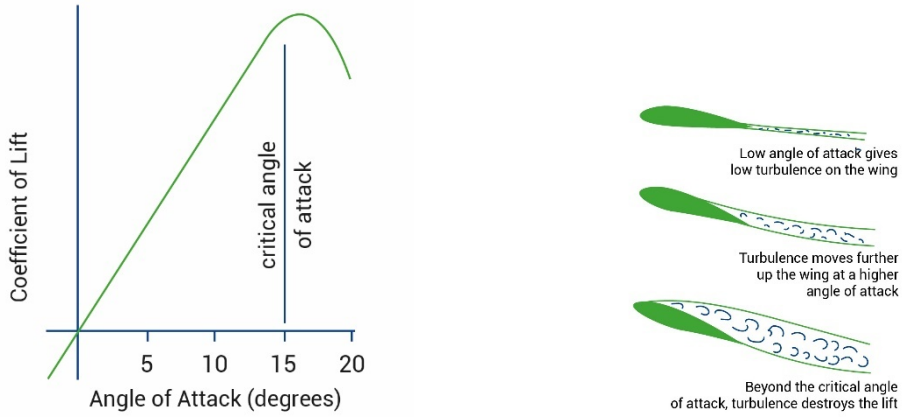


Figure A5 - Coefficient of lift and the angle of attack

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.

A.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 summarized 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**).

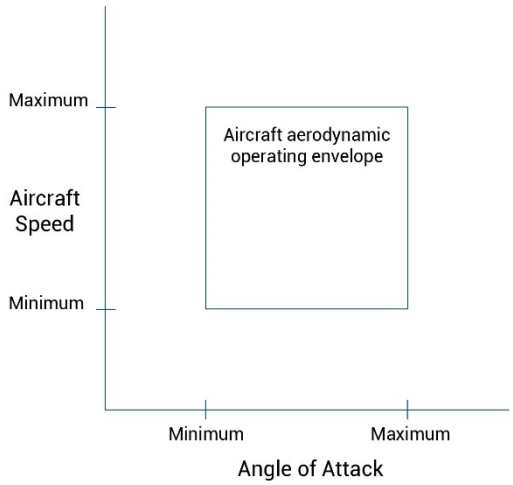


Figure A6 - Aerodynamic operating envelope

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A.3 TE3: EFFECTS OF FROZEN CONTAMINATION ON AIRCRAFT PERFORMANCE

A.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

A.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.

A.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.

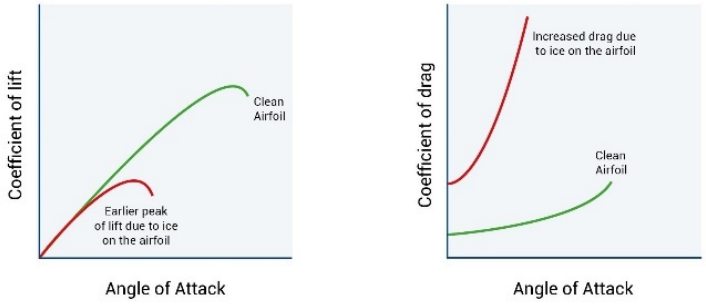


Figure A7 - Decrease in airfoil stall angle and increase in drag coefficient

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.

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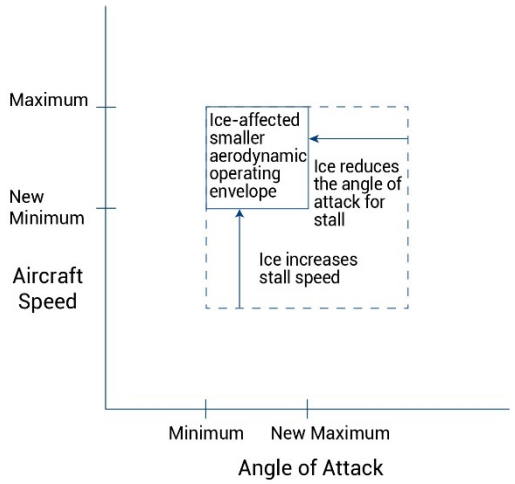


Figure A8 - The smaller aerodynamic operating envelope due to frozen contamination on the wings

A.3.4 Aircraft Icing

A.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 takeoff.

A.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 is not effective for removing and does not protect against ice accumulation in flight. In-flight icing is not addressed further in this standard.

A.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.

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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 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.

A.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.

A.3.7 Effects of Frost on Stall

Tests have also been performed of 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.

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A.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.

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

A.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

A.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, 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. 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 takeoff.*

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**.

A.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 these regulators, the International Civil Aviation Organization (ICAO), the International Air Transport Association (IATA), and aircraft manufacturers such as Boeing and Airbus.

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A.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 the 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. In addition, there has been a recent initiative by the SAE, ICAO, and IATA 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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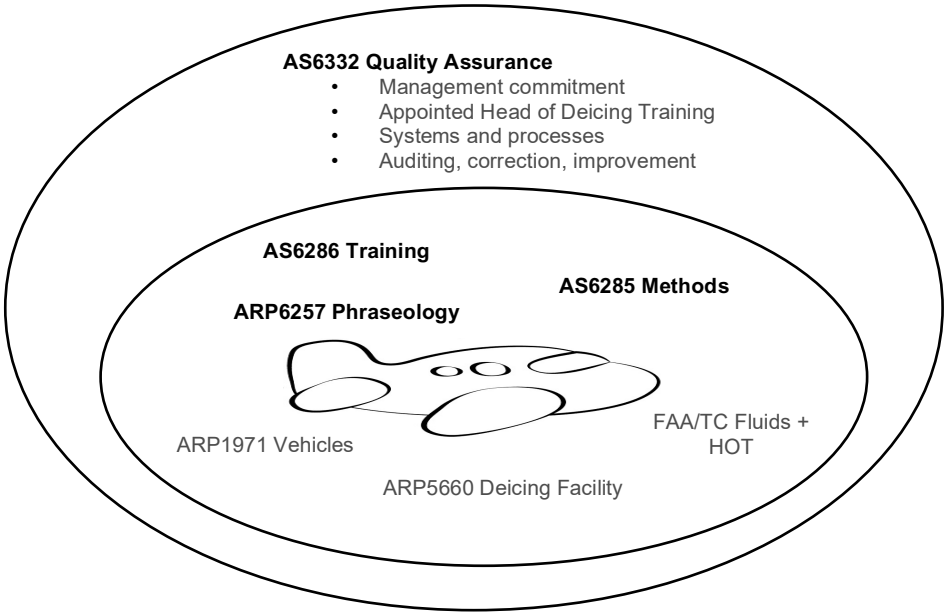


Figure A9 - The global aircraft ground deicing standards (shown in bold)

A.4.5 The New SAE Global Aircraft Ground Deicing Standards

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

- **ARP6257: Phraseology**. This short standard specifies the recommended communication phrases and dialogue that should take place between the aircraft flight crew and the ground deicing crew to ensure the safe and effective deicing/anti-icing of the aircraft. The standard is to ensure that both the flight crew and ground crew know what they should say, and what they should expect to hear from the other crew to minimize misunderstandings and ensure a clean aircraft for takeoff.

- **AS6285: 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.

- **AS6286: 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 Appendix B 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”).

- **AS6332: 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, that learning from incidents and events is captured, analyzed 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.

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A.4.6 Other Related SAE Standards and Documents

Although the four newer SAE global standards above contain most of the information and best practices necessary to carry out deicing/anti-icing of aircraft at an airport, 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 **TE10** 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 standardization 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 **TE8** of this standard.

A.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 summarized 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.

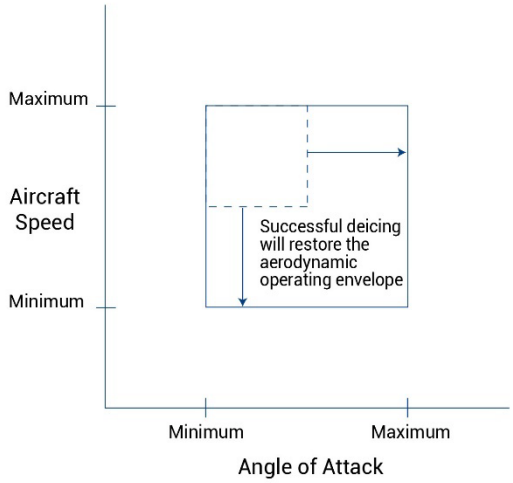


Figure A10 - Restoration of aerodynamic performance by deicing and anti-icing of the aircraft

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A.5 TE5: METEOROLOGICAL CONSIDERATIONS FOR ICE FORMATION

A.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

A.5.2 General Weather Conditions and Aircraft Ground Icing

A.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.

A.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.

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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. Company and aircraft manufacturer limits for allowing a certain amount of frost (and areas where allowed) should be noted.

A.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 the aircraft surface temperature is at or below 0 °C (32 °F) and at or below dew point.

b. Dew point and frost point

The dewpoint is the temperature at a given atmospheric pressure to which air must be cooled to cause saturation. The dewpoint can occur below or above 0 °C (32 °F). The frost point is the temperature, at or below 0 °C (32 °F), at which moisture in the air will undergo deposition as a layer of frost on an exposed surface. The frost point occurs between the outside air temperature and the dewpoint.

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/dm^2/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/dm^2/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 diameter range from about 2 to 5 mm (0.08 to 0.2 inch). Snow pellets are brittle, easily crushed; they bounce or break on hard ground.

A.5.4 Weather Conditions or Situations That May Also Lead to The Buildup of Frozen Contamination on An Aircraft

A.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 build-up when:

a. Wing temperatures remain well below 0 °C (32 °F) during the turnaround/transit

b. Ambient temperatures between -2 °C and +15 °C (28 °F 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.

A.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 °C (28 °F) and +15 °C (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.

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