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TP 14052E
(10/2023)

HOW TO USE THIS DOCUMENT

This document's table of contents is arranged in a manner that is intended to suggest a logical flow of information. The Chapter names have been chosen to accurately reflect the content.

Operators are advised to start with the Chapter entitled: "*Ground Icing Program Guidelines*". This Chapter outlines the required contents of an approved aircraft ground icing program. Each section of the Ground Icing Program chapter refers in turn to other chapters of the document for additional detail.

Other document users may choose to refer to the table of contents Chapter names to guide their search for information and guidance.

Document-specific term definitions are located in the Glossary chapter, and acronyms are presented in a specific chapter, both are located at the back of the document.

Numerous references and other documents of interest have been identified in the References chapter. Reader may choose to enhance their knowledge of specific issues by researching the listed documents.

The use of this document is not mandated by Regulation; however, if the Guidance in this document is followed then the following words, within the context of this document, take on a particular connotation:

1. *Should*
Should means that it is advisable to follow the suggested activity, process or practice.
2. *Must/Shall*
Must or Shall means that the suggested activity, process, or practice needs to be followed because there are significant safety implications.

FOREWORD

This Guidance document contains information applicable to the Operation of Aircraft in Canada under Ground Icing Conditions.

The information herein derives from many sources ranging from operational experience, research and development and Regulations.

It is intended that all of those involved in Ground Icing Operations will find some information in this document that will assist them in their understanding of such operations.

There are a very large number of variables involved in operating aircraft during ground icing conditions. For this reason, it is difficult to prescribe a solution for each and every situation that may arise. Therefore, this document generally identifies the principles at play and it is understood that a large measure of sound judgment will be required in many instances to ensure the continuance of safe aircraft operations under ground icing conditions.

A ground icing specialist is available at Transport Canada Headquarters, Commercial Flight Standards Division for consultation.

Original document signed by Andrew Larsen for

Stacey Mason
Director, Standards Branch
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CHANGE CONTROL RECORDS

Description of Change

Edition 8 replaces the previous Edition of TP14052E dated November 2022 and should be used in conjunction with the HOT Guidelines as published on the Transport Canada website at:

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Sidebars indicate text which has been added, deleted or modified.

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Edition 3	June 2018	Release of Edition 3 of TP 14052E	All
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CHAPTER 1 Introduction

1.1 Background

Over the years, Transport Canada (TC) has received numerous requests for advice, information and direction regarding aircraft ground deicing and anti-icing operations. The requests included information on personnel training, equipment requirements, fluid specifications and performance, the use of the Holdover Time (HOT) Guidelines, required communications, Canadian Aviation Regulations (CARs), the deicing process, and other related topics.

1.2 Purpose of the Document

This guidance document has been generated to serve as an Aircraft Ground Icing resource to the Canadian Aviation Industry.

It is anticipated that the information contained in this TP guidance document will serve operators, deicing service providers, Centralized Deicing Facility (CDF) operators, maintenance personnel, managers, Transport Canada Operations Inspectors, and others involved in aircraft ground icing operations.

No attempt has been made to regenerate existing documents, rather, whenever, possible, reference has been made to authoritative documents or organizations with subject matter expertise. In this way the user of this guidance document can pursue a greater depth of subject matter knowledge.

This document should be used in conjunction with the annually published Holdover Time (HOT) Guidelines.

1.3 Hazards of Ice, Snow and Frost

A very small amount of roughness, in thickness as low as 0.40 mm (1/64 in.), caused by ice, snow or frost, disrupts the air flow over the lift and control surfaces of an aircraft. The consequences of this roughness is severe lift loss, increased drag and impaired manoeuvrability, particularly during the takeoff and initial climb phases of flight. Ice can also interfere with the movement of control surfaces or add significantly to aircraft weight. There is no such thing as an insignificant amount of ice.

Ice can form even when the Outside Air Temperature (OAT) is well above 0°C (32°F). An aircraft equipped with wing fuel tanks may have fuel that is at a sufficiently low temperature such that it lowers the wing skin temperature to below the freezing point. This phenomenon is known as cold-soaking. This situation can also occur when an aircraft has been cruising at high altitude for a period of time followed by a quick descent to a landing in a humid environment. Liquid water coming in contact with a wing, which is at a below freezing temperature, will then freeze to the wing surfaces.

Cold-soaking can also be caused by fueling an aircraft with cold fuel. If there is rain or high humidity, ice can form on the cold-soaked wing and accumulate over time. This ice can be invisible to the eye and is

often referred to as clear ice. This ice can be detected by performing a tactile inspection or by using specially designed ice detecting systems such as a Ground Ice Detection System (GIDS).

Sheets of clear ice dislodged from the wing or fuselage during takeoff or climb can be ingested by aft fuselage mounted engines, thereby causing a flameout or damage. Sheets of dislodged clear ice can also cause impact damage to critical surfaces such as the horizontal stabilizer.

1.4 Canadian Aviation Regulations and Standards

Canadian Aviation Regulations (CARs) 602.11 states, in part that: “No person shall conduct or attempt to conduct a take-off in an aircraft that has frost, ice or snow adhering to any of its critical surfaces”; and the associated General Operating Flight Rules Standard (GOFRS) 622.11, outlines the requirements of a ground icing program. Related Commercial Air Services Standard (CASS) also form the basis of requirements on matters related to training and content of company operations manuals.

The following Regulations and Standards are also applicable:

1.4.1 General Operating Flight Rules and Standards

- a) CAR 602.11 Aircraft Icing
- b) GOFRS 622.11 Ground Icing Operations
- c) CAR 604.169(1) Flight Crew Members - Ground Instruction
- d) CAR 604.170(1) Flight Crew Members - Aircraft Operation Training
- e) CAR 604.179 Flight Attendants
- f) CAR 604.180(1) Flight Dispatchers and Flight Followers
- g) CAR 604.181 Ground and Airborne Icing Operations
- h) CAR 604.197(1) General Requirement

1.4.2 Commercial Air Service — Aerial Work

- a) CAR 702.76(2)(d)(iv) Training
- b) CASS 722.09(f) General Conditions of Air Operator Certificate—Operational Support Services
- c) CASS 722.76(4) Training Program — Company Indoctrination Training
- d) CASS 722.76(8) Training Program — Aircraft Services and Ground Handling Training
- e) CASS 722.76(10) Training Program — Initial and Annual Recurrent
- f) CASS 722.76(14) Training — Surface Contamination Training
- g) CASS 722.82(1)(s) Contents of a Company Operations Manual — COM for IFR & VFR at Night Operations
- h) CASS 722.82 (2)(p) Contents of a Company Operations Manual —Operations Manual for Day VFR Operations

1.4.3 Commercial Air Service — Air Taxi Operations

- a) CAR 703.98(2)(v) Training Program
- b) CASS 723.07(3)(g) Issuance or Amendment of Air Operator Certificate—Operational Support Services and Equipment
- c) CASS 723.98(5)(f) Training Programs—Company Indoctrination Training
- d) CASS 723.98(17) Training Programs—Aeroplane Surface Contamination Training
- e) CASS 723.105(1)(t) Contents of Company Operations Manual
- f) CASS 723.105(2)(n) Contents of Company Operations Manual

1.4.4 Commercial Air Service — Commuter Operations

- a) CAR 704.115(2)(c) Training Program
- b) CASS 724.115(6)(f) Training Program — Company Indoctrination Training
- c) CASS 724.115(18) Training Program — Aeroplane Surface Contamination Training
- d) CASS 724.115(26)(e) Training Program — Aeroplane Servicing and Ground Handling Training for Pilots
- e) CASS 724.121(t) Contents of Company Operations Manual

1.4.5 Commercial Air Service — Airline Operations

- a) CAR 705.124(2)(a)(iv) Training Program
- b) CAR 705.124(2)(b)(iv) Training Program
- c) CASS 725.07(4)(f) Issuance and Amendment of Air Operator Certificate — Operational Support Service and Equipment
- d) CASS 725.124(5)(f) Training Program — Company Indoctrination Training
- e) CASS 725.124(23) Training Program — Aeroplane Surface Contamination Training
- f) CASS 725.124(31)(e) Training Program — Aeroplane Servicing and Ground Handling Training for Pilots
- g) CASS 725.135(t) Contents of Company Operations Manual

CHAPTER 2 Ground Icing Program Guidelines

2.1 Development of a Ground Icing Program (GIP)

In accordance with the CARs, CAR 705 operators (Airline Operations) are required to establish a Ground Icing Program (GIP). CAR 701 operators (Foreign Air Operations) are also required to have an established GIP either approved by Transport Canada or the State of the foreign air operator.

Operators conducting operations under CAR 702 (Aerial Work), 703 (Air Taxi) and 704 (Commuter Operation) and foreign air operators operating in Canada are not specifically required by regulation to have a GIP. However, they are strongly encouraged to institute such a program. The rationale for instituting a GIP for these operators is that they must address procedures for dealing with ground icing operations in any case. The GIP provides a structured approach for addressing ground icing operations.

A sample GIP has not been provided, since it was deemed impossible to create one that would address every possible organization and situation. Instead, it was deemed more appropriate to provide guidance material on the preparation and minimum requirements of a GIP, which along with the contents of the other chapters of this TP, provide sufficient knowledge to both the producer of the GIP and the Transport Canada inspector responsible for approving the associated GIP.

Accordingly, this chapter provides guidance with respect to the material and areas that need to be addressed in a GIP.

For ease of reference and continuity, the flow and layout of this chapter follows the layout of the overall document. Cross-references to the appropriate chapters of this TP have been included to minimize duplication of information and to facilitate usability of the document.

2.2 Elements of a Ground Icing Program

General Operating and Flight Regulation Standard (GOFRS) 622.11 was amended in 2020 to include new content that reflects the evolution of technologies supporting operators and industry's increased knowledge of aircraft ground icing. GOFRS 622.11 provides a list of the minimum requirements which must be contained in a GIP.

2.2.1 Introduction and Responsibilities

A GIP is established to document specific procedures, guidelines and processes for the operation of aircraft under ground icing conditions to ensure that aircraft take-off without contamination adhering to critical surfaces. A GIP is necessary to ensure that everyone involved in the operations of aircraft under icing conditions understand their respective responsibilities and are properly trained and knowledgeable in their respective areas. Furthermore, an overriding objective in preparing a GIP is to assist in the creation of an organization that works harmoniously toward the goal of ensuring that no person shall conduct or attempt to conduct a take-off in an aircraft that has frost, ice or snow adhering to any of its critical surfaces.

This section of the GIP must:

- a) Address the reasons for having a de/anti-icing program;
- b) Clearly define the roles and responsibilities of individuals associated with the operations of aircraft under ground icing conditions.

The individuals with de/anti-icing responsibilities include, but are not limited to:

- a) The Pilot-in-Command (PIC);
- b) The cabin crew;
- c) Flight dispatchers, flight followers;
- d) Deicing operators;
- e) Maintenance crew;
- f) Management team; and
- g) Local Air Traffic Control (ATC).

See Chapter 3, *Roles and Responsibilities* for greater detail on this material.

2.2.2 Definitions

It is imperative that those involved in ground icing operations understand several fundamental icing terms. Furthermore, it is vitally important that all individuals have a common understanding of the terminology and phraseology in use in order to improve communications and minimize understanding errors. Therefore this section of the GIP must include definitions associated with operations of aircraft under icing conditions.

Subjects in the definition section include, but are not limited to:

- a) Weather conditions such as freezing drizzle, clear ice, freezing fog, freezing mist, frost, rain, rime ice, ice pellets, ice crystals, snow pellets, snow and snow grains;
- b) Aircraft terms and definitions such as critical flight control surfaces, engines, and surfaces that may require deicing;
- c) Representative surfaces;
- d) Deicing fluids;
- e) Anti-icing fluids;
- f) Manual removal methods;
- g) Fluid properties such as lowest operational use temperature (LOUT), refraction, viscosity, pH;
- h) One-step or two-step de/anti-icing process;
- i) Holdover times, their use and limitations;
- j) Holdover time determination systems, their use and limitations;
- k) Aircraft inspection processes for pre and post de/anti-icing.

NOTE: Although not exhaustive the Glossary in Chapter 18, contains details of many of the common definitions in current use.

2.2.3 Operator Management Plan

2.2.3.1 Ground Icing Program Responsibilities

The operator's management plan must:

- a) Identify the management position responsible for the overall program development, integration, co-ordination, implementation and use;
- b) Identify subordinate positions;
- c) Identify operational responsibilities of flight crew, dispatchers and management personnel and associated procedures;
- d) Identify the chain of command and/or include an organizational chart;
- e) Identify the relationship between Operations, Maintenance and other internal departments;
- f) Ensure that maintenance organization not have sole responsibility for the GIP;
- g) Ensure integration and co-ordination of the program elements within the organization;
- h) Disseminate the program to all persons with duties, responsibilities and functions within the plan;
- i) Publish a detailed description of the program in the appropriate company manuals;
- j) Ensure sufficient trained personnel, adequate facilities and adequate equipment are available at airports where the program may be applied;
- k) Ensure adequate management supervision of the program;
- l) Identify the individual responsible for initiating and ceasing ground icing operations;
- m) Identify the individual responsible for authorizing and co-coordinating the program with ATC and airport authorities.
- n) Identify the responsibilities associated with the maintenance organization;
- o) Identify what maintenance personnel, facilities and equipment are required to support the program;
- p) Ensure that quality processes and procedures are in place and maintained for the handling, testing and storage of fluids;
- q) Ensure that there is a program in place to maintain the de/anti-icing equipment in proper working condition;
- r) Identify aircraft-specific procedures;
- s) Identify deicing procedures other than fluid deicing;
- t) Ensure contracted service providers are adequately trained; and
- u) Ensure contracted service providers are audited on a regular basis.

2.2.3.2 Quality Organization and Safety Management System

A description of the quality organization or, if applicable, the Safety Management System (SMS) organization which is in place is required.

For greater details refer to Chapter 4, *Quality Organization*.

2.2.3.3 Record keeping

At a minimum, the organization must ensure the following records are maintained:

- a) A detailed & accurate recording process for fluid management must be developed and maintained throughout the deicing season for safety reasons. The extent and the detail of the records will depend on the complexity of the operation. This process should be open for audit by operators, Transport Canada inspectors, airport authorities, and Environment Canada staff.

Mishandling de/anti-icing fluids (e.g. storage in incorrect containers, improper pumping or shearing) can result in a significant loss of its operational fluid effectiveness as a result in degradation of fluid thickeners, surfactants or freezing point depressants (FPD). Likewise, aircraft operators or deicing service providers typically perform viscosity checks on de/anti-icing fluids for quality control purposes. It is important to utilize standardized measurement methods to ensure accurate and consistent reporting and record keeping of these measurements.

- b) Initial and recurrent training records for each individual associated with the program.

2.2.4 Training and Testing

Each operator required to have a GIP must develop its own deicing training program to reflect operational needs, company resources, operational limitations, and regulatory requirements.

The larger the deicing operation is, the more complex and involved it will be. Personnel responsibilities need to be clearly defined and a suitable training program that includes emphasis on effective teamwork and communication needs to be developed and well understood by all involved personnel.

The Organization must provide initial and annual training and testing for all ground, operations, flight crews and maintenance personnel who have responsibilities within the program.

2.2.4.1 Initial training for flight crew and other operations personnel

At a minimum, initial training for flight crew and other operations personnel who have responsibilities within the GIP must cover the following (additional training may be required for larger and more complex organizations):

- a) Company policy
- b) Effects of contamination

- c) Weather conditions requiring de/anti-icing
- d) Fluids & fluid application methods and techniques
- e) Holdover time considerations
- f) Inspection procedures
- g) Communications
- h) Safety

2.2.4.2 Recurrent training for flight crew and other operations personnel

At a minimum, recurrent training for flight crew and other operations personnel who have responsibilities within the GIP must cover the following (additional training may be required for larger and more complex organizations):

- a) A review current of deicing and anti-icing operations and inspection procedures;
- b) A review of any changes to the program;
- c) A review of the latest available research and development on ground deicing and anti-icing operations;
- d) Issuance of an information circular prior to commencement of the winter operations to all involved personnel; the circular must review procedures and present any new information.

2.2.4.3 Initial training for ground deicing crews and maintenance personnel

At a minimum, initial training for ground deicing crews and maintenance personnel must cover the following (additional training may be required for larger and more complex organizations):

- a) Company policy
- b) Effects of contamination
- c) Weather conditions requiring de/anti-icing
- d) De/Anti-icing vehicle and equipment
- e) Fluids & fluid application methods and techniques
- f) Holdover time considerations
- g) Inspection procedures
- h) Safety

2.2.4.4 Recurrent training for ground deicing crews and maintenance personnel

At a minimum, recurrent training for ground deicing crews and maintenance personnel must cover the following (additional training may be required for larger and more complex organizations):

- a) A review of current deicing and anti-icing operations and inspection procedures;
- b) A review of any changes to the program;
- c) A review of the latest available research and development on ground deicing and anti-icing operations; and
- d) Issuance of an information circular prior to commencement of winter operations to all involved personnel. The circular must review procedures and present any new information.

An operator that contracts deicing/anti-icing services from another organization is responsible for ensuring that the training program of the contractor and application of deicing/anti-icing operation standards meet the operator's own GIP criteria. The operator is responsible for documenting the contractor's procedures and training.

All trained personnel must be tested on all information covered in their organization's respective initial and recurrent training programs, and any operator's GIP if their organization provides services to said operator.

Detailed training requirements are contained in Chapter 5, *Training and Testing*.

2.2.5 Personnel Safety

Management and employees with responsibilities in this program must receive personal safety training. Initial and then annual recurrent training should be given on these items relating to personal safety. A healthy safety culture within the service provider organization should be a principle objective.

NOTE: Work Place Hazardous Material Information System 2015 (WHMIS 2015) training must be given to all employees.

Personnel safety is covered in greater detail in Chapter 6, *Personnel Safety*.

2.2.6 Communications

Effective communication before, during and after deicing operations between all parties is crucial. Specific communication procedures must be defined for various operational scenarios including, at a minimum:

- a) On gate deicing;
- b) Off gate deicing;
- c) Hangar anti-icing;
- d) Engines on versus engines off deicing;
- e) End of runway deicing;
- f) Vehicle operators or man in bucket communications;
- g) Call signs as applicable;
- h) Pad control communications;
- i) Communication to the flight crew;
- j) Equipment and personnel safely away from the aircraft calls; and
- k) Emergency procedures.

See Chapter 7, *Communications* for further details on ensuring and implementing adequate communications.

2.2.7 Aircraft Deicing/Anti-icing

2.2.7.1 Fluids

Operators need to know how to test, store, use, contain and track all fluids available to them. Details with respect to fluids can be found in Chapter 8, *Fluids*.

2.2.7.2 Equipment

Operators need to know how to test, inspect and operate all equipment available to them. All de/anti-icing equipment shall be maintained in a fit and safe condition in order to perform its intended function.

The details associated with equipment maintenance and operations are contained in Chapter 9, *Equipment*.

2.2.7.3 Procedures and Preventative Measures

Flight and maintenance crews need to understand the various preventative measures that can be used to minimize frozen contamination accretion while on the ground. This can include the use of temporary shelters, hangars or covers.

Flight maintenance crews and de/anti-icing operators must understand the various methods available to remove frozen contamination and, if necessary, methods to protect recently cleaned surfaces.

The details associated with these measures and procedures are contained in Chapter 10, *Preventative Measures and Aircraft De/Anti-icing Procedures*.

2.2.8 Holdover Times

Flight crews, flight dispatchers, maintenance crews and deicing operators must have a clear understanding of the Holdover Time Guidelines.

The details associated with the use and interpretation of HOT Guidelines, are contained in Chapter 11, *Holdover Time Guidelines & Associated Procedures*.

2.2.9 Operational Issues

The de/anti-icing operation is by its very nature a complex and fast paced environment with tight deadlines and often performed in very difficult weather. All these factors together yield a higher-than-normal risk level and a higher potential for accidents to occur.

Given this environment, flight crew, operational control, cabin safety, and other operational issues can be expected. These operational issues are discussed in greater detail in Chapter 12, *Operational Issues*.

2.2.10 Environmental Responsibilities

The operator, service provider or CDF shall observe all applicable environmental rules. Details on environmental considerations are contained in Chapter 13, *Environmental*.

2.2.11 Use of Contractor Services

The contracting out of de/anti-icing services can be broadly divided into services provided by a CDF and services provided by a service provider which is not a CDF.

The contracting of deicing and anti-icing services shall be clearly defined in the GIP. The procedures to be followed in using the contracted services must be clearly defined within the GIP.

Greater detail on the use of contracted services is contained in Chapter 14, *Facilities*.

2.2.12 Emergencies

Should an emergency occur during the deicing process or within the designated deicing area, an emergency response plan must be in place. There must be a means of communicating (by visual/audio means, etc.) the emergency situation between those involved. At a minimum, the following subjects should be included:

- a) Medical emergency on board the aircraft;
- b) Ground equipment fire;
- c) Aircraft fire;
- d) Aircraft evacuation;
- e) Aircraft hijacking;
- f) Aircraft bomb threat;
- g) Ground vehicle to aircraft contact;
- h) Aircraft to aircraft contact;
- i) Personnel injury;
- j) Major fluid leak and
- k) Other situations that may arise and which may be site specific.

Further details on an emergency response plan are contained in Chapter 15, *Emergencies*.

CHAPTER 3 Roles & Responsibilities

This Chapter describes the roles and responsibilities related to operators and service providers.

3.1 Introduction and Responsibilities

A GIP is established to document specific procedures, guidelines and processes for the safe operation of aircraft under ground icing conditions to ensure that aircraft take-off without contamination adhering to critical surfaces. A GIP is necessary to ensure that everyone involved in the operations of aircraft, de/anti-icing equipment and decision making for operations under icing conditions understand their respective responsibilities and are properly trained and knowledgeable in their respective areas. Furthermore, an overriding objective in preparing a GIP is to assist all organizations and individuals involved in winter operations to achieve a high level of cohesion toward the goal of ensuring that no person shall conduct or attempt to conduct a take-off in an aircraft that has frost, ice or snow adhering to any of its critical surfaces.

The *Introduction and Responsibilities* section of the GIP must:

- a) Address the reasons for having a de/ anti-icing program;
- b) Clearly define the roles and responsibilities of individuals associated with the operations of aircraft under ground icing conditions.

The individuals with de/anti-icing responsibilities include, but are not limited to:

- a) The PIC;
- b) The cabin crew;
- c) Flight dispatchers, flight followers;
- d) Deicing operators;
- e) Maintenance crew;
- f) Management team; and
- g) Local Air Traffic Control (ATC)

3.2 Operator Responsibilities

3.2.1 Operator Management Plan

The operator must have a management plan and the plan must:

- a) Identify the management position responsible for the overall program development, integration, co-ordination, implementation and use;
- b) Identify subordinate positions;
- c) Identify operational responsibilities of flight crew, dispatchers and management personnel and associated procedures;
- d) Identify the chain of command and/or include an organizational chart;

- e) Identify the relationship between Operations, Maintenance and other internal departments;
- f) Ensure that maintenance organization not have sole responsibility for the GIP;
- g) Ensure integration and co-ordination of the program elements within the organization;
- h) Disseminate the program to all persons with duties, responsibilities and functions within the plan;
- i) Publish a detailed description of the program in the appropriate company manuals;
- j) Ensure sufficient trained personnel, adequate facilities and adequate equipment are available at airports where the program may be applied;
- k) Ensure adequate management supervision of the program;
- l) Identify the individual responsible for initiating and ceasing ground icing operations;
- m) Identify the individual responsible for authorizing and co-coordinating the program with ATC and airport authorities.
- n) Identify the responsibilities associated with the maintenance organization;
- o) Identify what maintenance personnel, facilities and equipment are required to support the program;
- p) Ensure that quality processes and procedures are in place and maintained for the handling, testing and storage of fluids;
- q) Ensure that there is a program in place to maintain the de/anti-icing equipment in proper working condition;
- r) Identify aircraft-specific procedures;
- s) Identify deicing procedures other than fluid deicing;
- t) Ensure contracted service providers are adequately trained; and
- u) Ensure contracted service providers are audited on a regular basis.

3.3 Service Provider Responsibilities

Although there are no specific Regulations that govern the activities of a service provider, this section outlines those items that must be addressed, as a minimum.

3.3.1 Management Responsibilities

Front line employees look to management for direction and guidance especially if they are new to the operation. Management is ultimately responsible for the integration, coordination and management of the Ground Icing Program, and must:

- a) Ensure that quality processes and procedures are maintained;
- b) Ensure that an effective initial and recurrent training program is in place for their employees;
- c) Ensure as a minimum that employee files contain the results of the initial and the most recent annual recurrent training and examination scores as a minimum;
- d) Establish and then maintain an effective process to ensure that all deicing team members (front line employees and supervisory staff) are made aware of any changes to local operational procedures in a timely manner;

- e) Ensures that sufficient competent personnel, adequate facilities equipment and deicing/anti-icing fluids are available;
- f) Liaise with the local airport authority on applicable airport issues by attending meetings and communicating regularly;
- g) Implement procedures for continued operational safety; and
- h) Maintain an environmentally responsible deicing operations program.

3.3.2 Front Line Employee Responsibilities

This section highlights the front-line employee responsibilities as related to aircraft deicing and/or anti-icing.

Employees charged with the task of inspecting aircraft for potential contamination, then the de-ice and/or anti-icing task, followed by a post deicing inspection, must understand the scope and magnitude of their responsibilities before they are called on to provide a service.

Failure to either identify the need to de-ice/anti-ice, or effectively confirm that the aircraft critical surfaces are clean for takeoff could result in the loss of human life, or damage to an aircraft. The front-line employees must also understand that workplace mistakes could be fatal.

3.3.2.1 Training

Employees must complete all required training before de-icing, anti-icing, performing inspections or providing critical deicing communication to flight crews.

Employees must be trained to find information regarding specific deicing/anti-icing procedures for the aircraft which they are servicing.

Employees must ensure that they receive “initial” and annual recurrent deicing/anti-icing training.

An examination should be conducted by the employer to verify that the individual’s training has been effective. The examination results should be corrected, and the results retained on each individual’s file.

The files of each employee should contain the training completed, and results of the initial and the most recent annual examination scores as a minimum.

3.3.2.2 Communications

The failure to communicate effectively and in a timely manner is often the root cause of many aviation accidents. The employee must:

- a) Understand the communication process for all de/anti-icing operations, including: before, during and after de/anti-icing;
- b) Report to their immediate supervisor any conditions that limit or prevent effective communication;
- c) Use a verbal and a visual signal to arrive, park and then depart an aircraft that requires deicing services, and
- d) Understand the basic communication and control responsibilities of other agencies involved in the deicing process (i.e., ATC, Apron, and Flight Operations) such that problems or failure to follow procedures can be identified and reported to the employees' supervisor or manager.

3.3.2.3 Procedures

Front line employees must follow the deicing procedures as defined by their employer. If a problem with a process or procedure is identified then the employee is responsible for reporting the problem, without delay, to his or her immediate supervisor.

In summary, members of the deicing team are responsible for following and upholding service provider procedures to ensure safety during all deicing operations.

3.3.2.4 Equipment

Front line employees must ensure that:

- a) All deicing equipment is utilized as per established procedures (including pre deicing equipment inspections);
- b) All personal protective equipment, as supplied by the employer, is utilized as designed and as per service provider procedures; and
- c) Critical communication equipment is available and utilized as per approved corporate procedures for deicing operations.

CHAPTER 4 Quality Organization

4.1 Quality Assurance Program

4.1.1 Objectives

The *Canadian Aviation Regulations* require that Airline Operations (subpart 705) establish a Safety Management System (SMS) which includes a Quality Assurance Program (QAP). A QAP, for the purposes of ground icing operations, ensures that the established deicing and anti-icing processes and procedures are being effectively utilized by the employees, thus contributing to safe deicing operations.

- a) Further, a QAP should be one which can help identify deicing operation process or procedure shortcomings;
- b) Can assist in establishing a fix for the shortcoming;
- c) Can help incorporate the fix into the training program; and
- d) Can result in establishing a revised process or procedure to replace the flawed process or procedure; in this way the “Quality Loop” is satisfied.

4.1.2 Management Plan

According to CARs, the aircraft operator is responsible for the operational control of an aircraft. In order to properly exercise operational control under ground icing conditions, a Management Plan to ensure proper execution of the operator’s GIP must be developed and implemented.

The Management Plan will identify the management position responsible for the overall GIP, identify each subordinate position, and describe those functions and responsibilities needed to properly manage the GIP. The Management Plan must also describe operational responsibilities and procedures, delineate the chain of command, define the relationship between its operations and maintenance groups, and ensure that all parties are informed of their responsibilities with regard to the GIP. Although the GIP is usually an operations responsibility, it may be shared between operations and maintenance. The GIP may be the sole responsibility of operations, but never the sole responsibility of maintenance.

Industry may consult SAE document AS 6332 - *Aircraft Ground Deicing/Anti-icing Quality Management*, which establishes the general requirements for the quality management of aircraft ground deicing/anti-icing systems and processes.

4.1.3 Scope

The scope of the QAP should include at least the following elements of a GIP:

- a) Safety procedures
- b) Deicing equipment, calibration, operation and positioning
- c) Fluid application procedures
- d) Fluid quality assurance

- e) Contamination removal procedures
- f) Aircraft specific techniques
- g) Personnel training
- h) Emergency procedures
- i) Communications, and
- j) Records

4.1.4 Operations Briefings

4.1.4.1 Pre-Operations Briefing

Prior to daily deicing operations, it is essential that all employees be made aware of the expected weather conditions, the anticipated aircraft traffic and any changes or non-standard equipment or procedures that may arise during the operation. This briefing is not only important for operational efficiency purposes but is a key safety of operations tactic.

4.1.4.2 Post-Operations Briefing

Following a period of deicing operations, once operations have ceased, it is appropriate for management to conduct an evaluation of the operation with the involvement of the employees.

It is recommended that each deicing operation be followed by a debriefing session with the participants in order to discuss operational matters, to evaluate overall performance by everyone, as well as to discuss any specific operational topics deemed necessary.

This kind of post operations debriefing serves many functions including: identifying safety issues; identifying process or procedure errors; identifying employee errors which require training; identifying deficiencies in the training program; identifying communication weaknesses; and identifying circumstances which, if changed, may improve the overall safety and efficiency of deicing operations.

4.1.5 Internal Audits

The TC Publication *TP 13750 - Commercial and Business Aviation Inspection and Audit (Checklists) Manual* serve as guides for the conduct of Transport Canada audits, however, the principles and practices suggested by these documents may also serve the purposes of the deicing service provider. In particular, the “*Ground Icing Operations Program Checklist*”, contained in the *CBA Inspection and Audit (Checklists) Manual*, may serve as an important guide on subject areas that should be addressed. These documents can be accessed via the Internet at the following web address: <https://tc.canada.ca/en>.

An operator’s approved GIP will be subjected to a Transport Canada audit on a regular basis as is required by regulation. A Transport Canada operations inspector may choose to inspect the operation at any time. However, a regularly conducted internal audit, by the deicing service provider, will provide feedback to company managers and thereby assist in keep the deicing operation safe and efficient.

It is suggested that these self-audits be carried out on an ad hoc basis with the results being discussed and documented at the management level. The frequency and the scope of each audit should be clearly identified in a procedures manual. A corrective action process should be established for items identified as a concern during the audit. A record of the implementation or disposition of the corrective measures recommended by the auditor should be retained on file.

Records of these self-audits should be maintained on a file to aid in tracking operational improvements or continuing deficiencies. The records may also be of assistance when it is time for a Transport Canada Audit.

4.1.6 Corrective Action

A process should be in place, which ensures that, internal and external audit findings are addressed in an appropriate manner through a documented corrective action plan. This approach serves several important functions, in addition to making the company management aware of perceived operational shortcomings, including: the recording of issues, the documentation of proposed corrective measures, the tracking of corrective measures completion and it serves as a record for the future.

4.2 Record Keeping

An accurate, detailed record keeping system must be in place to allow easy access to all information pertaining to the deicing/anti-icing operation and fluids management. Care must be taken to ensure that not only is the information accurate but also that it is recorded in a timely fashion and retained for a minimum of two years.

The information may be kept in either paper or electronic format, as may be agreed in the approved ground icing program.

4.2.1 Minimum required records

At a minimum, the records that need to be maintained include, but are not restricted to, the following:

- a) Training is to include: individual's name, signature specimen, date of initial training, date of latest recurrent training, and the name of the individual providing the training
- b) Acceptance of de/anti-icing fluid delivery is to include: date, batch/waybill number, time of delivery, refractometer and/or viscosity test results and amount received. Tests must be completed at delivery and at regular intervals. A test (e.g., colour, refractive index) must be done each time a fluid is transferred. Records should be kept for a minimum of two years after use
- c) Field Tests:
 - i. For Type I Fluid: label test, colour, refraction, suspended matter
 - ii. For Type II, III and IV: label test, colour, refraction, suspended matter, field viscosity test
- d) Test frequency: see manufacturer product information bulletin
- e) Equipment log sheets – a record of maintenance and repair work should be kept on each piece of equipment

- f) Aircraft de-icing fluid (ADF) and aircraft anti-icing fluid (AAF) mitigation plan – also known as a glycol management plan, must be available
- g) Refractometer calibration and testing: Refractometers must be calibrated annually prior to the deicing season and should be tested before use. A record of these tests should be kept on file at the station for a minimum of two (2) years. The information that should be recorded, and which attests to the validity of the calibration, is listed below.
 - i. Company name
 - ii. Date of the calibration
 - iii. Refractometer ID number
 - iv. Refractometer reading
 - v. Tester's initials
 - vi. Tester's number/ID
- h) Internal audit dates, results and actions.

4.2.2 Application report

It is recommended that a deicing/anti-icing operation form be developed which can be used to record the following required information.

- a) Operation record number
- b) Station identification
- c) Date/Time of operation
- d) Operator name
- e) Aircraft registration
- f) Type of aircraft
- g) Flight number
- h) Weather conditions
- i) Aircraft condition upon arrival
- j) Outside air temperature
- k) Deicing location
- l) Quantity of Type I ADF used
- m) Quantity of thickened AAF used
- n) Start/Finish time for Type I ADF application
- o) Start/Finish time for thickened AAF application
- p) Refractometer reading for fluid in use
- q) Type I fluid mixture ratio
- r) Deicing trucks involved
- s) Truck driver and operator identification
- t) Type of deicing/anti-icing requested by the pilot
- u) Remarks (e.g., Type of inspection)

This document will become the official record that the deicing operation was carried out. The signatures of the individuals that accomplished the deicing/anti-icing operation should be present.

4.2.3 Fluid Test Log

4.2.3.1 Delivery of ADF/AAF

Each delivery of ADF/AAF is to be recorded on separate forms. The information collected should include:

- a) Date
- b) Tanker/vehicle number
- c) Tanker/vehicle arrival and departure time
- d) "Seal number" which should coincide with the documentation accompanying the delivery
- e) Refractometer test values
- f) Colour verification
- g) Fluid sample results
- h) Batch number
- i) Suspended matter notation, and
- j) Identity of the tank and location where the fluid was off loaded (fluid storage destination)

The records should be kept on file at the station for a minimum of two (2) years.

4.2.3.2 Truck Refills

Each time a truck/cart is partially or completely refilled; immediately prior to the first use of the equipment for the day or any time there is a deicing truck/cart crew change, a refractometer test must be taken and recorded on an appropriate form, to verify the quality of the ADF/AAF in the deicing truck. This information must be kept on file at the station for a minimum of two (2) years.

4.2.3.3 Stored Glycol Testing

Fluid types, in their storage tank, must have a refractometer test carried out according to the following:

- a) Type I Fluid
 - i. After adding fluid to the storage tank
 - ii. Type I glycol stored in a tank must be tested once a month
 - iii. Testing must also be conducted prior to commencing deicing each day during the deicing season
 - iv. Records of these must be kept on a form at the station for a minimum period of 2 years.

NOTE: Type I fluids stored for more than two years should be sampled and the sample should be sent to the manufacturer for testing. Conformance testing to specifications for colour, suspended matter, pH, and refractive index are the minimum required parameters to be evaluated. A record of the manufacturer's test results is to be kept on file at the station for a minimum of two (2) years.

- b) Types II, III & IV Fluid
 - i. After adding fluid to the storage tank

- ii. Testing must also be conducted prior to commencing deicing each day during the deicing season
- iii. Records of these must be kept on a form at the station for a minimum period of 2 years.

NOTE: Fluids stored for more than one year should be sampled and sent to the manufacturer for testing. Conformance testing to specifications for colour, suspended matter, pH, viscosity and refractive index are the minimum required parameters to be evaluated. A record of the manufacturer's test results should be kept on file for a minimum of two (2) years.

4.2.3.4 Fluid Viscosity Test

Types II, III & IV fluids are subjected to viscosity degradation when an incorrect type of pump is being used to transfer the product from vessel to vessel.

The sampling of a fluid's viscosity at the nozzles of each type of truck used by the service provider should be carried out on an annual basis for the purpose of analyzing the impact that the pumps have on the fluid's viscosity. The samples should be forwarded to the fluid manufacturer and the results should be kept on file for a two-year period.

4.2.3.5 Refractometer Calibration and Testing

Refractometers should be calibrated annually prior to the deicing season and should be tested prior to use. A record of these tests should be kept on file at the station for a minimum of two (2) years. The information that should be recorded, and which attests to the validity of the calibration, is listed below.

- i. Company name
- ii. Date of the calibration
- iii. Refractometer ID number
- iv. Refractometer reading
- v. Tester's initials
- vi. Tester's number/ID

CHAPTER 5 Training and Testing

5.1 Training Overview

5.1.1 General

The service provider's training program is an element of a GIP. An operator's GIP must be Transport Canada approved for CARs 705 operations. The operator is responsible for ensuring that the service provider meets all of the requirements of the operator's program including the training.

In some cases, when there is a single service provider at an airport. At the time of this publication the following Canadian airports have single service providers:

- i. Vancouver (YVR)
- ii. Calgary (YYC)
- iii. Edmonton (YEG)
- iv. Winnipeg (YWG)
- v. Toronto (YYZ)
- vi. Ottawa (YOW)
- vii. Montreal (YUL)
- viii. Mirabel (YMX)
- ix. St. John's (YYT)

Notwithstanding, the operator must ensure that the service provider at a Transport Canada accepted facility is conducting operations in a manner consistent with operator's program, including its training program.

GOFRS 622.11, Division III—Training, identifies the minimum training elements that are required in an approved GIP. This Standard should be consulted to ensure that the training program includes all of the required elements.

5.1.2 Training Reference Material

All personnel engaged in de/anti-icing aircraft must successfully complete a comprehensive training program on methods and procedures. Training for deicing services should meet the requirements of latest revisions of SAE *Aerospace Specification (AS) 6285 – Aircraft Ground Deicing/Anti-icing Processes* and the contents of *AS6286 - Training and Qualification Program for Deicing/Anti-icing of Aircraft on the Ground*. Transport Canada does not recommend the use of any minimum fluid quantity values as not all anti-icing fluid holdover times found in the *Holdover Time Guidelines* may be attained through the use of this information. Transport Canada recommends training on proper fluid application be achieved through processes described in AS6285 and/or in section 10.6.2.2 of this document. See Chapter 19, *References* of this document for information on how to acquire AS6285 and AS6286 and other SAE documents.

5.1.3 Training Outline

The training course outline should address at least the following subjects:

- a) Management plan
 - i. Flight operations
 - ii. Ground operations
- b) Hazards of frost, ice, snow and slush on aircraft surfaces
- c) Pre take off contamination check requirements
- d) Aircraft critical surfaces
- e) Representative surfaces
- f) Aircraft surface contamination recognition
- g) Holdover time guidelines
- h) Allowance time tables
- i) Deicing and anti-icing fluids
 - i. Storage & handling
 - ii. Characteristics
 - iii. Hazards
- j) Health, safety & first aid
- k) Communications
 - i. Normal
 - ii. Alternate/Emergency
- l) Methods and procedures
- m) Emergency procedures
- n) Ground Icing equipment operation
- o) Environmental considerations
- p) Initial and recurrent training requirements
- q) Record keeping
- r) Lessons learned, and
- s) Examinations (corrected to 100%)

5.1.4 Training Program Administration

The training program should be managed, reviewed and updated annually as required to ensure that:

- a) Both initial and annual recurrent training and testing will be conducted to ensure that all deicing, operations and flight crews obtain and retain a thorough knowledge of aircraft ground de/anti-icing regulations, standards, policies and procedures, including new procedures and lessons learned;
- b) A record of the training and testing will be placed on the individual's file. As a minimum, the first and most recent qualification results must be on the individual's file
- c) Training will be provided for all aircraft types requiring de/anti-icing

- d) Personnel required to de/anti-ice aircraft with the aircraft engines running will complete additional training in this procedure.

5.2 General Operating and Flight Rules Training and Testing requirements

5.2.1 Content

An operator's ground icing training program shall include:

- a) Both initial and annual recurrent training for all operational and ground/maintenance personnel who have responsibilities within the program; and
- b) Testing of crew members and other operations and ground/maintenance personnel who have responsibilities within the program.

5.2.2 Contractor Training

An operator who contracts de/anti-icing services from another organization is responsible for ensuring that the training program of the contractor and application of deicing/anti-icing operations standards meet the operator's own GIP criteria. Through the operator, the contractor's procedures and training programs shall be documented.

5.2.3 Initial Flight Crew and Operations Personnel Training

At a minimum, initial training for flight crew and other operations personnel must cover the following (additional training may be required for larger and more complex organizations):

5.2.3.1 Company Policy

- a) Must not take-off or attempt to take-off with contamination adhering to critical surfaces
- b) Individual responsibilities within the program, and
- c) Protection of the environment

5.2.3.2 Effects of Contamination

- a) The detrimental effects of contamination on critical surfaces including aircraft performance and stability, additional weight, engine performance, aircraft sensors, etc.;
- b) The effects of precipitation (ice crystals, ice pellets, frost, freezing fog, freezing mist, snow, freezing drizzle and freezing rain, high humidity on cold-soaked wings) on critical surfaces and under wings, and
- c) Identification of critical aircraft surfaces by aircraft type

5.2.3.3 Weather conditions requiring de/anti-icing

- a) Company procedures that must be followed to determine if ground-icing conditions exist and when the conditions cease to exist

- b) Identifying the person that is responsible for deciding that ground deicing operations must begin and when they will end
- c) Procedures for reporting contamination on arrival to the person responsible for co-coordinating de/anti-icing operations
- d) Identifying the various freezing precipitation weather conditions that impact flight operation, and
- e) The significance of: freezing rain vs. freezing drizzle; frost – upper wing and lower wing; different snow conditions such as pellets, grains, wet and dry snow.

5.2.3.4 Fluids & Fluid Application Methods and Techniques

- a) Types, purpose, characteristics such as LOOUT and uses of deicing and anti-icing fluid
- b) Composition and identification of fluids
- c) Fluid properties such as LOOUT, viscosity, refraction, Brix
- d) The effects of deicing and anti-icing fluids on aircraft performance and handling
- e) The procedures associated with deicing and anti-icing an aircraft in a safe and efficient manner
- f) Fluid application methods (e.g., techniques for Type I, II, III and IV fluids)
- g) Supervisory responsibilities of flight crew at locations where previously arranged contracted services are unavailable, and
- h) Aircraft and location specific procedures where applicable

5.2.3.5 Holdover Time Considerations

- a) Holdover time guidelines, including source of HOT data, precipitation category, visibility in snow, relationship of change in precipitation to HOT, etc.
- b) HOT guidelines relationship between holdover time and fluid concentration, precipitation and temperature
- c) The use of Holdover Time Determination Reports (HOTDR) derived from Holdover Determination Systems (HOTDS)
- d) When holdover time begins and ends, and
- e) Procedures that must be followed when HOT is exceeded, including any required inspections and alternate means of determining whether surfaces are contaminated
- f) Communication procedures, which cover: how to inform the PIC of the type of fluid used, the start time of the final fluid application, and any requirements for coordination.

5.2.3.6 Inspection Procedures

- a) Identification of critical surfaces and representative surfaces (where applicable) that must be inspected
- b) Types of inspections
- c) Techniques for detecting/recognizing contamination and loss of fluid effectiveness including loss of gloss, snow or ice accumulation, surface freezing, etc.
- d) Communication procedures between flight crew and deicing personnel

5.2.3.7 Safety

- a) Safety precautions in and around aircraft during fluid application with aircraft engine running
- b) Appropriate communication procedures including the information that must be exchanged between the flight crew and the service provider, which includes, at a minimum, the type of fluid used (and concentration if required) and the start time of the final application.

5.2.4 Recurrent Flight Crew and Operations Personnel Training

At a minimum, recurrent training for flight crew and other operations personnel who have responsibilities within the GIP, must cover the following (additional training may be required for larger and more complex organizations):

- a) A review current deicing and anti-icing operations and inspection procedures
- b) A review of any changes to the program
- c) A review of the latest available research and development on ground deicing and anti-icing operations
- d) Issuance of information circular prior to commencement of the winter operations to all involved personnel. The circular must review procedures and present any new information.

5.2.5 Initial Ground Icing and Maintenance Personnel Training

At a minimum, initial training for ground deicing crews and maintenance personnel must cover the following (additional training may be required for larger and more complex organizations):

5.2.5.1 Company Policy

- a) Must not take-off or attempt to take-off with contamination adhering to critical surfaces
- b) Individual responsibilities within the program
- c) Protection of the environment

5.2.5.2 Effects of Contamination

- a) The detrimental effects of contamination on critical surfaces including aircraft performance and stability, additional weight, engine performance, aircraft sensors etc.
- b) The effects of freezing precipitation (frost, freezing fog, freezing mist, snow, rain, high humidity on cold-soaked wings) on critical surfaces and under wings
- c) Identification of critical surfaces by aircraft type.

5.2.5.3 Weather Conditions Requiring De/Anti-Icing

- a) Company procedures that must be followed to determine if ground-icing conditions exist and when the conditions cease to exist
- b) Identifying the person that is responsible for deciding that ground deicing operations must begin and when they will end
- c) Procedures for reporting contamination on arrival to the person responsible for co-ordinating de/anti-icing operations
- d) Identifying the various freezing precipitation weather conditions that impact flight operations
- e) The significance of freezing rain vs. freezing drizzle; Frost – upper wing and lower wing; different snow conditions such as pellets, grains, wet snow; and slush.

5.2.5.4 De/Anti-Icing Vehicle and Equipment

- a) Required checks appropriate to the vehicles and equipment in use
- b) Reporting of equipment deficiencies
- c) Reporting of observed aircraft irregularities
- d) Reporting of incidents and accidents
- e) Vehicle positioning techniques
- f) Practical training on equipment usage and spraying techniques

5.2.5.5 Fluids & Fluid Application Methods and Techniques

- a) Types, purpose, characteristics (e.g., LOU) and uses of deicing and anti-icing fluid
- b) Composition and identification of fluids
- c) The effects of deicing and anti-icing fluids on RAM-air intakes, aircraft sensors, and other sensitive components
- d) The procedures associated with deicing and anti-icing an aircraft in a safe and efficient manner and prevention of foreign object debris (FOD) to engines
- e) Fluid application methods (e.g., techniques for Type I, II, III and IV fluids)
- f) Identification of critical aircraft surfaces by aircraft type
- g) Supervisory responsibilities of flight crew at locations where previously arranged contracted services are unavailable; and
- h) Aircraft-specific application procedures and associated cautions

5.2.5.6 Holdover Time Considerations

- a) Hold over time guidelines, including source of HOT date, precipitation category, relationship of change in precipitation to HOT
- b) HOT guidelines relationship between holdover time, temperature and fluid concentration
- c) When holdover time begins and ends
- d) Procedures that must be followed when HOT is exceeded, including any required inspections and alternate means of determining whether surfaces are contaminated

- e) Appropriate communications procedures including information, which must be exchanged between flight crew and service provider, such as: type of fluid used, start time of final application, as a minimum.

5.2.5.7 Inspection Procedures

- a) Definition and identification of critical surfaces and representative surfaces (where applicable) that must be inspected
- b) Types of inspections
- c) Techniques for detecting/recognizing contamination and loss of fluid effectiveness including loss of gloss, snow or ice accumulation and surface freezing, etc.

5.2.5.8 Safety

- a) Safety precautions in and around aircraft during fluid application with aircraft engine running
- b) Appropriate communication procedures including the information that must be exchanged between the flight crew and the service provider, which includes, at a minimum, the type of fluid used and the start time of final application
- c) Personnel safety equipment and its correct use

5.2.6 Outline for Recurrent Ground Icing and Maintenance Personnel Training

At a minimum, recurrent training for ground deicing crews and maintenance personnel must cover the following (additional training may be required for larger and more complex organizations):

- a) A review of current deicing and anti-icing operations and inspection procedures
- b) A review of any changes to the program
- c) A review of the latest available research and development on ground deicing and anti-icing operations; and
- d) Issuance of an information circular prior to commencement of winter operations to all involved personnel. The circular must review procedures and present any new information

All trained personnel must be tested on all information covered in their respective initial and recurrent training programs.

An operator that contracts de/anti-icing services from another organization is responsible for ensuring that the training program of the contractor and application of de/anti-icing operation standards meet the operator's own GIP criteria. The operator is responsible for auditing and documenting the contractor's procedures and training.

CHAPTER 6 Personnel Safety

6.1 Occupational Health and Safety

The following is a synopsis of the minimum safety and health requirements mandated by the Canada Labour Code, (the Code), Part II and its pursuant Canadian Occupational Health and Safety Regulations (COHSR). The salient points of the Code which pertain to the deicing and anti-icing operation are discussed herein.

The purpose of the Code is to prevent accidents and injury to health arising out of, linked with or occurring during the course of employment. It is the duty and responsibility of the employer to ensure that the safety and health of every employee is protected and ensure that employees know about hazards in their work place including any foreseeable health or safety hazards.

6.1.1 Roles and Responsibilities of the Employee

The employees' obligations are to:

- a) Use safety materials, equipment, devices and clothing provided for their protection;
- b) Comply with employer's instructions and follow safety and health procedures; and
- c) Report accidents, occurrences and contraventions of the Code to the employer, as well as any circumstances likely to be hazardous in the work place.

6.1.2 Roles and Responsibilities of the Employer

6.1.2.1 Training

Employers shall provide employees:

- a) With information on health and safety; their rights and responsibilities as explained in the Canada Labour Code, Part II
- b) With instruction, training and procedures in performing their job without compromising their health or safety
- c) With training for supervisors and managers relative to the Canada Labour Code, Part II and its pursuant regulations in order to be informed of their responsibilities in health and safety as the employer's representative.

6.1.2.2 Personal Protective Equipment - Safety Materials, Equipment, Devices and Clothing and Safety Restraining Devices

The employer shall provide the employee with all necessary personal protective equipment that fits properly and comfortably and is designed to protect the person from the hazardous exposure or potential hazard. Safety materials, equipment, devices and clothing used to protect the health and safety of the employee must be Canadian Standards Association (CSA) approved.

- a) Protective headwear and headsets
- b) Footwear (boots)
- c) Eye and face protection (masks, goggles)
- d) Respiratory Protection, as required
- e) Skin protection (coveralls, rainwear, and neoprene gloves)
- f) Fall protection systems (harness, lanyards)
- g) Reflective Safety Vests

Protective Equipment shall be selected, maintained, inspected and tested and kept in a clean and sanitary condition. This involves establishing a purchasing and issuance system and life cycle management of the protective equipment.

Employers shall instruct the employees in the proper and safe use of the personal protective equipment and to effectively deal with emergency situations.

6.1.2.3 Hazardous Substances

Employers are required to:

- a) inform employees of existing or foreseeable hazards including those where there is exposure to hazardous substances;
- b) establish an education program which includes instruction and training in:
 1. product identifier, hazardous substance information, Safety Data Sheets (SDS), WHMIS 2015 for controlled products;
 2. procedures to implement and follow for the storage, handling and use of hazardous substances;
 3. accessing computerized versions of SDS, where applicable;
- c) maintain control of hazardous substances;
- d) obtain a current SDS and any other available product safety information from the fluid supplier or manufacturer and take the necessary steps to ensure that the product is used safely and in an environmentally acceptable manner;
- e) comply with the information contained in the manufacturer's publication and in the current SDS; and
- f) ensure that the least hazardous products are used for the intended purpose where possible.
- g) Safety information should be provided to employees, contractors, and customers, or any other users of the product(s), and they should be advised to follow the same precautionary measures.

6.1.2.4 Materials Handling Equipment

Motorized or manual deicing/anti-icing vehicles shall:

- a) be designed and constructed to protect the health and safety of individuals;
- b) be inspected, tested and maintained on a frequency specified by the employer while the mobile cranes must meet CSA standards; and
- c) be operated within the areas marked for use including vehicle safety zones.

6.1.2.5 Job Safety Analysis

As the authority on the deicing and anti-icing operation, the employer is obliged to assess all the health and safety risks and develop safety procedures that eliminates or mitigates risks before an employee is required to carry out work. It is recommended that each employer follow a Job Safety Analysis evaluation process to establish best practices and safe job methods while identifying the hazards in the deicing/anti-icing operations.

NOTE: Refer to the Canadian Centre for Occupational Health and Safety (CCOHS) document entitled 'Job Safety Analysis Made Simple' <http://www.ccohs.ca/products/publications/JSA.html>.

6.1.2.6 Work Place Inspections

The deicing/anti-icing area shall be inspected at least once a year by the work place occupational health and safety committee or the OH&S representative. All elements of the operation in this area shall be assessed including work place conditions, all work place activities, communication, coordination and procedures as well as review of the relative policies and implementation monitoring.

6.1.2.7 Accident Investigation, Recording and Reporting

Employers are obligated to:

- a) investigate, record and report accidents, occupational diseases or other hazardous occurrences affecting employees;
- b) telephone or telex the safety officer within 24 hours where the occurrence results in: death, disabling injury to two or more, loss of body member or loss of usefulness, permanent impairment of body function, explosion, or damage to elevating device or freefall of the elevating device;
- c) provide written report within 14 days to the safety officer where the occurrence resulted in: disabling injury, electric shock, toxic or oxygen deficient atmosphere, implementation of emergency procedures or fire or explosion.

6.1.2.8 First Aid

A qualified first aid attendant and first aid supplies and equipment shall be provided at work places where there are two or more employees for remote workplaces, and where there are six or more employees at other workplaces. A list of qualified First Aid personnel shall accompany the First Aid kit.

First aid information such as procedures relative to rendering any injury, first aid locations, emergency telephone numbers, and transportation procedures shall be readily available.

6.2 Safety

6.2.1 Jet Blast

Engine exhaust-Caution must be exercised when in the engine exhaust heat and velocity hazard areas. The hazard areas exist in a reverse funnel fashion, which extends past the tail of the aircraft. Aircraft manufactures specify the hazards area dependent on the engine type. Even when an aircraft engine is running at low thrust or idle equipment, operators must maintain safe distances from the aircraft.

6.2.2 Engine Inlet

Engine inlet vortices are normally only visible when water or steam exhaust is present in them. Foreign objects are capable of being ingested and causing damage to aircraft engines. Personnel can also be ingested when in close proximity to operating engines, which can be fatal. Aircraft manufactures specify the hazardous area dependent on the engine type.

6.2.3 Safety Zones

Safe Zones are designated areas used for manoeuvring deicing equipment and provide clearance for aircraft to transition through the deicing pad.

6.2.4 Slippery Aprons

Areas sprayed with deicing fluid may become slippery. Exercise caution when walking or when operating equipment on apron areas where fluid has been deposited. If an accumulation of fluid occurs on the apron, it is recommended that mechanical means, such as vacuum trucks, should be used to pick up the over sprayed fluid.

6.2.5 Visibility/Wind/Weather

Extreme weather conditions may warrant the change of vehicle patterns due to safety concerns. Deicing equipment may have operating restrictions under high wind conditions. Consult the equipment manufacturers for equipment operational restrictions. Under poor visibility, conditions deicing operations may need to be slowed or ceased until conditions improve.

6.2.6 Aircraft and Vehicle Movement

The vehicle movement patterns around aircraft must be established with regard to the facility/area in which they are operating. Adherence to established procedures will sustain a consistent and safe operation.

6.2.7 Aircraft Positioning

Positioning “Light” aircraft behind “Heavy” aircraft with engines operating should be avoided when operationally feasible. The PIC must be advised to use “minimal break away power”, in the event that a “Light” aircraft is positioned behind a “Heavy” aircraft.

6.2.8 Procedures

Front line employees must follow the deicing procedures as defined by their employer. If a problem with a process or procedure is identified then the employee is responsible for reporting the problem, without delay, to his or her immediate supervisor.

CHAPTER 7 Communications

Reference to a service provider, in the context of this document, implies any of the following: the operator's own service provider, a contracted service, or a CDF.

7.1 Communication Background

Poor communications between flight crew and service providers during deicing operations have directly led to serious and fatal incidents of personnel involved in the deicing operations.

Effective and clear communication between the aircraft crew and the service provider must be established. The communication procedures must be concise and easily understood with no room for misinterpretation.

7.2 Communication Plan

A *Communication Plan* is an essential part of a GIP. The following subsection details required elements in the Communication Plan.

7.2.1 Local Airport/Operator Communication Responsibilities

Prior to the annual start-up of de/anti-icing operations at an airport, stakeholders need to have a clearly defined set of responsibilities regarding communications at the de/anti-icing operations location. The plan will need to be clearly defined and understood by all of those involved.

7.2.2 Specific Communication Responsibilities

Clearly understood procedures relating to the management and transfer of communication responsibilities needs to be established, in particular, for the following:

- a) ATC manoeuvring areas
- b) Apron Advisory (e.g., aircraft movement areas)
- c) De/anti-icing facility areas

7.2.3 Establishing a Committee

It is recommended that a local airport committee be established, which includes representatives from each of the stakeholder organizations. This committee should help establish the communication processes and procedures to be followed during ground icing operations. In addition, this Committee should meet regularly to discuss and resolve issues that arise during operations.

7.3 Communications Methodology

Communications between the deicing service provider and the PIC of the aircraft about to receive the deicing services must be established. Communication is typically established either through the use of a

designated radio frequency, through a direct link to the aircraft through a hard-wired head set or through message boards, which all communicate vital information to the flight crew.

A backup communication strategy should be established so that, in the event of a principle communications failure, the safety of the operations is preserved. Backup communication may take the form of clearly understood hand signals, alternate radio communication or other methods. Emergency communication procedures should be in place and practiced at routine intervals to ensure that personnel are proficient in their implementation.

7.4 Responsibilities

7.4.1 Pilot-In-Command (PIC)

The PIC is responsible for the safe operation of the aircraft at all times, however, during ground icing operations and during the deicing process, the PIC relies on clear, concise and accurate communication with numerous other people when making decisions affecting aircraft and personnel safety.

Warning: The PIC shall not move the aircraft in the deicing area without clear and concise communication to the effect that all equipment and personnel are clear of the aircraft and that it is safe to do so.

7.4.2 Service Provider

The service provider will be required to maintain continuous communication with the PIC during the de/anti-icing process. Key safety information will need to be communicated to the PIC as discussed further in section 12.6.

7.5 Standardization of Communication Procedures

Communications procedures must be standardized to the maximum extent possible. Service provider personnel need to be trained to these procedures. The operators need to be briefed on the procedures and need to follow the procedures. Standardized procedures reduce the possibility of operational confusion. Only through following standardized communication procedures can the safety of ground icing operations be reasonably assured.

At least the following communication information should be standardized:

- a) Pushback instructions including information about the requirement for de/anti-icing services;
- b) Routing to the de/anti-icing area;
- c) Required communications between the PIC and service provider;
- d) Facility and ATC communication control transfer; and
- e) Communication training requirements.

7.6 Approaching the Deicing Area

7.6.1 Risks

The deicing area is often very congested with aircraft, equipment and personnel. Visibility is often very poor. The risk of having a collision between aircraft and ground equipment or personnel is high. Vigilance by everyone involved at the deicing area must be of the highest order.

7.6.2 Safety Factors

The most important safety factor for avoiding a deicing area accident, in addition to competent and well-trained personnel, is the establishment of clear and concise communications procedures. This is especially true as an aircraft approaches the deicing area. If any doubt exists regarding the safety of aircraft movement when approaching the deicing area, the PIC should stop the aircraft and resolve the concern.

7.7 Departing the Deicing Area

7.7.1 Procedures

The procedures used by the service provider for departures out of the deicing area must be made clear to the flight crews who will utilize them. Pilots of aircraft departing the area must have clear understanding of the point of departure, required ground track, visual signals (Deicing Operator hand signals or message boards, as appropriate), engine handling procedures, etc. These directions should be included in the pertinent literature and be made available to the pilots.

If in-pavement lighting and or hand signals are used, they should be standardized. Pilots need a clear indication regarding when to depart the deicing location; and, the deicing crews need to know that standard in-pavement lighting configurations and hand signals will be followed. The safety of both the service provider and the aircraft depend upon strict adherence to these procedures.

An aircraft departing the pad incorrectly could result in damage to the aircraft, damage to ground equipment, loss of separation between the aircraft and the ground crews, possible damage to other aircraft parked or manoeuvring within the pad, or grievous injury to personnel. Irrespective of the method used, there should be no confusion in the pilot's mind as to how, when or where to exit the deicing area. Inclement weather, slippery conditions and poor visibility will only worsen the situation and increase the potential for an accident.

Maintaining a direct radio communication link between the aircraft's PIC and the service provider can help to reduce the possibility of errors being made during the departure and exit from the deicing location. However, even when a pilot is talking directly to the service provider, if a hand signal or in-pavement guidance light or marker system is misinterpreted, an incident or accident can occur. Reliable, documented procedures and a continuous radio link between the aircraft and the service provider will ensure a safe and efficient departure and exit from the deicing location.

NOTE: After exiting the deicing location, the PIC is responsible for contacting the appropriate agency for taxi instructions, and for tracking the holdover time (HOT).

7.7.2 Responsibilities

The service provider will be responsible for advising the aircraft PIC that the aircraft is free of obstructions, that icing equipment and personnel are safely away from the aircraft, and that the aircraft is authorized to depart the deicing area. This information is normally communicated via radio communications and may be confirmed by well-understood visual signals. However, visual communications can be difficult during conditions of low visibility or at night.

NOTE: In recent years lighted message boards have been used to communicate important safety information to the PIC. The procedures for the use of these boards must be well understood.

7.7.3 Notification

The departure notification to the PIC needs to include at least the following:

- a) Confirmation that all staff and equipment are safely away from the aircraft;
- b) The PIC is authorized to start the engines (if applicable); and
- c) The PIC should standby for a signal/clearance to depart the deicing area.

NOTE: The PIC will be responsible for contacting ATC on the appropriate radio frequency for taxi instructions when it is appropriate to do so.

7.8 Training of Service Provider Staff

The service provider will need to develop a training program that places particular emphasis on arrival and departure communications for aircraft. The training must satisfy the operator's GIP. The communications training should emphasize at least the following points:

- a) Aircraft arrival & departure communication procedures;
- b) Start of de/anti-icing operations announcement;
- c) Completion of deicing/anti-icing operations announcements;
- d) Aircraft clearance procedures; and
- e) Necessary information to be communicated to the PIC regarding times and fluids used.

7.9 Training of Non-Service Provider Staff

7.9.1 General

Outside parties, such as snowplough operators and sweeper operators, need to clearly understand their role and responsibility as related to the control of aircraft and related co-ordination activities when deicing operations are either anticipated or are underway. The individuals involved will need to conduct themselves in accordance with all of the approved or agreed procedures related to the deicing operation.

7.9.2 Responsibilities

The operator and the service provider are responsible for ensuring these individuals are appropriately trained and that their roles are accomplished in a safe manner.

7.10 Service Provider Management Responsibilities

The service provider Management is responsible for ensuring that the staff are well trained regarding ground icing operations communication procedures. Further, management will ensure that:

- a) The operator's approved GIP is being followed;
- b) A quality assurance audit program is in place to ensure that the staff are following the appropriate communications procedures;
- c) Any changes to local procedures are relayed immediately to deicing personnel; and
- d) An effective initial and recurrent communication training program is in place and functioning effectively.

7.11 Passengers

Passengers can be the source of information regarding the ground deicing process. They may report the sighting of contamination on a wings' surface, the presence of noxious fumes entering the cabin as a result of discharging deicing fluids into the inlet of the cabin air conditioning system, or other concerns. The cabin safety personnel are often the first to be made aware of a passengers' concern for safety.

7.12 Flight Deck/Cabin Crew Communication

Where, before commencing take-off, a crew member of an aircraft observes that there is frost, ice or snow adhering to the wings of the aircraft, the crew member shall immediately report that observation to the PIC, and the PIC or a flight crew member designated by the PIC shall inspect the wings of the aircraft before take-off.

7.13 New Communication Technology

7.13.1 Lighted Message Boards

There have been recent developments in the use of illuminated message boards at airport deicing pads, which relay pertinent ground icing operation information to the PIC.

It is important that the PIC is trained and is completely familiar with the procedures to be followed when using illuminated message boards at airports so equipped. The procedures for using this type of communication should be identified in operator's GIP.

7.14 Emergency Communication Procedures

Communication procedures which address emergencies which may arise at the deicing area need to be established. Personnel working at the deicing area shall be trained on the emergency procedures on an initial and recurrent basis. Periodic testing of personnel on the emergency procedures throughout the icing season should be conducted.

7.15 Communications Summary

The failure to communicate effectively and in a timely manner is often the root cause of many aviation accidents. The employee must:

- a) Understand the communication process for all deicing/anti-icing operations, including: before, during and after deicing/anti-icing;
- b) Report to their immediate supervisor any conditions that limit or prevent effective communication;
- c) Use established verbal and/or visual signals to direct arriving, parking and departing aircraft
- d) Understand the basic communication and control responsibilities of other agencies involved in the deicing process (e.g., ATS, Apron, Flight Operations).

CHAPTER 8 Fluids

8.1 General

The information contained in this chapter of the document is intended to be generic and not specific to any particular product or company.

8.1.1 De/Anti-Icing

The most common techniques for removing frozen precipitation from aircraft critical surfaces and protecting the aircraft against re-contamination are accomplished with aircraft deicing and anti-icing fluids respectively.

Deicing is a procedure by which frost, ice, snow or slush (i.e., the frozen contamination) is removed from an aircraft by use of a heated aircraft deicing fluid (ADF), to provide clean surfaces. Anti-icing is a procedure in which an aircraft anti-icing fluid (AAF) is applied to a surface free of frozen contaminants in order to protect the surface from the accumulation of frozen contaminants for a limited period of time.

De/anti-icing fluids are only required until the aircraft becomes airborne, after which the on-board de/anti-icing system then operate. The rotation speed of an aircraft is important as it determines which de/anti-icing fluid is most appropriate for use. Serious aerodynamic consequences can result with incorrect fluid use. Consult the manufacturers Pilot Operating Handbook, Aircraft Flight Manuals, or Maintenance Manuals for complete details.

8.1.2 Fluid Description

ADFs are typically ethylene glycol, diethylene glycol or propylene glycol-based while more recent innovations have led to the commercialization of non-glycol-based fluid. Most of these fluids contain corrosion inhibitors, surfactants (wetting agents) and dyes. These fluids are formulated to assist in removing ice, snow and frost from the exterior surfaces of aircraft and also provide a short period of anti-icing protection. Type I fluids are typically used for the deicing function.

Anti-icing fluids are similar in composition except that they also contain polymeric thickeners and are formulated to prevent the formation of unabsorbed frozen contamination for a longer period of time than deicing fluids. Although the protection time of thickened fluids is longer than non-thickened fluids, it is still for a limited period of time.

8.1.3 Industry Fluid Specifications

The Society of Automotive Engineers International (SAE) and the International Standards Organization (ISO) have specifications for ADF and AAF. The ISO specifications are derived from the SAE specifications and are therefore usually dated. Transport Canada recognizes only the most up-to-date SAE specifications, and all fluids applied to aircraft must meet these specifications.

NOTE: Only current SAE Specifications and documents are recognized by Transport Canada.

The SAE specifications are:

- a) SAE Aerospace Material Specification (AMS) 1424 “Aircraft Deicing/Anti-icing Fluid SAE Type I”
- b) SAE AMS1428: “Deicing/Anti-icing Fluid SAE Type II, III and IV”

NOTE: Users should request certificates of conformance to these SAE specifications from the fluid manufacturers.

8.1.4 Acceptable Fluids

Transport Canada does not approve or qualify de/anti-icing fluids but does list those that have met the requirements

Typically, aircraft manufacturers will generally indicate in the Aircraft Flight Manual (AFM) or Aircraft Maintenance Manual (AMM) the applicable industry specifications for aircraft consumable materials. The industry fluid specifications for de/anti-icing fluids were discussed in Section 8.1.3.

The SAE specifications require the completion of numerous chemical and physical tests at specialized laboratories. These tests are principally for measuring the compatibility of materials used in aircraft construction and the physical properties of the fluids against the appropriate SAE specification.

Also, the SAE specifications require a series of anti-icing and aerodynamic performance tests. The aerodynamic performance tests are conducted in a calibrated wind tunnel for the purposes of measuring the aerodynamic and “flow off” characteristics of the fluid against the appropriate SAE specification.

Furthermore, fluids undergo endurance time testing to establish holdover times for the annually published HOT guidelines. The methods and practices to obtain endurance times are outlined in the SAE Aerospace Recommended Practice (ARP) 5945 for Type I fluids and ARP5485 for Type II, III and IV fluids. From these endurance times, holdover times are established and published in the TC HOT Guidelines. The process utilized to establish holdover times for Type II, III and IV fluids are outlined in ARP5718.

8.1.4.1 Testing Laboratories

A listing of the laboratories known to provide testing for de/anti-icing fluids to internationally accepted standards and recommended practices that are associated to the holdover times published by Transport Canada can be found in the *Holdover Time Guidelines*.

8.1.5 Recommended Practices

The fluids must be used in accordance with the approved GIP. Application should respect the fluid manufacturer’s instructions and be applied in accordance with the guidance found in the *Holdover Time Guidelines* Fluid Application Tables.

8.1.6 Type I, II, III, & IV De/Anti-icing Fluid Specifications

The SAE documents AMS1424 & AMS1428 should be consulted for detailed information on fluids specifications.

8.1.6.1 Performance Properties

Properties are fluid specific and knowledge of these properties is critical to safe ground icing operations. The Fluid Manufacturer's recommendations should be followed.

The following are some important considerations relating to fluid use: the freezing point of the fluid, the freezing point of different dilutions of aircraft de/anti-icing fluids, the freezing point determination methods, the freezing point buffer, the adjustment of the fluid concentration and the fluid viscosity. Other important factors include: the selection and care of refractometers, checking the zero and calibration of refractometers, and the LOU). Following are explanations of these considerations:

a) Freezing Point

Frequent determinations of the freezing point of fluids are required to ensure that the desired freezing point is maintained. The freezing points can be measured directly using the American Society for Testing Materials (ASTM) D 1177 method, which measures the temperature of the first ice crystal formation. However, this method is cumbersome for use in the field. The freezing point of fluids can be effectively and easily monitored in the field by measuring refraction. The magnitude of the refraction is related to the freezing point depressant concentration contained in the fluid and therefore to the freezing point of the fluid.

The fluid manufacturers should be consulted for further operational information on the procurement and the training required for refractometer use in the field.

b) Freezing Point Buffer

The freezing point of a fluid is normally a function of the glycol concentration. An assessment of the fluid concentration can be performed in the field by measuring the refractive index of the fluid. The magnitude of refraction (how much light bends) is related to the concentration of glycol in the solution and hence the freezing point. Fluid manufacturers provide fluid specification charts that correlate refraction index, also called BRIX, versus fluid freezing point. Since there could be some error in reading the BRIX, or the skin temperature could be lower than the outside air temperature, it was decided to add a safety buffer to all the calculations, and a value of 10°C was agreed for Type I fluids, by the SAE G-12 Aircraft Deicing Fluids Committee, and 7°C for Types II & IV fluids

This buffer allows for absorption of precipitation, for errors in application, and for the influence of variations in the weather conditions.

c) Lowest Operational Use Temperature (LOUT) of Types I, II, III, & IV Fluids

Just as an aircraft has a specific operating envelope within which it is approved to be operated, de/anti-icing fluids are also tested and qualified for operation within a specific temperature envelope.

The qualification of de/anti-icing fluids, also called freezing point depressants (FPD), is a complex and thorough process, which evaluates a multitude of fluid properties and characteristics. The one of particular interest in this case is the LOUT).

The LOUT is fluid concentration specific. The fluid concentration may change if the fluid is subjected to sustained heating

The LOUT for a given fluid is the higher of: The values in this table were determined using test results from pre-production fluid samples when available. In some cases, the fluid manufacturer requested the publication of a more conservative value than the pre-production test value. The lowest operational use temperature (LOUT) for a given fluid is the higher of:

1. The lowest temperature at which the fluid meets the aerodynamic acceptance (AAT) test for a given aircraft type;
2. The actual freezing point of the fluid plus its freezing point buffer (Type I = 10°C/18°F; Type II/III/IV = 7°C/13°F); or
3. For diluted Type II/III/IV fluids, the coldest temperature for which holdover times are published.

NOTE: Manufacturers state that a fluid must not be used when the outside air temperature or skin temperature is below the LOUT of the fluid.

An example of establishing a LOUT follows:

Consider a Type I fluid that has met the aerodynamics acceptance test down to -45°C.

The reported freezing point of the fluid (as measured by the service provider) is -43°C.

The OAT is -39°C.

The LOUT for a given fluid is the higher of:

- i. The lowest temperature at which the fluid meets the aerodynamic acceptance test for a given aircraft type, in this case -45°C; or
- ii. The actual freezing point of the fluid plus a freezing point buffer of 10°C, in this case -43°C +10°C = -33°C.

For this example, the LOUT is -33°C and since the OAT is -39°C, *this fluid, as is must not be used.*

d) Lowest On-Wing Viscosity (LOWV) and Highest On-Wing Viscosity (HOWV)

Type II, III and IV fluids are delivered at high viscosities. The application process of anti-icing fluid requires the pumping the fluid through the pump mechanism and the nozzle of the anti-icing vehicles; these processes shear the fluid and is likely to reduce its viscosity. Lowering the viscosity reduces the HOT of the fluid.

Conversely, fluids that settle or are stored for prolonged periods of time may establish a viscosity that is higher than that of the manufacturer's recommended value. This could impact the fluid's aerodynamic performance and consequently the fluid's LOUT.

Each manufacturer produces the fluid and guarantees that their delivered fluid's viscosity lies within a specific range of viscosity values. The high end of the viscosity range impacts the aerodynamic performance, and the low end of the viscosity range affects the HOT values.

e) Types II, III, and IV Fluids Viscosity Check

For Types II, III, and IV fluids, viscosity checks should be performed at the beginning of the icing season, periodically throughout the winter, and any time fluid contamination or damage is suspected or after major deicing truck pumping and spraying system maintenance. These checks should include samples obtained through the spray nozzles of application equipment. The checks have to be conducted using one of the measurement methods in Aerospace Standard (AS) 9968, Laboratory Viscosity Measurement of Thickened Aircraft Deicing/Anti icing Fluids with a Viscometer (manufacturer method or an alternate method) provided for the specific fluid brand/product and dilution in the tables, Type II Fluids Tested for Anti-Icing Performance and Aerodynamic Acceptance; Type III Fluids Tested for Anti-Icing Performance and Aerodynamic Acceptance; or Type IV Fluids Tested for Anti-Icing Performance and Aerodynamic Acceptance, which list fluids tested for anti-icing performance and aerodynamic acceptance. The viscosities obtained during these checks should be compared to the LOWV and HOWV values provided in these tables; fluid samples with viscosities below the stated LOWV cannot be used with the HOT tables, as they may not provide the HOT protection stated in the tables. Fluid samples with viscosities above the stated HOWV should not be used as this may compromise its use down to the lowest operational use temperature (LOUT). Viscosity measurement methods and values for dilutions of Types II, III, and IV fluids are included in the TC HOT Guidelines to facilitate fluid viscosity checks in locations where thickened fluids are diluted before applying and, in some cases, may be stored diluted.

f) Aerodynamics

De/anti-icing fluid remaining on the aircraft following the deicing and/or anti-icing operation has an effect on the aerodynamic performance of any aircraft. As the temperature decreases, fluids generally become more viscous and have an increased negative effect on the aerodynamics.

As an aircraft gains speed on its takeoff run the aerodynamic shear forces cause the fluids to flow off the aircraft's surfaces. The amount of fluid that is sheared off the aircraft depends upon the speeds reached during the takeoff run and the time it took to reach those speeds.

There are three separate aerodynamic acceptance tests which reflect various aircraft takeoff profiles:

1. Aircraft with rotation speeds (V_r) between 60 knots and 100 knots (low speed ramp)
2. Aircraft with V_r between 80 knots and 100 knots (middle speed ramp)
3. Aircraft with V_r exceeding 100 knots (high speed ramp)

The objective of the tests is to determine the coldest temperature at which the ADF/AAF have acceptable aerodynamic characteristics as they flow off lifting and control surfaces during the takeoff ground acceleration and climb

Aircraft manufacturers should be consulted to establish which fluids can be safely used on their models of aircraft.

g) High Speed Test

The High-Speed Aerodynamic test as described in SAE Aerospace Specification (AS) 5900 - *Standard Test Method for Aerodynamic Acceptance of SAE AMS1424 and SAE AMS1428 Aircraft Deicing/Anti-icing Fluids* establishes the aerodynamic flow off requirements for fluids used to deice or anti-ice large transport jet aircraft with rotation speeds generally exceeding 100 knots and with ground acceleration to lift of times exceeding 23 seconds.

Some slow take off speed aircraft manufacturers have allowed the use of fluids designed for high-speed aircraft on their models. There are often changes required to take off procedures, to take off configuration or to both. The aircraft manufacturer must be consulted.

h) Mid Speed Test

The Mid Speed Aerodynamic test as described in SAE AS5900 establishes the aerodynamic flow off requirements for fluids used to deice or anti-ice aircraft whose takeoff rotation speeds are generally between 80 knots and 100 knots and with ground acceleration to rotation time between 16 seconds and 20 seconds.

i) Low Speed Test

The Low Speed Aerodynamic test as described in SAE AS5900 establishes the aerodynamic flow off requirements for fluids used to deice or anti-ice slower aircraft whose takeoff rotation speeds generally exceed 60 knots and with ground acceleration to rotation time exceeding 16 seconds.

NOTE: Consult the aircraft manufacturer to determine if the aircraft to be treated falls within the high speed, middle speed or low speed aerodynamic acceptance criterion, to determine which type of fluid can safely be used.

8.1.6.2 Operational Properties

a) Colour

Colours are used as a visual aid in the application of fluids to aircraft surfaces

SAE fluid specifications indicate the appropriate colour for each of the Types of fluids, as follows:

- i. Type I: Orange
- ii. Type II: Yellow
- iii. Type III: Bright yellow
- iv. Type IV: Green

NOTE: If the colour of the fluid being applied to the aircraft is NOT the colour anticipated, the procedure should be stopped and the situation investigated.

b) Hard Water

The fluid manufacturer should be consulted to establish the acceptable levels of water hardness for use with their brand specific fluids.

8.1.6.3 Physical Properties

The physical properties of interest include: refraction, specific gravity, pH, viscosity, flash point, and surface tension. Contact the fluid manufacturer regarding the physical properties of their fluids.

8.1.6.4 Collection and Disposal

All runoff from deicing operations shall be contained, collected and disposed of in accordance with applicable federal, provincial/territorial and/or municipal regulations and guidelines. Please note that laws and regulations governing treatment, recycling or disposal are always subject to change. It is the responsibility of the user to assure that disposal is appropriate and is in compliance with legal requirements.

8.1.6.5 Environmental Impact

The local Environment Canada representative should be contacted for information on the detailed requirements for protection of the environment from the adverse effects of deicing fluids with respect to federal airports. A local provincial/territorial or municipal environmental representative should be contacted for more information on non-federally-owned airports. See Chapter 13 of this document for further information on environmental issues.

Aircraft deicing or anti-icing fluids that are allowed to enter surface waters can have an adverse effect on aquatic life. For this reason, it is recommended that the runoff from deicing operations be contained and diverted to either a water treatment system or a glycol reclamation system.

8.1.6.6 Storage, Handling and Testing

The fluid manufacturer's storage, handling and testing recommendations should be followed. It is also advisable to consult SAE AIR5704 - *Field Viscosity Test for Thickened Aircraft Anti-Icing Fluids*, AS9968 - *Laboratory Viscosity Measurement of Thickened Aircraft Deicing/Anti-icing Fluids*, AS6285, AS6286, AMS1424 and AMS1428 for additional information on storage, handling and testing of fluids.

- a) In addition to information contained in the fluid manufacturer's recommendations and the SAE documents above, the following information should be considered:
 - i. **Materials compatibility.** What materials can be used to handle and store the fluids including which elastomers can be used for hoses and gaskets.
 - ii. **UV degradation.** Some fluid or fluid components may degrade upon prolonged exposure to UV light. Specific recommendations should be obtained from the fluid manufacturer on how to deal with UV degradation. Fluid contained in site gauges is particularly vulnerable.
 - iii. **Storage tanks.** Materials compatibility needs to be assured. There are specific regulations and standards regarding the construction, installation and operation of storage tank systems for deicing products. They are contained in the Canadian Council of Ministers of the Environment (CCME) in the *Environmental Code of Practice for Aboveground and Underground Storage Tank Systems Containing Petroleum and Allied Petroleum Products* at <http://publications.gc.ca/site/eng/9.649089/publication.html?pedisable=true>.
 - iv. **Receiving/transfer of fluid.** Prior to unloading fluid, check the shipping documents, product label, refraction, colour, for suspended matter and any other test recommended by the manufacturer. Make certain that all of these properties are within the range recommended by the fluid manufacturer.
 - v. **Label.** The contents of storage vessels must be correctly identified on the label.
 - vi. **Colour.** Most fluids are colour coded. Type I fluids are orange; Type II fluids are water white / pale straw, Type III fluids are bright yellow and Type IV fluids are green. If the fluid is different from that defined by the manufacturer, the fluid may be considered unacceptable. Do not depend on colour alone to determine that the correct product has been delivered or is being used. Always check the label, shipping papers and refraction index.

- vii. **Refraction.** Obtain the acceptable range of refraction of the fluid from the manufacturer and make sure that the fluid is within the acceptable range. With concentrated Type I fluids, the user must dilute the fluid concentrate depending upon the need. The user has to set the acceptable refraction range depending upon the OAT.
- viii. **Viscosity.** Viscosity is not normally measured on Type I fluids. However, it is a critical property for Type II, III and IV fluids. Viscosity in the laboratory is commonly measured using a Brookfield™ viscometer. SAE AS9968 - Laboratory Viscosity Measurement of Thickened Aircraft Deicing/Anti-icing Fluids with the Brookfield LV Viscometer describes a standard method for viscosity measurements of thickened (AMS1428) anti-icing fluids. Fluid manufacturers may publish alternate methods for their fluids. In case of conflicting results between the two methods, the manufacturer method takes precedence. To compare viscosities, exactly the same measurement elements (including spindle and container size) must have been used to obtain those viscosities.
- ix. **Suspended matter.** Look at the sample, it should be substantially free from suspended matter, and must not have any oily residues within or on the surface. The presence of any oily residue is a form of contamination. Such a contamination may interfere with the setting capabilities of the fluid. A fluid that does not wet well may have significantly shorter holdover times. Do not use a fluid that has any sign of an oily residue.
- x. **pH.** The pH can be measured using a portable pH meter. These meters are available from several laboratory equipment vendors. Ask the fluid manufacturer for the acceptable pH range for the fluid in question.
- xi. **Sampling.** It is important to obtain representative samples, whenever collecting samples. Some fluid manufacturers provide sampling guidelines.
- xii. **Records.** Keep records of the test results.
- xiii. **Test frequency.**

1. Bulk Storage

Test the fluid from all vessels at least once a year before the deicing season begins and continue to do so on a regular basis. Check the label, colour, refraction, suspended matter, and pH of aircraft de/anti-icing fluids to make certain that they have not been degraded or contaminated. Test samples from delivery vessels, storage tanks, and aircraft deicing truck tanks. Use the fluid only if the label, colour, refraction, suspended matter and pH are within the accepted range.

2. Mixing

Whenever water is mixed with deicing fluids check the colour, refraction and suspended matter of the resulting fluid mixture. Use the fluid only if the test results are within the accepted range.

3. Transferred

Whenever fluids are transferred, check the label on both the source and receiving vessel. Also check the colour, the refraction index and the suspended matter present, of the fluid in the receiving vessel after the transfer. Use the fluid only if the test results are within the accepted range.

4. Small Sealed Vessels

Sealed totes or barrels are tested when opened.

5. Deicing Equipment

Tested daily and/or when refilled.

b) Additional Tests by the Fluid Manufacturer

Fluid samples should be sent to the fluid manufacturer for a full analysis and confirmation of acceptability when:

- i. The product samples tested fail to meet all of the requirements;
- ii. Contamination is suspected; or
- iii. Any time there is doubt about the integrity of the fluid.

c) Fluid Contamination

Fluid contamination can generally be avoided by following established procedures and practices:

- i. **Dedicated equipment.** Use dedicated storage and handling facilities for deicing fluids. Make certain that loading and unloading lines are clean. Routine inspections are required.
- ii. **Forbidden mixtures.** Do not mix fluids with any other product unless approved by the fluid manufacturer.
- iii. **Internal inspection of tanks.** Some deicing/anti-icing trucks have the anti-icing fluid tank sharing a common wall with the deicing fluid tank. Some tank walls can develop cracks, allowing deicing and anti-icing fluids to mix. The presence of even small amounts of deicing fluid in the anti-icing fluid can cause significant anti-icing fluid performance degradation and thus effect the HOT times. Valves and hoses can also leak and allow fluid mixing or contamination. Routine inspection is required to help prevent these issues from arising.
- iv. **Labeling.** Conspicuously label storage tanks, loading and transfer lines, valves, deicing/anti-icing truck tanks, and pumps for instant identification to minimize the risk of product contamination. Before transferring any fluid, check the label on both the source and receiving vessels, as required by WHMIS regulations.

- v. **New equipment.** New equipment placed into service should be thoroughly cleaned. Pay particular attention to new deicing trucks, which are often shipped with an antifreeze solution in the pump and piping system. Drain the system and rinse with clean water before filling the truck with deicing fluid and introducing it into service.
- vi. **Transfer of fluid.** Transfer of fluid from deicing equipment into storage tanks should not be accomplished without appropriately testing the fluid. If the fluids were contaminated this action would result in the contamination of the fluid in the storage tank.
- vii. **Weatherproof covers.** Make certain that the truck and storage tank covers are weatherproof and do not allow water into the tank; however, recognize that proper venting is still required. If it is suspected that water or contaminants have entered the tanks, check the product in the tanks to ensure that it continues to meet minimum specification(s), and if necessary, thoroughly clean the tanks and ensure that the covers are repaired to a weatherproof state.

d) Pumps and Filters

Type II, III and IV fluids may be degraded through shearing during pumping. Check with the fluid manufacturer regarding the types of pumps that are acceptable for pumping their fluids. The viscosity of the fluid generally increases as its temperature is lowered, therefore, additional pumping power will often be required to pump the fluid at temperatures near the fluid freezing point.

The user should always check that the design and construction of the deicing storage system is appropriate for use with the de/anti-icing fluid in use. Some fluids can be filtered while others cannot. Check with the fluid manufacturer regarding the suitability of filters.

e) Heating Type I Deicing Fluids

The effectiveness of a Type I deicing fluid in removing frozen contaminants from an aircraft's critical surfaces is principally the result of it being applied at a heated temperature.

The time of protection provided by Type I fluids is directly related to the heat input to the aircraft's critical surfaces. Therefore, in order to achieve the published HOT values for Type I fluids, the fluids must be heated as indicated.

The following points should be noted regarding heating Type I fluids:

- i. **Standby heated storage.** Deicing fluid should not be stored at a high temperature since prolonged heating may lead to fluid degradation or increased concentration of glycol. It may be maintained in heated standby storage before or during the active deicing events to save time when heating to the final application temperature. If heated, the fluid should be kept in the standby mode at a temperature that does not exceed the temperature recommended by the fluid manufacturer. Avoid heating during idle times because this may result in thermally induced degradation.

- ii. **Heating for application.** Follow the fluid manufacturer's recommendation. Typically, temperatures should be in the range of plus 60°C to plus 82°C.
- iii. **Evaporation.** When the deicing fluid is heated (either standby heating or heating for application) there may be water evaporation resulting in an increase in the glycol concentration and of the refractive index. The refractive index should be checked regularly to ensure that the deicing fluid refraction index and freezing point are within the acceptable range. Evaporation may be minimized by keeping the lids closed on the fluid tanks, however the vents must be kept open at all times. Water loss by evaporation can be replenished by direct addition to the tank. The addition of the appropriate quantity of water or deicing fluid to the tank must be accompanied by an adequate mixing process, such as recirculation. It is important to measure the refractive index of the solution in the storage tank following any addition of water or deicing fluid, in order to confirm that the fluid retains the proper freezing point.
- iv. **Thermal degradation.** A lowering of the fluid pH or fluid discolouration is indicative of thermal degradation. Do not use a deicing fluid solution if the pH is not in the accepted range because it may cause aircraft corrosion.

NOTE: Generally, in North America, Types II, III & IV are not specifically heated but may be heated if required. If a Type III is used as a deicing fluid, it is generally applied heated. See the fluid manufacturer's product information bulletins for more information on this issue.

f) Shelf Life of De/Anti-icing Fluids

The fluid manufacturers should be consulted for shelf-life information on their products.

Generally, properly used and stored fluids are formulated with components that should be stable under unheated storage conditions. However, periodic testing of the fluid is prudent and recommended to ensure that the fluid is still acceptable for use. Fluid stored unheated for one year should be sampled and tested for conformance to specifications for colour, suspended matter, pH and refraction. If there is doubt on the fluid not meeting the specification requirements, a sample should be sent to the fluid manufacturer for further testing. These measurements should be repeated every year. Sampling guidelines should be available from the fluid manufacturers.

The fluid manufacturers should be consulted for shelf-life information on their products.

For heated storage conditions, fluids should be checked in accordance with the fluid manufacturer's recommendations.

g) Apron

Areas sprayed with deicing fluid may become slippery. Exercise caution when walking or when operating equipment on apron areas where fluid has been deposited. If an

accumulation of fluid occurs on the apron, it is recommended that mechanical means, such as vacuum trucks, should be used to pick up the over sprayed fluid.

h) Deicing Equipment Inspections

It is suggested that the following routine inspections should be conducted:

- i. **Tank inspection.** Inspect storage tanks and deicing trucks at least once per year or more often if the need arises (e.g., if suspect fluid has been added to a tank). It is considered appropriate to inspect and test just prior to the winter operating season. If contamination occurs, the cause of the contamination should be identified and steps should be taken to ensure that it does not re-occur.
- ii. **Corrosion in carbon steel tanks most often occurs in the vapor space of partially empty tanks above the fluid level.** To minimize corrosion, keep the tanks full during the summer months and at other low use periods. An internal inspection of the tanks may be required on a regular basis.
- iii. **Application equipment inspection.** It is recommended that equipment testing occur annually, preferably immediately prior to the operating season. Prior to using deicing fluids, test the application equipment including but not limited to: spray nozzles, tanks, and hoses.
- iv. **It is also recommended to test the fluid after any modification or repair to the application equipment.** Examples of this include replacement of pumps/valves and nozzles. The following situations have been reported in the field: pump speed too fast after pump replacement; fluid valves on trucks not opening completely after repairs, causing the fluid to be sheared as it passes through the restricted valve.
- v. **Test Instrument.** Routine calibration and recertification of each instrument's performance should be conducted in accordance with the instrument manufacturer's instructions.

8.1.7 Application

Individual aircraft manufacturers may provide specific deicing and anti-icing recommendations for the various models of their aircraft. The aircraft operators should obtain and follow these specific recommendations. Also, industry standard practices should be followed in addition to the guidance contained in SAE AS6285 and AS6286 with the exception of *Table B.2.4 Amount of Fluid for Anti-Icing with Thickened Fluids* located in SAE AS6286 Appendix B. Transport Canada was made aware that the most recent revision (Revision C) of SAE AS6286, which removes this table, was not published as planned. Transport Canada does not recommend the use of this table as not all anti-icing fluid holdover times found in the *Holdover Time Guidelines* may be attained through the use of the information found in the minimum quantity tables. Transport Canada recommends training on proper fluid application be achieved through processes described in AS6285 and/or in section 10.6.2.2 of this document.

Fluid manufacturers may also have specific operational procedures to be followed to maximize fluid effectiveness. For example, there may be specific pressures, temperatures and procedures to ensure that the fluid is effective in removing frozen contaminants from aircraft surfaces.

Always consult the aircraft maintenance manual for fluid application restrictions such as maximum fluid pressure to be applied to aircraft surfaces.

8.1.7.1 Trained Personnel

Only properly trained personnel shall be employed in the aircraft de/anti-icing process. Personnel are required to read, understand and follow the precautions listed in the fluid manufacturer's product information bulletin, on the product label, and any Safety Data Sheet (SDS) prior to using these materials.

NOTE: SAE AS6286 should be consulted for more detailed information on training and training programs for ground de/anti-icing personnel.

8.1.7.2 Precautions

Unless otherwise authorized by the aircraft manufacturer, deicing fluids should only be used for application on aircraft exterior surfaces and, in general, should not be applied on the following:

- a) Cockpit windows
- b) Landing gear and wheel bays
- c) Directly onto cabin windows, rather the fluid should be directed above the windows and allowed to flow down
- d) Engines and Auxiliary Power Units (APU) inlets
- e) Opened vents or outlet valves on the aircraft
- f) Opened baggage compartment doors
- g) Pitot static air ports, engine inlet probes and angle of attack vanes
- h) Other areas as specified by the aircraft manufacturer

8.1.8 Safety Data Sheet (SDS)

When considering the use of any products in a particular application, the latest Safety Data Sheet (SDS) for the product under consideration should be reviewed to ensure that the intended use can be accomplished safely. The SDS can be obtained from the fluid manufacturer.

The SDS, in Canada, should conform to the Workplace Hazardous Material Information System 2015 (WHMIS 2015) legislation and be available in both official languages. It is important to obtain any other available product safety information from the fluid manufacturer and take the necessary steps to ensure that the product is used and disposed of in a safe and environmentally satisfactory manner.

Government regulations and material use conditions are subject to change, and it is the user's responsibility to determine that they have current and up to date information on the product, on safety, on operational issues, and on environmental regulations and standards.

The user of any product should read, understand, and comply with the information contained in the manufacturer's publications and in the current SDS. This information shall be available at all times to employees.

8.1.9 Recommended Practices and Specifications

Application should respect the fluid and aircraft manufacturers' instructions and be applied in accordance with the most recent version of SAE AS6285.

8.1.10 Emergency Service

Transport Canada maintains a 24-hour emergency service for information on chemical products and how they should be handled during emergency situations, such as spills and accidental releases to the environment. (Call CANUTEC at 613-996-6666, *666 (Cellular), or e-mail canutec@tc.gc.ca)

Many fluid manufacturers also have a 24-hour emergency service for their products. The user should obtain the manufacturer's emergency phone number for ready reference.

NOTE: DO NOT WAIT, if in doubt, call a specialist for advice.

CHAPTER 9 Equipment

9.1 Vehicle & Equipment Standards and Operations

9.1.1 Design

Deicing equipment should be designed and capable of operation such that personnel safety is not compromised. Furthermore, the equipment should operate safely and efficiently under all foreseeable operating conditions.

Equipment fluid dispensing systems should be designed and operated in accordance with the requirements of the appropriate fluid and equipment manufacturer.

Generally, the vehicle design should be in accordance with SAE ARP1971, and SAE ARP4806.

Vehicles shall comply with applicable Federal Motor Vehicle Safety Standard (FMVSS) standards, and shall be legal for highway operation.

9.1.2 Manufacture

Self-propelled deicing vehicles should be manufactured in accordance with SAE ARP1971 and ARP4806.

Equipment should have sufficient lights installed to ensure that surfaces being de/anti-iced can be properly checked and inspected by the operator during low visibility conditions.

9.1.3 Maintenance

A preventive maintenance program that is recognized or approved by the equipment manufacturer should be established to ensure that the equipment consistently operates to its design specification.

9.1.4 Operation

Equipment should be capable of efficiently and safely removing all manner of frozen precipitation experienced or likely to be experienced at the airport.

NOTE: Type II, III and IV fluids, in particular, must be applied using specialized equipment. Not doing so in the correct manner and/or with the incorrect equipment, increases the chances that they will NOT function as designed and therefore NOT provide the expected protection as indicated in the HOT tables.

NOTE: Equipment intended for use during deicing operations, where the aircraft engine is operating, may have to be operated a greater distance from the aircraft. Refer to the appropriate manufacturer's documentation for details.

- a) All deicing equipment shall be utilized as per established procedures (including pre-deicing equipment inspections).
- b) All personal protective equipment, as supplied by the employer, shall be utilized as designed and as per service provider procedures.
- c) Communication equipment shall be available and utilized as per approved procedures for deicing operations.

CHAPTER 10 Preventative Measures and De/Anti-Icing Procedures

10.1 Introduction

Specific rules set forth by the CARs require that: “No person shall conduct or attempt to conduct a take-off in an aircraft that has frost, ice or snow adhering to any of its critical surfaces”.

10.2 Choice of de/anti-icing procedure

10.2.1 Aircraft in Hangars

A good method of ensuring that an aircraft is clean of contamination is by preventing the contamination from collecting in the first place; that is park the aircraft in a hangar. Availability of space, particularly for larger aircraft is a major obstacle with respect to the use of hangars on a routine basis.

If precipitation is present, care must be taken to reduce the skin temperature to below freezing prior to taking the aircraft from the hangar. This can be accomplished by opening the hangar doors prior to rolling the aircraft out. This of course will impact on the users of the hangar. Depending on the facility, it may be possible to apply anti-icing fluids prior to departing the hangar.

Parking a fully or partially fuelled aircraft in a heated hangar presents special considerations. The temperature of the fuel will gradually rise towards the ambient temperature of the hangar. When the fuel is in contact with the upper surface of the wing, the wing surface will assume the temperature of the fuel; so cooling the wing surface by opening the hangar doors is less effective. This temperature effect will be present for an extended time period while the fuel cools once the aircraft is exposed to the outside temperature. When precipitation is present, the warm surface can cause snow and sleet to warm and stick to the wing or to melt. In this instance the application of deicing/anti-icing fluids may be the only effective solution. Possibly, under these circumstances, the aircraft should not be hangered with significant volumes of fuel in wing tanks.

Once an aircraft is contaminated, if a heated hangar is available, the heat and shelter from the elements will greatly help the removal of contamination. This will take time but if available greatly reduces the amount of deicing fluid required.

10.2.2 Wing covers

Many operators of smaller aircraft have found wing covers to be an effective way to prevent the buildup of contamination on wings. Wing covers, although effective, have some drawbacks. Extreme care is required in both installation and removal of the covers in order to avoid damage to the aircraft. Depending on the aircraft type, ladders or a similar device are required during installation and removal of covers; and in inclement weather safety is a concern when climbing ladders due to the possibility of slipping.

Installing covers on wings that are already contaminated often leads to problems. One other drawback of wing covers is the requirement for a large area to store the covers and allow them to dry (i.e., a place to hang them). There have also been problems of wings “sweating” while covered, and then having the covers freeze to the wings.

10.3 Fluid Application Procedures

SAE document AS6285, fluid manufacturers’ recommendations, and the AMM should be consulted in establishing sound operational de/anti-icing procedures.

The deicing/anti-icing operation should be performed as close in time to the takeoff procedure as possible. This generally means that the location chosen on an airport for deicing should be as near to the end of the operational runway as is possible.

De/anti-icing near the beginning of departure runways reduces the interval between the anti-icing processes and take off. It is this interval that determines whether takeoff can be achieved prior to fluid failure. Once the fluid has failed, the aircraft must be de/anti-iced again. Under no circumstances shall a second application of anti-icing fluid be applied over a contaminated anti-icing fluid layer.

Research has indicated that if the fluid is not applied correctly, the HOT Guideline values are not achievable.

NOTE: Types II, III & IV fluids, in particular, must be applied using specialized equipment. If these fluids are not applied in the correct manner and with the correct equipment, as recommended by the fluid manufacturer, they will NOT function as designed and will therefore NOT provide the expected protection as indicated in the HOT tables.

Preliminary information on Type III fluids, suggests that the use of older Type I application equipment with Type III fluids could present a problem. There is a concern that the older Type I equipment may overheat the Type III fluid and adversely affect its long-term stability and HOT performance. The fluid manufacturer must be contacted for specific application recommendations pertinent to Type III fluids.

10.4 Procedure Selection

Guidelines for appropriate application of de/anti-icing fluids are provided in the Transport Canada HOT Guidelines, which includes separate tables for the application of Type I fluid, Type II, III and IV Fluid. These tables are updated annually as required.

NOTE: Fluid application tables published by other entities may not provide equivalent information to those published by Transport Canada. Therefore, the Transport Canada holdover / allowance times are not applicable unless the guidance in the Transport Canada fluid application tables is used.

Depending on the prevalent weather conditions, available equipment, technology, fluids and the desired holdover time, a one step or a two-step de/anti-icing procedure may be appropriate. The aircraft must be treated symmetrically for aerodynamic reasons, as recommended in SAE AS6285.

Individual aircraft manufacturers provide guidance on specific anti-icing or deicing procedures for their particular aircraft models. An operator must obtain and follow the aircraft manufacturers' guidance.

It is also necessary for the operator to understand aircraft deicing and anti-icing standard practices, such as those published in SAE AS6285. The Regulations, Standards and Guidance published by Transport Canada must also be followed.

The effectiveness of anti-icing fluid in protecting the aircraft's critical surfaces from the adherence of frozen contaminants is dependent upon the correct execution of the deicing process. The proper procedures and equipment must be employed to ensure that when both deicing and anti-icing have been accomplished the aircraft is safe for takeoff. This assurance requires that a thoroughly qualified and trained deicing crew accomplish the tasks.

The temperature of cold soaked wings can be considerably below the ambient temperature; therefore frost can build up in localized areas. When active frost is anticipated, the holdover times will be shortened when the wings are cold soaked, particularly when using Type I fluids. Consider applying SAE Type II or IV fluid to the surfaces as these will provide greater holdover times than Type I, along with better safety margins to prevent frost accumulation. Both wings should receive a symmetrical treatment for aerodynamic reasons.

NOTE: The following guidance is general in nature and is not intended to be fluid manufacturer specific.

10.4.1 One-Step Deicing/Anti-icing

Generally, in Canada the use of a one step process suggests that there isn't any active precipitation occurring at the time of deicing. However, in Europe the one step method is used with Type II & Type IV anti-icing fluids in a diluted and heated state, and applied with a specialized nozzle. Also, in Canada's Northern communities, given the extremely low temperatures, the only fluid option has been the Type I fluids, and a one-step procedure is sometimes used despite the associated short holdover times.

The thickened fluids, Types II, III & IV, should not be used unheated on an aircraft contaminated with any snow, ice or frost. The aircraft surfaces must first be cleaned before application of an unheated fluid.

10.4.2 Two Step Deicing/Anti-icing

Two step deicing/anti-icing is generally used when the aircraft is contaminated and when precipitation is active.

If a two-step procedure is used, the first step is typically performed using a deicing fluid; however, alternate deicing technology or mechanical methods may be used depending on the circumstances. The selection of fluid type and concentration depends on the ambient temperature, the weather conditions and the desired holdover time. When performing a two-step process, the freezing point of a fluid used for the first step must not be above the ambient temperature. The freezing point of an SAE Type I fluid used for a one-step process, or as the second step of a two-step operation, must be at least 10°C below the ambient temperature. The second step is to be performed before the first step freezes, typically within 3 minutes. This time may be higher than 3 minutes in some conditions, but potentially lower in heavy precipitation, colder temperatures, or for critical surfaces constructed of composite materials. If necessary, the second step shall be applied area by area. When deicing fluid is used in step 1, the application of the second step fluid will flush away the first step fluid and leave a film of anti-icing fluid, which is designed to be of adequate thickness. If freezing of the deicing fluid has occurred, step 1 must be repeated. Refer to the SAE AS6285 document for additional details.

SAE Type I fluids have limited effectiveness as an anti-icing fluid due to their short holdover time. SAE Type II, III, or IV fluids used as deicing/anti-icing agents may have a temperature application limit of -25°C. The application limit may be lower provided a 7°C buffer between the freezing point and the ambient temperature is maintained and the fluid has been demonstrated to be aerodynamically acceptable at this ambient temperature.

a) First Step

Apply heated ADF until all of the frozen contaminants have been removed from the aircraft's critical surfaces. The ADF is typically heated so that it will arrive at the application nozzle at around 60-82°C (140-180°F).

No frozen contaminants shall remain after application of an ADF, including under the fluid.

Aircraft surfaces shall be treated symmetrically for aerodynamic reasons.

b) Second Step

Apply the AAF to aircraft surfaces before any freezing of the ADF occurs. Typically, the application of AAF should occur within 3 minutes of deicing with a heated ADF.

Aircraft surfaces shall be treated symmetrically for aerodynamic reasons.

See the applications section for further considerations in the application of the fluids.

10.5 No Spray Zones

Operators need to clearly understand where they can or cannot directly spray ADF/AAF.

Examples of no spray zones include, but are not limited to:

a) Engine inlets and openings

- b) APU inlets
- c) Engine exhaust openings
- d) Aircraft brakes
- e) Flight deck windows
- f) Cabin windows
- g) Passenger door handles
- h) Static ports
- i) Pitot heads
- j) Air data sensors
- k) Avionics vents; and
- l) Aircraft manufacturer specified “no spray” areas

Consideration must also be given to factors which continuously vary with time including the number and types of vehicles in use, a one step or a two-step process, local weather conditions, local operational peculiarities, and so on.

The various aircraft types that will be de/anti-iced at a station need to be identified. The operators must be very familiar with any unique deicing considerations based upon aircraft type.

10.6 Fluid Application

10.6.1 Spray Pressure

During the deicing process, it is a combination of temperature and fluid velocity that dictate the efficiency with which the frozen contaminants are dislodged from the aircraft’s surfaces. This is most effectively accomplished with a nozzle spray angle of approximately 45 degrees. Contaminants not removed from the surfaces by the initial impact of the fluid are melted off, or debonded, by virtue of the thermal energy contained in the heated deicing fluid.

Excess pressure can result in fluid velocities out of the nozzle that can cause impact damage to aircraft components. The aircraft manufacturer should be consulted to ensure that any proposed deicing procedures will not damage the aircraft and render it unsafe for flight.

When applying anti-icing (AAF) fluids to the aircraft surfaces only correct pumping equipment must be used to avoid shearing the fluid and thereby destroying the fluid’s HOT capacity. The fluid manufacturer should be contacted to determine what methods should be employed in the application of their fluids.

10.6.2 Proper Coverage

Proper fluid coverage is absolutely essential for proper fluid performance. It is imperative that the personnel applying the fluid are properly trained and that a consistent fluid application technique is utilized. Adequate fluid quantities must be expended to accomplish the de/anti-icing tasks. Proper training will help ensure that the de/anti-icing task is accomplished in a manner that utilizes the fluids

most effectively and that the aircraft is subsequently rendered safe for flight. Fluid application procedures and details on coverage can be obtained from SAE AS6285

10.6.2.1 Deicing

The deicing with fluids process is not completed until the aircraft's critical surfaces are completely free from frozen contamination. This can only be accomplished with the use of a sufficient quantity of deicing fluid to complete the task.

For the purpose of deicing, hot Type I fluid is generally applied directly onto the total aircraft surface to be de-iced. If applied only to the front part of the wing, allowing it to flow back to the aft part, the fluid will cool down significantly as it moves on the surface of the wing making it less effective, or even ineffective in melting frozen contamination on the aft part of the wing.

It is considered imperative that the leading edges of the wings and control surfaces be thoroughly cleaned of any contaminant. No frozen precipitation or contamination can be allowed to remain underneath the deicing fluid. Hot Type I fluid must be applied in sufficient quantity that the remaining fluid on the surfaces to be protected has a freezing point at least 10°C below Outside Air Temperature (OAT). As the fluid is applied, it is being diluted by the melted ice, snow or whatever frozen accumulation it is removing. Its freezing point is thus increased.

Sufficient ADF must be applied to make sure that fluid diluted by melted slush, snow or ice is flushed away. This is best accomplished by applying the fluid from the high point on the wing to the low point on the wing. Typically, from wing tip to wing root.

10.6.2.2 Anti-icing

The anti-icing process is not properly accomplished if an insufficient amount fluid has been used and which results in incomplete or inadequate coverage of the surfaces to be treated.

For the second step of a two-step procedure, a sufficient amount of aircraft anti-icing fluid must be applied that can completely cover the surfaces and form an adequate coating. The HOT table values are based upon the application of sufficient fluid. Insufficient coverage results in a thin layer and reduced protection of uncertain duration.

The application process should be continuous and as short as possible. Anti-icing should be carried out as near to the departure time as possible in order to utilize available holdover time. While thickness will vary in time over the profile of the wing surface, the anti-icing fluid should be distributed uniformly. In order to control the uniformity, all horizontal aircraft surfaces should be visually checked during application of the fluid. As a rule of thumb, a sufficient amount of fluid has been applied when it can be visually confirmed that the fluid is just beginning to run off the leading and trailing edges of the surfaces.

For a typical, Type IV fluid, between 1 mm and 3 mm thickness layer is required. It takes 2 litres of fluid to cover 1 square metre to a depth of 2 mm. Since application is never perfect, it will take more than

2 litres/square metres to achieve this 2 mm fluid thickness (In non-metric units, it will take at least 2 U.S. gallon/ 40 sq. ft. to achieve 0.08 inches). Conversion factors:

- a) 2 litres = 0.5284 U.S. gallon;
- b) 2 mm = about 0.08 inch
- c) 1 square metre = 10.76 square feet

NOTE: For more detailed information on specific fluids, contact the de/anti-icing fluid manufacturer.

10.6.2.3 Heat loss

The heated ADF should be dispensed as close to the surface to be deiced as possible, however a solid flow of fluid should not be pointed directly at the surface. The fluid should be applied at a low angle to avoid damage to the aircraft surfaces. Application of heated fluid from a distance results in the significant cooling of the fluid to the aircraft surfaces, which will reduce the fluid's ability to remove frozen contaminants. The thermal energy contained in heated ADF fluids has been shown to be a principle factor in the efficient removal of frozen contaminants from the aircraft's surfaces. Therefore, within limits, the hotter the fluid is when it reaches the aircraft's surfaces, the more effective it will be in removing the contaminants. The deicing operator training program will need to emphasize correct techniques to get the best performance from the fluid in use.

10.6.2.4 Areas to be covered

The application strategy should adopt standard techniques while considering unique procedures necessary for specific aircraft design differences. Where possible, mechanical removal of snow, ice or slush accumulations should be considered as well as the proper execution of such procedures.

All windows and doors of the aircraft must be closed during spraying. The engine may be shut down or idling and air-conditioning and/or APU air must be off, unless otherwise recommended by the airframe and engine manufacturer.

A spray to provide an even and uniformly distributed film should be used in a continuous process of application.

The surfaces to be treated are typically:

- a) Wing leading and trailing edges
- b) Wing and controls upper surfaces
- c) Horizontal stabilizer and elevator upper surfaces
- d) Vertical stabilizer and rudder
- e) Fuselage upper surfaces on aircraft. Follow the aircraft manufacturers' recommendations with respect to de/anti-icing the fuselage of aircraft with rear mounted engines.

Care must be taken to ensure that ice, snow and slush has not accumulated or has not been overlooked in critical places such as the flight control hinge areas, APU inlet or between stationary and moveable surfaces. The front and rear sides of fan blades must be checked prior to start-up when engines are not

running. Clear ice can form below a layer of snow or slush and can be hard to detect therefore the surface of the aircraft must be carefully examined after deicing.

In general, de/anti-icing must be done in a leading edge to trailing edge direction. Failure to follow this methodology may result in contamination being forced into the wing or stabilizer openings where it could re-freeze and jam control systems and result in an unsafe condition.

NOTE: T-tail aircraft have the potential to tip due to the imbalance caused when the wings are clean and the tail surfaces have heavy accumulation. The tail should be de-iced first when heavy contamination is present.

10.6.3 Excessive application

Excess application can become a safety problem. The tarmac surfaces become slippery because of the fluid and the cleanup process become onerous and expensive. Any accumulation of fluid on the ground must be cleaned up and disposed of in a safe and environmentally friendly manner.

Training of deicing crews will help minimize waste and deicing costs.

10.7 Fluid Dry Out

There have been reported incidents of restricted movement of flight control surfaces, while in flight, which has been attributed to fluid dry out. Further, testing has shown that diluted Type II and IV fluids can produce more of a gel residue than neat (undiluted) fluids.

Dry out may occur with repeated use of Type II, III and IV fluids without prior application of hot water or without a heated Type I fluid mixture. The result can be that fluid will collect in aerodynamically quiet areas or crevices. The fluids do not flow out of these areas during normal take off conditions. These residues have been known to re-hydrate and expand under certain atmospheric conditions, such as during high humidity or rain. Subsequent to re-hydration the residues may freeze, typically during flight at higher altitudes. The re-hydrated fluid gels have been found in and around gaps between stabilizers, elevators, tabs, and hinge areas. The problem can be exacerbated for aircraft without powered controls. Pilots have reported that they have had to reduce their altitude until the frozen residue melted, which restored full flight control movement.

It is suggested that regular spraying of aircraft with a hot Type I fluid/water mixture may alleviate the occurrence of fluid dry out. Such routine procedures may result in the requirement for more frequent lubrication of components. If the high-pressure washing does not clear the gel, it may be necessary to implement maintenance procedures to address the issue. An increased frequency of inspection is recommended, to help avoid difficulties in flight due to a fluid dry out condition. Special attention should be paid to inspection of such areas as:

- a) spaces in the area of flight controls
- b) between the horizontal stabilizer and the elevator
- c) spaces between the flaps and the wing, including any associated drain holes in these areas

- d) other such areas where fluid may collect

It is recommended that anyone intending to use thickened fluids contact the fluid manufacturer for further information on fluid dry out and establish a program to monitor for such occurrences.

10.8 Deicing and Anti-icing Fluid Compatibility

Research has indicated that the effectiveness of an AAF can be seriously diminished if proper procedures are not followed when applying it over a Type I fluid. Therefore, a sufficient quantity of AAF should be applied to ensure complete displacement of any remaining Type I fluid from the aircraft surfaces.

Operators should ensure that the ADF and AAF being used on their aircraft are compatible. This can be accomplished by contacting the respective fluid manufacturer.

10.8.1 Non-Glycol Deicing Fluids Containing Alkali Organic Salts

There has been evidence that some non-glycol-based Type I fluids may pose a significant safety hazard when given their impact on anti-icing fluid. Specifically, Type I fluids containing alkali organic salts (AOS) have been shown to significantly degrade thickening agents contained in anti-icing fluids potentially resulting in a reduction of the fluid's viscosity and holdover time. It is preferable that operators avoid the use of any de-icing fluid containing AOS. In operational situations where this may not be possible, special attention should be given to ensure that a sufficient amount of anti-icing fluid has been applied to ensure complete removal of this deicing fluid so that the anti-icing fluid will have the appropriate holdover time.

10.8.2 De/Anti-icing Fluid Compatibility with Runway Deicer

Past research has showed that when thickened aircraft anti-icing fluid came in contact with minimal amounts of runway deicing fluids (formate or acetate based), the anti-icing protection provided by the aircraft AAF can be diminished as a result of the dissociation of the thickening agents in this fluid and can holdover times.

This can occur when fluids from the runway are splashed onto the wing by the nose gear wheels or from the use of engine thrust reversers at landing prior to when the aircraft is anti-iced using a one-step process as protection for the next flight. Additional tests also showed that when using a two-step de/anti-icing process, the application of the first step cleans off the contamination from the runway deicing fluid so that the anti-icing protection provided with the second step is not affected by the runway deicing fluids. It is therefore recommended that de/anti-icing applications be performed using a two-step process.

10.9 Blending Type I Fluids

For economic and environmental reasons Fluid Blending has become a viable option at some Canadian airports. ADF concentrate can be blended dependent upon the outside air temperature and the type of deicing process that will be accomplished (i.e., one step or two step process).

Irrespective of the glycol/water mixture ratio, all Type I fluids will be referred to as “Type I” fluids, provided that the fluid freezing point exceeds the required Lowest Operational Use Temperature (LOUT) value.

Type I fluid may be diluted and used to deice aircraft in accordance with the fluid concentration and temperature charts provided by the fluid manufacturer.

10.10 Using Type IV Fluid to Prevent Frost Formation Overnight

There are occasions when operators apply Type IV fluid to the critical surfaces of an aircraft in the evening prior to the period of the day when frost will start to form. The holdover time for Type IV fluid during active frost conditions is longer than other precipitation conditions. A determination on what subsequent de/anti-icing operations are required will depend on: the type of precipitation experienced by the aircraft, whether the HOT has expired, and the results of an inspection to confirm that the integrity of the fluid has been maintained and that contamination is not adhering to the critical surfaces.

NOTE: Dehydration of the fluid can negatively impact the fluid performance.

Should precipitation start at any point during overnight treatment of AAF, there will be a requirement to completely deice and then anti-ice the aircraft to re-establish a valid HOT.

The operator should always contact the fluid manufacturer for guidance on the use of their fluid.

NOTE: The operator shall inspect the critical surfaces to ensure that the fluid integrity has been maintained (e.g.: fluid has not gelled). Check with the fluid manufacturer to determine what procedure to follow if a gel has formed.

10.11 Applying Type IV Fluid in a Hangar

There are operational conditions when operators may choose to anti-ice their aircraft while the aircraft is in a heated hangar. This is one way to reduce the consumption of deicing fluid and to minimize the environmental impact of deicing.

The period of time after fluid application and the air temperature in the hangar both have an effect on the ability of the fluid to protect the aircraft when it is pulled out of the hangar and into freezing/frozen precipitation. The holdover time of a fluid is based largely on the fluid’s thickness on the surface which is very temperature dependant. Unless otherwise approved in an operator’s program, the holdover time clock must be started at the time of the first application of anti-icing fluid onto a clean wing. It may not be started when the aircraft is first exposed to freezing/frozen precipitation.

10.11.1 Applying Anti-Icing Fluid in a Hangar – T-tail Aircraft

When anti-icing T-tail aircraft in a hangar, care must be taken to ensure that the horizontal stabilizer/elevator of the aircraft is not in close proximity to the ceiling heating system. Excessive heating

of these critical surfaces during and after anti-icing can reduce applied anti-icing fluid thickness below what is required to achieve the holdover time.

If it is impossible to position the aircraft in such a way that the tail section is not below a heating element, consider disabling the heating element before, during and after anti-icing. Alternately, consider opening the hangar doors to cool all surfaces if this can be done without exposing the aircraft to additional contamination.

10.12 Manual Methods

Reducing the amount of deicing fluid used can have a positive impact on both the cost and the environmental. Manual methods of snow removal should be used whenever possible, as long as safety is not compromised. There are a wide variety of devices available to assist in the removal of frozen contaminants from aircraft. Factors such as temperature, amount of contamination, wind conditions, and contaminant location must be taken into account when choosing the method.

Under extremely low temperatures, the use of glycol-based fluids is limited (refer to the fluid manufacturers' specifications for details). In these circumstances, manual methods may be the only option.

Some of the more common devices are:

- a) Brooms
- b) Brushes
- c) Ropes
- d) Scrapers
- e) Mops

NOTE: Extreme care must be taken anytime manual methods are used to protect the highly sensitive and often fragile sensors and navigation antennas. Also very vulnerable to damage are: pitot tubes, static ports, angle of attack sensors, and vortex generators. When sweeping or "pulling" contamination off an aircraft, care must be taken to use motions which pull contamination away from any openings, in order to avoid forcing the contamination into any openings on the wings or stabilizers.

10.12.1 Brooms

The most commonly used and most readily available manual tool is the broom. Although a common household broom could be used, a larger, sturdier commercial variety is usually chosen. Care must be taken to ensure the bristles are sturdy enough to be effective, yet not so stiff as to do damage to the skin of the aircraft. The broom that is to be used to sweep the snow should not be used to break the ice or to sweep floors and other surfaces.

Brooms are very useful in cleaning windows and other sensitive areas (e.g.: a radome) where the application of hot liquid is best avoided or prohibited.

Extra attention should be paid to safety, especially when combined with the tendency to stretch the reach with a broom. If a ladder or other such device is used, personnel must be certain that it is safe to use. Slippery surfaces can make climbing dangerous.

Personnel have attempted to sweep snow from wing and tail surfaces while standing on these surfaces. This is an extremely unsafe practice with a very high risk of a slip and fall accident. As well, many surfaces are not stressed to support the weight of a person.

A tactile inspection must be performed after using a broom to remove contamination from aircraft surfaces to ensure it is clean and safe for flight.

The following points should be considered when using a broom to clean frozen contaminants from the critical surfaces of an aircraft:

- a) Ensure the flight crew and/or maintenance personnel conducting aircraft checks are aware that contamination removal is being conducted and advise them when the removal procedures are complete;
- b) Ensure that control surfaces are in the "neutral" position (all leading edge devices, flaps and spoilers are retracted, unless they are deployed for an operational reason);
- c) Ensure the horizontal stabilizer is in the full nose down position;
- d) For safety reasons, sweep from the bucket of a deicing vehicle or use the wing inspection ladder;
- e) Sweep from leading edge of the wing to the trailing edge. Generally try not to push contamination from the trailing edge towards the leading edge, otherwise this may push frozen contamination into cracks and crevasses and cause flight control difficulties later;
- f) Generally, sweep contamination from wing tip to wing root;
- g) Sweep contamination away from flight controls, hinges points and bay areas; and
- h) If all of the contamination cannot be removed when working from the leading edge, because the broom is not long enough, then remove the remaining contamination by dragging it off the trailing edge. Ensure that the handle of the broom does not come in contact with the wing flap or any other surface of the wing because damage may result.

10.12.2 Ropes

Ropes have also been used effectively to "pull" heavy snow off a wing. Care must be taken when the rope is getting close to the actual skin of the aircraft. Ropes are much less effective on light "fluffy" snow. The ropes are typically used in a seesaw motion between two persons, with the rope touching the aircraft's surface.

Rope can be used in an effort to remove accumulations of frost, typically from high wing and tail surfaces. Care must be taken to avoid damage to the finish of the paint or to the deicing boot.

A thorough inspection must be accomplished to ensure that the critical surfaces are clean for takeoff. It may be necessary to follow up with another method to get the critical surfaces completely clean.

10.12.3 Scrapers

The most common type of scraper used is the commercial variety used to remove accumulation from building roofs. Because the handles of this type of scraper will often make contact with the wing, care must be taken to protect the wing. This can be accomplished by covering the handle with a foam wrap. Normally best with wet heavy snow, the scraper should be used in a pulling motion from Leading Edge to Trailing edge (i.e.: lay the scraper high on the aircraft surface and pull toward you).

Also available commercially, and of similar benefit to the scraper, is the squeegee. Squeegees are generally available in a variety of sizes and have foam or a similarly soft material on one side and a rubber blade on the other side.

10.12.4 Polishing frost

Polishing frost is not considered an acceptable method of preparing an aircraft for flight. This method would leave frost contamination on the critical surfaces prior to take off, which would not comply with CAR 602.11 and GOFRS 622.11, and would not satisfy the “clean wing concept”.

10.12.5 Portable Forced Air Heaters

Heat from a portable forced air heater can effectively remove frost and ice from critical surfaces. These heaters are commonly found in remote and Northern Canadian locations and are normally used to heat aircraft interiors and to pre-heat aircraft engines.

The operator directs the airflow from a flexible duct onto the contaminated surface and the combined effect of the heated air and low velocity airflow melts and evaporates contaminants.

Special precautions may be required when using this method because the water resulting from melting the frozen contaminants may flow into flight control or other sensitive spaces and later re-freeze. The consequences may be that the controls won't function properly.

This technique has the effect of briefly warming the wing surface and can cause snow or other contaminants to stick to the surface when precipitation is present. The operator must keep moving the duct to avoid overheating any spot as these heaters generate enough heat to cause damage to de-ice boots and other equipment if directed at a single spot for too long.

10.13 Technology Options

10.13.1 Alternate Technologies

The cost and potential environmental impact of deicing with conventional fluids, has driven the demand for the development of alternate deicing technologies. When considering the benefits of these technologies, it is important to understand that while the methodology may differ from that used with conventional fluids, the basic principles of de/anti-icing still apply. Some of the alternate technologies, available at the time of publication, are described in this section.

10.13.2 Infrared Heat Systems

Transport Canada approval for operational use of these systems at airports and on commercial aeroplanes had not been undertaken at the time of publication.

10.13.3 Hot Water

Hot water may be used to remove large amounts of contamination (such as ice) from an aircraft, provided that the OAT is 0°C and above as per the application procedures for SAE Type I, II, III and IV fluids described in the Transport Canada HOT Guidelines document.

10.13.3.1 Procedures

Deicing with hot water requires many safety precautions and separate equipment. The following is guidance for deicing using hot water:

- a) Ensure personnel are trained in procedures for hot water deicing;
- b) Ensure that an appropriate and serviceable deicing vehicle is on site;
- c) Ensure that the truck tanks are identified by placarding each tank; e.g., water/100% glycol;
- d) Prior to using a vehicle for a deicing operation, verify the contents of each tank and perform a refractometer test on the contents;
- e) Ensure that the water temperature is between 140-180°F (60-82°C);
- f) Ensure that the ambient temperatures are reviewed hourly and compared to the permitted temperature ranges for water usage; and
- g) Immediately over-spray all surfaces sprayed with water using heated Type I fluid. Type IV should NOT be applied after applying hot water unless an application of heated Type I is applied first.

10.13.4 Forced Air Systems

10.13.4.1 Introduction

The use of forced air to remove contaminants, particularly snow, is a maturing technology. The concerns regarding the effect of large quantities of deicing fluid on the environment, in particular, has resulted in renewed forced air research efforts in recent years.

The results of the research are promising but as with any technology, there are compromises to be made when using forced air systems. Nonetheless, ongoing research is revealing that there is significant potential for forced air systems both in terms of economic savings and environmental relief.

A subsequent inspection of the critical surfaces will be required after the use of forced air.

The use of forced air is subject to approval from the aircraft manufacturer.

10.13.4.2 General guidance on the use of forced air

The use of forced air to remove contamination from aircraft surfaces may save time and money. Forced air can be used as a one-step or a two-step process.

If using as a one-step procedure to remove contamination, the operator shall verify by a tactile inspection that the surface is clean and clear of contamination. If forced air has not removed all the contamination from the surfaces or you are not sure all contamination is removed, then an application of heated Type I is required.

Below are some suggested procedures when using forced air to remove contamination:

- a) Ensure that the flight crew and/or maintenance personnel conducting aircraft checks are aware that contamination removal is being conducted and when the removal procedures are complete
- b) Ensure that ground-handling staff is not loading/unloading baggage when forced air is being used
- c) Ensure that all cabin doors and cockpit windows are closed
- d) Ensure that the forced air is approximately the same temperature as the OAT. If air is hotter than OAT, this may melt the contamination causing it to re-freeze on the aircraft surface
- e) Always check with the aircraft manufacturer prior to using forced air on structures made of honeycomb
- f) Blow contamination from leading edge to trailing edge of the wings and stabilizers. Generally, don't use forced air to blow contamination from trailing edge to leading edge because this could force contaminants into the balance bays and into other cavities
- g) Avoid using the forced air near windscreen wipers, because damage may result
- h) Avoid using the forced air in areas that are made of rubber, plastic or other soft material, as damage may result
- i) The tip of the forced air nozzle should be no closer than three feet from the contaminated surface

10.13.4.3 Forced Air Modes

- a) Forced air alone

The use of forced air alone to remove contaminants is reasonably efficient when used to remove loose snow, but requires more diligence when used to remove adhering contaminants.

The effectiveness of forced air, at removing contaminants from the critical surfaces, depends upon a number of factors including: air stream velocity, air stream temperature, operator training and experience, outside air temperature, weather conditions and others.

b) Forced air augmented with Type I fluid

Heated Type I fluid is injected into the high speed air stream.

One advantage of this deicing method compared to the air alone system is that heated Type I fluid carries more thermal energy than just air alone. Heat is the principal mechanism for removing adhering contaminants from an aircraft's critical surfaces; hence the ability to remove contaminants is enhanced with this method.

c) Forced air with Type II and/or Type IV fluids injected in the air stream, or applied over the air stream

The combination of anti-icing fluid and high speed forced air introduces some new concerns as well as some benefits.

The anti-icing fluids must be handled correctly in order to retain their viscosity characteristics. One of the effects of injecting Type II & IV fluids into a high speed air stream is that of shear. If these fluids are sheared significantly they lose some of their viscosity.

The significance of this shear concern is that if the fluids are sheared excessively, the HOT values will not be valid for the fluid.

Excessive foaming is also a significant issue.

It is anticipated that the concern about loss of viscosity will be addressed as forced air system design and operation are advanced.

10.13.4.4 Safety Issues

The high speed airflow present in forced air systems can cause serious injury. Proper training and the use of protective equipment are required.

The noise level of forced air systems is typically very high. Hearing protection is a necessity when operating or working near these systems.

The high velocity air stream removes frozen contaminants from the aircraft and propels them at high speed. Personnel near a deicing operation, which is using a forced air system must be alerted to the fact that high speed debris is present.

Aircraft may be damaged by frozen projectiles. Care must be taken to direct the ice away from the aircraft surfaces, which may be struck with considerable force. Aft mounted engines are particularly vulnerable to ice FOD from this process. Aft mounted engines should always be shut down when deicing with force air.

10.13.4.5 Evaluation for operational use

Transport Canada has not evaluated a forced air system for operational use, at the time of publication of this document.

Transport Canada, Commercial Flight Standards (AARTF), should be contacted to discuss any proposal to use these systems during Commercial aircraft ground icing operations.

10.13.5 Ground Ice Detection Systems (GIDS)

The development of ground ice detection sensors has been stimulated by the difficulty in determining whether an aircraft is free of frozen contaminants prior to takeoff. Humans have a limited ability to accurately evaluate the condition of an aircraft's critical surface during ground icing operations. Impediments to ensuring the aircraft is free of frozen contaminants include poor lighting conditions, visibility restrictions due to blowing snow, and the difficulty in determining whether clear ice is present.

For the purposes of this document, these sensors are referred to as Remote on Ground Ice Detection Systems (ROGIDS). A Minimum Operational Performance Specification (MOPS) for these systems is identified in the SAE document AS5681.

Operators or service providers seeking authorization to incorporate ROGIDS into their operations should consult Transport Canada Advisory Circular AC 602-001, "Operational Use of Remote on Ground Ice Detection Systems (ROGIDS) for Post De-icing Applications". This document is available at the following website: <https://tc.canada.ca/en/aviation/reference-centre/advisory-circulars/advisory-circular-ac-no-602-001>.

10.13.6 Engines Running Deicing

Deicing crews must receive specific training to support "engines on" operations. Training subjects should include, but are not limited to:

- a) The potential effects of jet blast;
- b) Safety zones around running engines;
- c) Fluid application techniques – differences may exist;
- d) Effective positioning of deicing vehicles (including specific vehicle travel patterns);
- e) Do not spray fluids into aircraft engines, and why;
- f) Considerations for wing mounted engines vs. rear mounted or tail mounted engines;
- g) Engine inlet inspections; and
- h) Pilot communication requirements.

CHAPTER 11 Holdover Time Guidelines and Associated Procedures

11.1 Holdover Time (HOT)

11.1.1 Holdover Time Guidelines – General

Holdover Time tables are referred to as Holdover Time Guidelines because this term more appropriately represents their function in providing guidance to flight crew and the need for the flight crew to use judgment in their interpretation.

Holdover time guidelines provide an estimate of the length of time anti-icing fluids will be effective. Because holdover time is influenced by a number of factors, established times may be adjusted by the PIC according to the weather or other conditions. Operator manuals must describe the procedures to be followed for using holdover time guidelines. When the guidelines are used as decision-making criteria, the procedures to be followed by the PIC for varying the established values must also be specified.

The estimated time is expressed as a range in the Guidelines and is based upon the type and concentration of the specific fluid, the outside air temperature, and the kind and intensity of precipitation involved. Individual holdover timetable cell values are capped at 2 hours for all precipitation conditions except freezing fog, freezing mist or ice crystals which are capped at 4 hours.

The HOT guidelines are applicable to an aircraft experiencing ground icing conditions and do not apply once the aircraft is airborne.

The time that the fluid remains effective is the time from first application of anti-icing fluid on a clean wing until such time as ice crystals form or remain in the fluid creating a surface roughness. Holdover time cannot be precisely determined because it depends on many variables. Some of the variables include: prevailing precipitation type, intensity, temperature, wind and the humidity. The aircraft type and its configuration, effectiveness of the treatment on surfaces, taxiing direction relative to the wind and jet blast from other aircraft are equally important. The effects of these variables need to be taken into account by the PIC when establishing the HOT value. There is no simple solution to this complex issue.

The Federal Aviation Administration (FAA) and Transport Canada (TC) jointly publish the Holdover Time Guidelines and support the testing of anti-icing fluids, on a cost recovery basis, and, with the assistance of the members of the SAE Holdover Time Subcommittee, evaluate the test results and publish the recommended HOT guidelines for the manufacturer specific fluids. The generic tables for Type II and IV fluids are based on these manufacturers' tables and are also published by Transport Canada and the FAA. This procedure will continue with both the FAA and Transport Canada publishing the HOT Guidelines.

The values in the Type II generic holdover time guidelines are the shortest (worst case) holdover times of all Type II fluids. Similarly, the values in the Type IV generic holdover time guidelines are the shortest (worst case) holdover times of all Type IV fluids included in the Transport Canada list of fluids. These values are specific to precipitation condition, temperature range, fluid concentration, and precipitation rate. An analysis of all available Type II and Type IV fluids is done annually to determine these values. The generic holdover times can be used if the fluid and dilution being used is listed in the tables “Type II or Type IV fluids tested for Anti-Icing Performance and Aerodynamic Acceptance”. Any restrictions on the use of the fluid and its dilutions must be identified and applied.

NOTE: The lowest on-wing viscosity (LOWV) of the fluid being used must always be respected, even when the generic Type II or Type IV holdover times are used.

11.1.2 Current HOT Guidelines

The current HOT Guidelines can be found at the following website:

<https://tc.canada.ca/en/aviation/general-operating-flight-rules/holdover-time-hot-guidelines-icing-anti-icing-aircraft> .

The following information can be found at the above website:

- a) Active Frost HOT Guidelines;
- b) Type I Fluid Generic HOT Guidelines;
- c) Type II Fluid HOT Guidelines;
- d) Type III Fluid HOT Guidelines;
- e) Type IV Fluid HOT Guidelines;
- f) Mixed Snow and Freezing Fog HOT Guidelines;
- g) Ice Pellet and Small Hail Allowance Times;
- h) Snowfall Intensities as a Function of Prevailing Visibility;
- i) List of Fluids Tested for Anti-Icing Performance and Aerodynamic Acceptance; and
- j) De/Anti-Icing Fluid Application Procedures.

11.1.3 Use of Holdover Time as a Decision Making Criterion

The GOFRS 622.11 states in part: “When holdover timetables are used as decision-making criteria, only high confidence level times shall be used and the procedures to be followed after holdover time has expired must be clearly documented”.

11.1.4 Establishing the HOT range

Establishing the appropriate HOT time range will require the acquisition of at least the following information:

- a) Choose the precipitation type
- b) Determine the precipitation intensity
- c) Note the fluid in use, including

- i. Fluid Type; and
 - ii. Fluid manufacturer.
- d) The fluid dilution must be determined;
 - e) OAT must be noted; and
 - f) Flap and slat configuration.

Using this information, enter the appropriate HOT guideline and identify the HOT cell containing the range of times available.

11.1.4.1 Estimating the precipitation rate

- a) Snowfall rate

The METAR/SPECI reported snowfall intensity is based only on observed visibility in accordance with the Environment and Climate Change Canada *Manual of Surface Weather Observations* (MANOBS). Scientific research has demonstrated that the use of observed visibility in snow as the sole criteria in the MANOBS, for establishing snow intensity is not accurate enough for use with the holdover time guidelines. The evidence indicates that a visibility and temperature pair needs to be used for establishing the more accurate snowfall intensity required for use with the holdover time guidelines.

The highest snowfall intensities occur near 0°C. It has also been determined that during night time snowfall conditions, for the same snowfall intensity, visibility is about twice as good as it is during the day (i.e. one can see further at night than during the day for the same snowfall intensity). This factor must be considered in estimating the snowfall intensity.

The relationship between visibility and snowfall intensity was analyzed and is documented in TP 14151E. The relevant information from TP 14151E is contained in the Transport Canada “Snowfall Intensities as a Function of Prevailing Visibility” Table contained in the holdover time guidelines.

The METAR/SPECI reported visibility or flight crew observed visibility will be used with the “Snowfall Intensities as a Function of Prevailing Visibility” Table to establish snowfall intensity for Type I, II, III and IV holdover time guidelines, during snow, snow grain, or snow pellet precipitation conditions.

The “Snowfall Intensities as a Function of Prevailing Visibility” Table, should also be used when snow, snow grains or snow pellets, or the following conditions are occurring:

- Snow mixed with ice crystals
- Snow mixed with freezing fog
- Snow accompanied by blowing or drifting snow in the METAR/SPECI.

Examples:

CYUY 161300Z 26005KT 3/4SM -SN OVC015 M01/M05 A2964

In the above METAR the snowfall intensity is reported as light. However, based upon the Transport Canada “Snowfall Intensities as a Function of Prevailing Visibility” Table, with a visibility of 3/4 statute mile, during the day and a temperature of -1°C, the snowfall intensity is classified as moderate. The snowfall intensity of moderate – not the METAR reported intensity of light – will be used to determine which HOT Guideline value is appropriate for the fluid in use.

CYVO 160200Z 15011G17KT 1SM -SN DRSN OVC009 M06/M08 A2948

In the above METAR the snowfall intensity is reported as light. However, based upon the Transport Canada “Snowfall Intensities as a Function of Prevailing Visibility” Table, with a visibility of 1 statute mile, at night and a temperature of -6°C, the snowfall intensity is classified as moderate. The snowfall intensity of moderate – not the METAR reported intensity of light – will be used to determine which HOT Guideline value is appropriate for the fluid in use.

Rarely, there may be circumstances where the METAR/SPECI reported visibility or flight crew observed visibility is substantially reduced due to obscuration conditions such as fog, mist above 0°C, dust, haze, or smoke. These obscuration conditions contribute very little to the overall catch rate at the wing surface and using the “Snowfall Intensities as a Function of Prevailing Visibility” Table, would likely overestimate the snow fall intensity.

Under these conditions and with a careful assessment by the flight crew to ensure that the obscuration conditions are not concealing significant snowfall intensities, the METAR/SPECI reported snowfall intensity can be used. However, use of the snowfall intensity being reported in accordance with the Environment and Climate Change Canada Manual of Surface Weather Observations (MANOBS), may underestimate the actual snowfall intensity. as it does not directly correlate to the snowfall intensities used when determining holdover times.

Example:

CYTS 231000Z 21003KT ½ SM SN FG OVC003 M01/M01 A2969

In the above METAR, the snowfall intensity is reported as moderate. Based on the Transport Canada “Snowfall Intensities as a Function of Prevailing Visibility” Table, with a visibility of ½ statute mile, at night and a temperature of -1°C, the snowfall intensity is classified as heavy. However, since fog is present as an obscuring condition, a moderate snowfall intensity (as reported in the METAR) can be used to determine which HOT Guideline value is appropriate for the fluid in use, provided the crew can ensure that the obscuration is not concealing significant snowfall intensities.

NOTE: The Transport Canada “Snowfall Intensities as a Function of Prevailing Visibility” Table can be found along with the current HOT Guidelines through the Transport Canada website: <https://tc.canada.ca/en>

Use of Runway Visual Range (RVR) with the TC Snowfall Intensities as a Function of Prevailing Visibility Table

There has been some confusion regarding the values indicated below the visibility (in parentheses) in the Snowfall Intensity Table. The values indicated in parentheses refer to the visibility in meters and not an RVR.

RVR must not be used to determine visibility for the following reasons:

1. RVR transmissometers were never intended to measure visibility with respect to snowfall intensity for use with holdover time guidelines.
2. The RVR equipment is designed to provide pilots with an expected visual range along the runway, based on an associated runway edge and centerline lighting intensity. For a given obscuration phenomenon and precipitation intensity (fog, snow, etc.) the RVR will vary based on the selected runway lighting level. Therefore multiple RVR are possible for a given condition even though the meteorological conditions remain the same.
3. Furthermore RVR's in excess of 6000 ft. are simply reported as 6000+. This level of resolution, only allows limited use of the Snowfall Intensity table (for example in darkness and at a temperature of -1°C and an RVR of 6000+, the only conclusion that can be drawn from the Snowfall Intensity table is that we are not in heavy snow, and that we could be in Moderate, Light or Very Light Snow conditions).

Varying Weather Conditions After Completion of Anti-Icing Procedure

During periods when the weather conditions are varying after completion of the anti-icing procedure, crews should reassess the previously selected holdover time. When doing so crews need to consider the following:

1. Improving weather conditions – if the snowfall intensity decreases, the original HOT should be retained
 2. Worsening weather conditions – if the snowfall intensity increases, a new lower HOT should be established and used.
- b) Precipitation rates for other than snow.

Meteorological reports of precipitation rates for the airport of operation may be the best source of information for forms of precipitation other than snow.

Meteorologists report light freezing drizzle (-ZR) for a wide range of precipitation rates. Canadian meteorologists report light freezing drizzle for precipitation rates ranging from trace to 1.2 mm/hr.

The pilot alone has no way to measure or otherwise reasonably judge what the freezing drizzle precipitation rate is other than to receive information about the measurements taken by qualified meteorological persons. This measurement report will imply a rather wide range of possible precipitation rates. The worst case rate must be assumed.

That is, the highest precipitation rate must therefore be assumed, and hence the lowest HOT value in freezing drizzle cell, for the conditions, should be chosen. Likewise for light freezing rain the meteorologist reports would imply a rather wide range of precipitation values for the condition from 1.2 to 2.5 mm/hr. Again the lowest time value in the HOT cell for the conditions, corresponding to the highest rate, should be chosen.

11.1.4.2 Determining the lowest time value for the precipitation conditions present

Once the appropriate cell within the HOT Guidelines table for the conditions, temperature and fluid in use has been established, the lowest time value, based upon the precipitation rate, needs to be established. The process for obtaining this value may best be illustrated by use of an example.

Snow Example:

Assume that the precipitation condition is moderate snow. The fluid in use is a Type IV fluid and the generic Type IV HOT table will be used. The concentration of the fluid is 100/0. The temperature range is -3°C and above. Using this information it has been determined, by locating the correct cell, that the range of HOT times for these circumstances is 0:35 – 1:10, i.e. thirty five minutes to one hour and ten minutes.

For this example, the lowest HOT time limit is 35 minutes, based upon the published HOT guidelines for 2019/2020, accessible through the Transport Canada website.

Discussion:

The time limit is 35 minutes because the times shown in the HOT guidelines cell, i.e. 0:35 – 1:10, are the range of values are moderate snow.

If the precipitation condition were light snow, then its range would be 1:10 – 2:00.

11.1.5 Elapsed time is less than the lowest time in the HOT cell

Transport Canada has previously considered that under an approved GIP, if the lowest time in a cell has NOT been exceeded for conditions covered by the Guidelines there is no requirement to inspect the aircraft's critical surfaces prior to commencing a takeoff.

This position was based on evidence gained during fluids testing. The HOT values are conservative for the lowest number in the cell, if:

- a) The conditions present are NOT in excess of those conditions represented by the table (e.g. for snow, it would be a moderate snow condition)
- b) The impact of other factors (e.g. jet blast) has been considered and deemed not to affect the HOT

If there is doubt surrounding the conditions associated with using the lowest time as a decision-making criterion, an inspection prior to takeoff would be prudent. This inspection should be conducted in accordance with the procedures described in the Operator's GIP.

11.1.6 Elapsed time within the range of HOT for the conditions

Transport Canada considers that when the time that has expired since anti-icing is within the range of time chosen by the PIC for the conditions present and covered by the Guidelines, there is a requirement to conduct an inspection prior to takeoff. This inspection will usually be conducted from within the aircraft and may be an inspection of one or more of the representative surfaces of the aircraft. The inspection must be described in the operator's GIP.

11.1.7 Holdover Time Exceeded

Section 6.3 of the GOFRS 622.11 states, in part: "When holdover time tables are used as decision making criteria, take-off after holdover times have been exceeded can occur only if a pre-take-off contamination inspection is conducted, or the aircraft is de-iced/anti-iced again".

Transport Canada's interpretation of the phrase "inspected immediately prior to take-off", in the ground icing context, is that the inspection must be conducted within five minutes prior to beginning the take-off roll, except for Type I fluids.

Fluid testing has indicated that the above procedure must not be applied to Type I fluids. Type I fluids have very short HOT performance and fluid failure occurs suddenly. Therefore, it is not considered prudent to apply this procedure to Type I fluids. The procedure must only be applied to Types II, III and IV anti-icing fluids and then only when the pertinent minimum holdover time equals or exceeds 20 minutes.

If, after conducting the contamination inspection, it is not possible to take-off within five minutes, the aircraft must return for deicing/anti-icing.

Transport Canada considers that, when the time that has expired since anti-icing is greater than the largest value in the range of time chosen for the conditions present and covered by the Guidelines, there is a requirement to conduct an inspection of the critical surfaces prior to takeoff. This inspection must be conducted from outside the aircraft. This inspection must be described in the operator's GIP.

Fluid testing experience and operational testimony indicates that the ability of the PIC or his delegate to effectively examine the critical surfaces from within the aircraft, when the HOT has expired and the fluid may have failed, to be doubtful. Further, long exposure to frozen precipitation, wind and other factors, may have resulted in fluid failure in areas NOT visible from the inside of the aircraft. This last point is crucial. This is a high risk scenario which due diligence indicates requires a very thorough action.

Once the HOT time clock has been started it must not be stopped for intermittent precipitation. Intermittent precipitation conditions, during ground icing operations, are a common occurrence at some airports. As precipitation falls on an aircraft that has been anti-iced, the fluid is being diluted. The more diluted the fluid becomes, the more readily it flows off the aircraft, and the higher the freezing point becomes. Even if the precipitation stops falling, the diluted fluid will continue to flow off the aircraft due to gravity. There is no practical way to determine how much residual anti-icing fluid is on the wing under these circumstances. HOT values under these conditions have not been assessed. Therefore, after the anti-icing HOT clock has been started, it must not be stopped. HOT credit cannot be given due to the fact that the precipitation has temporarily stopped falling.

11.1.8 Meteorological Conditions for which no HOT Guidelines exist

The HOT Guidelines do not include guidance for all precipitation conditions. Holdover time guidelines have not been assessed for the following conditions:

- a) Hail (small hail is included)
- b) Moderate and heavy freezing rain
- c) Heavy snow
- d) Any mixed icing condition that is not otherwise specified in the HOT Guidelines

Additionally, holdover time guidelines have not been assessed for ice pellets or small hail, since a formal protocol for this testing has not yet been developed and included in standard SAE testing methodologies and no visual failure criteria have yet been identified for these conditions. Instead, allowance times have been developed for operations during ice pellet conditions as a result of research carried out by Transport Canada and the FAA. As it has been determined small hail is equivalent to ice pellets, allowance times are also provided for small hail conditions.

11.1.9 Use of De/Anti-icing Fluids

The operator is ultimately responsible for ensuring that only fluids tested to SAE AMS1424 or SAE AMS1428 are applied when the HOT Guidelines will be utilized operationally.

The Transport Canada Holdover Time Guidelines that are published on an annual basis contain lists of fluids that have been tested with respect to anti-icing performance (SAE AMS1424 or SAE AMS1428) and aerodynamic acceptance (SAE AMS1424 or SAE AMS1428) only.

Additionally, the end user is cautioned to verify that the de/anti-icing fluid in question meets other technical requirement tests such as fluid stability, toxicity, materials compatibility, in addition to AMS1424 and SAE AMS1428. The fluid manufacturer should supply all samples for testing and is

responsible for obtaining independent laboratory confirmation of conformance to test requirements of AMS1424 or AMS1428. The fluid manufacturer should provide certificates of conformance upon request.

11.1.10 HOT Guidelines

Operators choosing to not use HOT Guidelines will be expected to accomplish a pre-takeoff contamination inspection, from outside the aircraft, in all cases. This inspection must be conducted from outside the aircraft.

11.1.11 Lowest Operational Use Temperature (LOUT)

See *Chapter 8* on Fluids for an explanation and an example of establishing a LOUT.

11.1.12 Type I HOT Guidelines for Aircraft with Critical Surfaces Constructed of Composite Materials

It has been shown that the holdover time performance of Type I fluids on aircraft constructed primarily with composite materials is reduced when compared to aluminum-constructed aircraft. Type I fluid holdover time evaluations were conducted and holdover times have been developed for use with aircraft critical surfaces constructed primarily with composite materials.

It is not the intent that the composite holdover times be used on aircraft where previous experience has shown the acceptable use of aluminum holdover times (unless those aircraft have predominately or entirely composite critical surfaces). If there is any doubt, consult with the aircraft manufacturer to determine whether to use aluminum or composite holdover times.

11.1.13 Longer Holdover Times for 75/25 Dilutions

For some fluids in some conditions, holdover time increases when fluid concentration is reduced. This counter-intuitive phenomenon, which occurs rarely, happens when certain quantities of water added to fluids results in an increase in fluid viscosity and an enhancement in holdover time performance (up to a certain point). Without knowing about this phenomenon, an operator may think that the data presented in the related holdover time table is in error.

11.1.14 Holdover Times for Non-Standard Dilutions of Type II, III and IV fluids

No holdover times exist when a Type II, III, or IV fluid is diluted to other than the published 100/0, 75/25 or 50/50 dilutions as it is not possible to calculate its HOT nor its LOUT without additional endurance time testing and aerodynamic acceptance testing.

11.1.15 Holdover Times vs. Allowance Times

Holdover times are developed using testing protocols described in SAE ARP5485 and ARP5945. These protocols rely predominantly on the visual inspection of test surfaces to determine fluid failure, which occurs when the fluid is no longer able to absorb actively occurring frozen or freezing precipitation (e.g.

snow, freezing drizzle). Holdover times are applicable to most forms of precipitation with the exception of ice pellets. Due to their physical characteristics, ice pellets tend to become partially embedded in fluids and can take longer to melt compared to snow or other forms of precipitation. For this reason, the visual indicators conventionally used in developing holdover times cannot be applied to ice pellets.

As a means to address ice pellet precipitation, a test protocol was developed that uses a combination of aerodynamic fluid flow off performance of ice pellet-contaminated fluids in combination with visual inspection and evaluation of a wing model test surface. Since 2005, guidance has been derived from this testing protocol and is known as “Allowance Times”. This guidance is also applicable to small hail due to inherent similarities to ice pellets.

Operationally, both holdover times and allowance times provide the times for an aircraft to safely depart following proper de/anti-icing. The main difference between the two is the applicability of the pre takeoff contamination inspection (check) to holdover times, which cannot be used with allowance times. The only scenario for which an allowance time can be extended is if the precipitation stops and does not restart while still within the allowance time and the allowable 90-minute extension time.

11.1.16 Ice Pellet and Small Hail Allowance Times Operational Guidance

- a) Tests have shown that ice pellets generally remain in the frozen state imbedded in Type III and Type IV anti-icing fluid, and are not absorbed and dissolved by the fluid in the same manner as other forms of precipitation. Using current guidelines for determining anti-icing fluid failure, the presence of a contaminant not absorbed by the fluid (remaining imbedded) would be an indication that the fluid has failed. These imbedded ice pellets are generally not readily detectable by the human eye during pre-takeoff contamination inspection procedures. Therefore, a pre-takeoff contamination inspection in ice pellet conditions is not required. Furthermore, allowance times cannot be extended by an inspection of the aircraft critical surfaces.
- b) The research data have also shown that after proper deicing and anti-icing, the accumulation of light ice pellets, moderate ice pellets, and ice pellets mixed with other forms of precipitation in Type III and Type IV fluid will not prevent the fluid from flowing off the aerodynamic surfaces during takeoff. This flow-off, due to the shearing forces, occurs with rotation speeds consistent with Type III or Type IV anti-icing fluid recommended applications, and up to the applicable allowance time listed in the allowance time tables. These allowance times are from the start of the anti-icing fluid application. In constant precipitation, the allowance time ends when the fluid’s allowance time expires. Additionally, if the ice pellet precipitation stops, and the allowance time has not been exceeded, the operator is permitted to consider the anti-icing fluid effective without any further action up to 90 minutes after the start of the application time of the anti-icing fluid. To use this guidance in the following conditions, the outside air temperature (OAT) must remain constant or increase during the 90-minute period:
 - light ice pellets mixed with freezing drizzle;

- light ice pellets mixed with freezing rain; and
- light ice pellets mixed with rain.

Examples:

1. Type IV anti-icing fluid is applied with a start of application time of 10:00, OAT is 0°C, light ice pellets fall until 10:20 and stop and do not restart. The allowance time stops at 10:50; however, provided that no precipitation restarts after the allowance time of 10:50 the aircraft may take off without any further action up to 11:30.
 2. Type IV anti-icing fluid is applied with a start of application time of 10:00, OAT is 0°C, light ice pellets mixed with freezing drizzle falls until 10:10 and stops and restarts at 10:15 and stops at 10:20. The allowance time stops at 10:25, however provided that the OAT remains constant or increases and that no precipitation restarts after the allowance time of 10:25, the aircraft may take off without any further action up to 11:30.
 3. On the other hand, if Type IV anti-icing fluid is applied with a start of application time of 10:00, OAT is 0°C, light ice pellets mixed with freezing drizzle falls until 10:10 and stops and restarts at 10:30 with the allowance time stopping at 10:25 the aircraft may not takeoff, no matter how short the time or type of precipitation after 10:25, without being deiced and anti-iced if precipitation is present.
- c) Operators with a GIP updated to include the allowance time information contained herein will be allowed, in the specified ice pellet and small hail conditions listed in the Type III, Type IV EG and Type IV PG Allowance Times tables up to the specific allowance time, to commence the takeoff with the following restrictions:
1. The aircraft critical surfaces must be free of contaminants before applying anti icing fluid. If not, the aircraft must be properly deiced and checked to be free of contaminants before the application of anti-icing fluid.
 2. The allowance time is valid only if the aircraft is anti-iced with undiluted Type III or Type IV fluid.
 3. The Type III allowance times are only applicable for unheated anti-icing fluid applications.
 4. Due to the shearing qualities of Type III and Type IV fluids with imbedded ice pellets, allowance times are limited to aircraft with a rotation speed of 100 knots or greater, or 115 knots or greater as indicated in the allowance times tables.
 5. If the takeoff is not accomplished within the applicable allowance time, the aircraft must be completely deiced, and if precipitation is still present, anti-iced again prior to a subsequent takeoff. If the precipitation stops at or before the time limits of the applicable allowance time and does not restart, the aircraft may takeoff up to 90

minutes after the start of the application of the Type III or Type IV anti-icing fluid, subject to the restrictions in 2 above.

6. A pre-takeoff contamination inspection is not required. The allowance time cannot be extended by an internal or external inspection of the aircraft critical surfaces.
7. If ice pellet precipitation becomes heavier than moderate or if the light ice pellets mixed with other forms of allowable precipitation exceeds the listed intensities or temperature range, the allowance time cannot be used.
8. If the temperature decreases below the temperature on which the allowance time was based,
 - a. and the new lower temperature has an associated allowance time for the precipitation condition and the present time is within the new allowance time, then that new time must be used as the allowance time limit.
 - b. and the allowance time has expired (within the 90 minute post anti-icing window if the precipitation has stopped within the allowance time), the aircraft may not takeoff and must be completely deiced and, if applicable, anti-iced before a subsequent takeoff.
9. If an intensity is reported with small hail, the ice pellet condition with the equivalent intensity can be used, e.g. if light small hail is reported, the “light ice pellets” allowance times can be used. This also applies in mixed conditions, e.g. if light small hail mixed with snow is reported, use the “light ice pellets mixed with snow” allowance times.

11.1.17 Holdover Time Determination Systems (HOTDS)

The Holdover Time Determination System (HOTDS) is an automated system comprised of numerous sensors that measure weather conditions at an airport at pre-determined intervals. Air operators can leverage near real-time reporting of meteorological conditions at airports compared to traditional METAR/SPECI with HOTDS and apply them to the usage of anti-icing fluids and their applicable holdover times. Flight crews can obtain a holdover time through the Aircraft Communications Addressing and Reporting System (ACARS) and/or through internet connected applications (e.g. Electronic Flight Bag application) versus using a holdover timetable.

HOTDS leverage meteorological instruments and precipitation rate measurement devices to provide data inputs towards algorithms that emulate existing anti-icing fluid failure regression curves. Systems are sited at airports to sample the conditions encountered by aircraft. Flight crews request Holdover Time Determination Reports (HOTDR) from the system and are able to obtain a near real-time holdover time.

HOTDS provide holdover times that are more precise compared to the holdover timetable ranges found in the HOT Guidelines. Furthermore, HOTDS provide holdover times in heavy snow between 25-50 g/dm²/hr.

GOFRS Standard 622.11 set out the requirements for air operators on the use of HOTDS, including the minimum assurance requirements and performance specifications, which include:

- In the absence of a functional HOTDS, all requirements/elements typically found in GOFRS 622.11 must continue to apply as part of the approved GIP, including the use of holdover timetables. Furthermore, when utilizing the HOTDS, every requirement/element of GOFRS 622.11 not explicitly exempted by the existing HOTDS exemption must continue to apply as part of the approved GIP.
- Prior to using the HOTDS, the operator shall ensure that the HOTDS meets the applicable minimum performance specification set out in the HOTDS exemption.
- Operators are required to revise their respective Company Operations Manual (COM) to include operational procedures associated with the use of the HOTDS. The revised COM must be approved by Transport Canada Civil Aviation prior to the utilization of the HOTDS.
- Operators shall identify in the COM the airports where it intends on using a HOTDS for HOT and have contingency plans in the COM to address the possible outage of the HOTDS.
- Operators shall develop and provide a training program for their flight crew members and operations personnel on the use of the applicable HOTDS and associated reports.

There are limitations set out on the usage of HOTDS which differ from the use of traditional holdover timetables. When using HOTDS, a single value holdover time is limiting and take-off after the holdover time is exceeded is prohibited unless an external tactile inspection is conducted and the aircraft is deemed acceptable for flight or the aircraft is re-deiced/anti-iced as required.

Flight crews must be aware of prevailing weather changes subsequent to receiving an HOTDR; in such instances an updated HOTDR must be requested from the HOTDS. When more than one HOTDR is received after de/anti-icing, the HOTDR that applies depends on the measurement system used by the HOTDS:

- a) discrete measurement system: the most limiting HOTDR received must be used.
- b) continuously integrated measurement system: the most recent HOTDR must be used.

11.1.18 Degree-Specific Holdover Times (DSHOT)

A database of Degree-Specific Holdover Times (DSHOT) was created to support extending safe air operations in snow conditions and leverage the similar benefits of HOTDS and is an extension of the HOT Guidelines. The DSHOT database contains an expanded set of snow precipitation HOTs (very light snow,

light snow and moderate snow, snow grains, snow pellets, snow mixed with ice crystals, and snow mixed with freezing fog) for all Type II, III and IV anti-icing fluids listed in the HOT Guidelines. For a given fluid, this expanded set contains HOTS calculated at degree decrements (in °C) down to the AAF's LOU. The DSHOT for snow conditions can be used in conditions of snow mixed with ice crystals. A set of generic DSHOTS for Type II, Type III, and Type IV fluids is provided in separate tab of the database for conditions of snow mixed with freezing fog.

DSHOT data is also provided in generic format for Type II and Type IV fluids. The generic values for a given fluid type and temperature represent the lowest calculated HOT value of all fluids of that type at the specified temperature.

Operators incorporating DSHOT into their operations should carefully review guidance and conditions on the use of DSHOT data can be found in Advisory Circular (AC) 700-061 to determine applicable requirements.

11.2 Deicing and Anti-icing Inspection

11.2.1 General

The deicing process is intended to remove frozen contaminants from the aircraft's critical surfaces and to restore the aircraft to a configuration that neither significantly degrades the aerodynamic performance characteristics and handling qualities nor causes mechanical interference to occur. The criteria used to make the decision on whether or not to de-ice an aircraft is an integral part of the operator's GIP.

Where required, the operator's GIP must describe the methods to be used in this inspection, which may be conducted from the inside or the outside of the aircraft. The inspection may be visual or tactile, or may include the use of approved ground ice detection devices. The inspection may use representative aircraft surfaces to judge the extent of contamination. In some cases an outside the aircraft inspection is mandatory, for example, when an operator with an approved program is not using HOT guidelines.

Where only a visual inspection is done, the operator's GIP must specify the conditions, such as weather, lighting and visibility of critical surfaces, under which such an inspection can be conducted. Unless other procedures have been specifically approved, a tactile external inspection must be conducted on all aircraft without leading edge devices, such as the DC9-10 and the F-28.

There have been ground icing accidents associated with the improper inspection of high wing turboprop aircraft employed in commercial service. Particularly vulnerable are those high wing turbo prop aircraft operated from remote locations with minimally equipped facilities. For these types of operations, the pilot is usually the final person to perform the pre-take-off inspection. It is often difficult to clearly see frozen contaminants from a brief view of the upper wing surface, especially if the pilot is balancing on a strut to gain the necessary view. The use of proper inspection equipment, such as wing inspection ladders, is highly recommended.

It is the PIC's responsibility to ensure that aircraft critical surfaces are not contaminated at take-off. When the PIC does not conduct the inspection, the delegated person must provide an inspection report in clear language to the PIC, who must indicate that the report is complete and understood. A detailed description of the guidelines and procedures to be followed in communications between the delegated and the PIC, including the use of hand signals, must be included in the appropriate operator's manual.

11.2.2 Suggested Ground Icing Operational Practices

The following practices help the PIC ensure that his aircraft is safe for take-off:

- a) Be aware of the adverse effects of surface roughness on aircraft performance, flying qualities and flight characteristics;
- b) Be knowledgeable of the ground de/anti-icing practices and procedures being used on the aircraft;
- c) Do not allow the service provider organization to de/anti-icing your aircraft until both parties are familiar with the ground deicing practices and quality control procedures to be used;
- d) Be knowledgeable of the critical surfaces of the aircraft and ensure that these areas are properly de/anti-iced;
- e) Ensure that precautions are taken during the deicing process to avoid damage to aircraft components and equipment;
- f) Ensure that a thorough post de/anti-icing inspection is performed prior to take-off;
- g) Perform additional post de/anti-icing inspections as required;
- h) Ensure that engines or rotor blades are not be started until it has been ascertained that all ice deposits have been removed and that ground personnel are away from the danger areas for such procedures. It should be noted that ice particles shed from rotating components may damage the aircraft or injure ground personnel;
- i) Be aware that operations in close proximity to other aircraft can cause snow, ice particles, or moisture to be blown onto critical aircraft components; or, can cause dry snow to melt and refreeze on aircraft critical surfaces;
- j) The aircraft must not take-off if snow or slush is observed splashing onto critical areas of the aircraft, wing leading edges, control surfaces, or high lift devices, during taxi; and
- k) The aircraft must not take-off if positive evidence of a clean aircraft cannot be established.

11.2.3 Critical Surface Inspection

11.2.3.1 Introduction

Current regulations call for a "clean aircraft" concept, which may be determined through pre-flight inspections using visual, tactile or sensor based procedures.

The "clean aircraft" concept is, in large part, assured by a critical surface inspection, which is a pre-flight external inspection of critical surfaces conducted by a qualified person, to determine if the surfaces are contaminated by frost, ice, slush or snow. Under ground icing conditions, this inspection is mandatory.

The critical surface inspection phase is of prime importance in the overall deicing process and is directly related to the safety of the aircraft during take-off. Critical surface inspection procedures must therefore be design to ensure that an aircraft is free of contamination following deicing. During ground icing conditions with falling precipitation adhering to the critical surfaces, anti-icing will be required.

A critical surface inspection is required by GOFRS 622.11 8.1.2 and states that: “This inspection is mandatory whenever ground icing conditions exist, and if the aircraft is de-iced /anti-iced, must take place immediately after final application of the fluid. After the inspection, an inspection report must be made to the PIC by a qualified person”.

11.2.3.2 Post de/anti-icing application inspection

The following is a checklist of typical items to inspect, which may vary for different aircraft types. Recommendations from the aircraft manufacturer must be used when available.

- a) Wing leading & trailing edges, upper and lower surfaces
- b) Leading edges, upper and lower surfaces, and side panels of vertical and horizontal stabilizing devices
- c) High lift devices such as leading edge slats and leading or trailing edge flaps
- d) Spoilers and speed brakes
- e) All control surfaces and control balance bays
- f) Propellers
- g) Engine inlets, particle separators, and screens
- h) Windshields and other windows necessary for visibility
- i) Antennas
- j) Fuselage, including emergency exits and windows used by the crew for examining critical surface contamination
- k) Exposed instrumentation devices such as angle-of-attack vanes, pitot-static pressure probes, and static ports
- l) Fuel tank and fuel cap vents
- m) Cooling and auxiliary power unit (APU) air intakes, inlets, and exhausts
- n) Landing gear, including gear doors

NOTE: Once the post de/anti-icing inspection has been completed and is satisfactory, the aircraft should be released for take-off as soon as possible.

11.2.3.3 Training

This process must be clearly defined and understood by all of the personnel involved in the de/anti-icing process. Considerations should include, but are not limited to:

- a) Identification of aircraft critical surfaces
- b) Frozen contaminant identification and inspection procedures
- c) Definition and use of a “tactile” inspection
- d) Tactile inspection techniques

e) Pilot communications

Initial and annual recurrent training of operators that will be conducting critical surface inspections is mandatory.

11.2.3.4 Traditional methods of conducting a Critical Surface Inspection

a) Visual Inspection

The service provider's personnel are required to visually inspect all critical surfaces to ensure that the aircraft is free of contamination prior to de/anti-icing and prior to releasing the aircraft for departure. The aircrew may also need to inspect the representative surfaces (or the critical surfaces, where a representative surfaces is not designated) of the aircraft prior to take-off in accordance with approved company procedures.

It becomes more difficult, during night operations, during conditions of poor lighting and during inclement weather when visibility is substantially reduced, to achieve consistent results with visual inspections.

While some forms of contamination, such as snow or ice pellets, can easily be detected through a visual inspection, other contamination such as clear ice can be extremely difficult to detect visually. The forms of contamination which are the more difficult to detect may require special inspection methods to ensure that an aircraft's critical surfaces are clean.

b) Tactile Inspection

The tactile inspection procedure requires that the service provider's personnel touch the leading edge of the aircraft's wings and/or other critical surfaces to establish that the aircraft is free of adhering contaminants.

Service providers requiring that their personnel expose their bare hands to de/anti-icing fluids, as may be the case for a tactile inspection, need to consider procedures for the protection of these personnel from the possible long term effects of such fluid exposure.

The tactile inspection should be accomplished in a symmetrical manner.

The tactile inspection is a good procedure for the detection of clear ice on the aircraft's critical surfaces both before and after deicing.

On surfaces that are readily accessible, such as the leading edge, a tactile inspection can be accomplished with minimal disruption to the deicing operation. Other aircraft surfaces may present a formidable inspection challenge.

c) Tactile Wand

To address the issue of surfaces, which are difficult to reach, a pole may be used to perform the tactile inspection. This procedure must be well trained to ensure reliable results.

The physical check is accomplished by moving the ice detection pole across the critical surface in a sweeping pattern. If the wing surface has a consistent texture, either rough or smooth, ice may be present and deicing may be required.

As the pole is dragged across the inspection area, with ice present, a reduction in resistance of the pole to movement will be experienced. This is because the wing surface will have less friction. With ice present, the ice detection pole will glide smoothly over the entire surface.

NOTE: Caution must be taken when using the pole to ensure that no damage is done to the aircraft.

11.2.3.5 Split Scimitar Wingtip Devices and Strakes

Wingtip devices have various names, including winglets, strakes, sharklets, or raked wingtips. The guidance below applies for these devices.

- a) Without Split Scimitars or Strakes (Winglets, Sharklets, etc.): These devices must be confirmed to be free of frozen contamination as part of the pre-takeoff inspection. Current practices include a visual scan or the use of an approved representative surface, as specified in the operator's TC-approved ground deicing program.
- b) With Split Scimitars, Strakes, or Similar Devices: A new wingtip device element, the strake, has been introduced and is part of the split scimitar. The strake is installed outboard of the vertical component of the wingtip device and extends downward and therefore cannot be observed from inside the aircraft. Manufacturers may designate the upper inboard surface of the vertical element of the wingtip device as a representative surface to assure no frozen contamination is present. The anti-icing procedures specified require this inboard surface to be anti-iced first starting at the top and working downward. The strake is anti-iced after the inboard surface application is completed. A visual scan of the designated representative surface (upper inboard surface of the vertical element of both wingtips) is required prior to takeoff as part of the pre-takeoff inspection. This paragraph applies only to aircraft with split scimitar wingtip devices. This guidance will be revised when new wingtip types become available.
- c) Boeing wingtip devices currently in use on the B737 (including wingtip devices with split scimitar elements), B747, B757, B767, and MD11: Boeing has demonstrated that these wingtip devices do not require a visual inspection as part of the pre-takeoff inspection if a complete deicing of these wingtip device surfaces is accomplished during the aircraft deicing procedure. Following the accomplishment of the wingtip device deicing procedure no further action concerning the wingtip device is required as long as the determined HOT does not expire before departure. Upon expiration of the determined HOT prior to departure, a pre-takeoff contamination inspection must be accomplished. This inspection must include a visual inspection of the wingtip devices, and if adhering frozen contamination is detected, the aircraft must return for appropriate ground deicing/anti-icing retreatment prior to departure.

11.2.4 Pre-take-off Contamination Inspection

The pre-take-off inspection should be accomplished shortly before the aircraft enters the active runway for take-off or before the pilot initiates the take-off roll; and is the final confirmation for the pilot that the aircraft is free of frozen contaminants. Components that can be inspected vary by aircraft design; which affects their visibility from the cockpit and/or cabin. The pilot may require the assistance of trained and qualified ground personnel to assist in the pre-take-off contamination inspection. On hard wing aircraft, in addition to visual inspection, a tactile inspection may be required.

The procedures to be followed, the surfaces to be inspected and the related actions to be accomplished by the pilot are all to be detailed in the GIP, where such a program is required (a GIP is mandatory for CAR 705 Operators).

NOTE: In all circumstances this pre-takeoff contamination must be conducted from outside of the aircraft if the operator does not use ADF/AAF and their respective HOT guidelines.

11.2.4.1 Inspection immediately prior to take off

Transport Canada's interpretation of the phrase "inspected immediately prior to take-off", in the ground icing context, is that the inspection must be conducted within five minutes prior to beginning the take-off roll.

Fluid testing has indicated that this procedure must not be applied to Type I fluids. Type I fluids have very short HOT values and fluid failure occurs suddenly. Therefore, it is not considered prudent to apply this procedure to Type I fluids. The procedure should only be applied to Types II, III and IV anti-icing fluids and then only when the pertinent minimum holdover time exceeds 20 minutes.

If, after conducting the pre take off contamination inspection once, it is not possible to take-off within five minutes, the aircraft must return for deicing. Additional inspections and time extensions are not considered prudent.

11.2.5 Representative Surfaces

11.2.5.1 Function of representative surfaces

Particularly for large aircraft where very limited portions of the aircraft can be seen from inside, approved representative surfaces may be used to judge the condition of the aircraft's critical surfaces during ground icing conditions.

- a) Representative Surfaces are intended to be used, as a tool in gauging the contaminated state of critical surfaces on an aircraft after having used deicing and anti-icing fluids to clean the aircraft and then protect the aircraft from the freezing precipitation occurring during ground icing conditions.
- b) An aircraft's Representative Surface is a portion of the aircraft that can be readily and clearly observed by flight crew from inside the aircraft and is used to judge whether or not the

- surface has become contaminated. By determining the state of the Representative Surface, it can then be reasonably expected that other critical surfaces will be in the same (or better) condition.
- c) Prior to take-off, a visual check of the Representative Surfaces may be carried out by the PIC in command to ensure that contamination is not present at this stage of the flight; depending upon the requirements of the approved ground icing program. If conclusive, the aircraft may proceed to take-off, otherwise the aircraft must be de-iced again.

11.2.5.2 Representative surface approval guidelines

- a) The choice of representative surfaces should first consider any recommendations made by the aircraft manufacturer.
- b) Operational and other pertinent experience can be very useful in choosing a representative surface. This is especially valuable when the aircraft manufacturer hasn't offered any guidance on making the selection.
- c) Representative surfaces will normally be located on a critical surface of the aircraft.
- d) The surface being chosen should not be heated.
- e) The surface must be clearly visible and close enough for the viewer to determine that it is free of contamination. The location of the representative surface and the position inside the aircraft from which the surface is to be viewed must be specified for each aircraft type. This information must be clear and concise.
- f) If the surface is not adequately visible under all weather and lighting conditions, restrictions on its use must be clearly identified. Consideration should be given to locating representative surfaces in areas that can be illuminated by aircraft external lighting systems.
- g) Under some circumstances the presence of contrasting colours may be necessary in order to visually detect the presence of contamination. If a surface does not contain such contrast it may become necessary to paint a portion of the surface in contrasting colours to aid the flight crew.
- h) The representative surface should not be located in an area where the fluid tends to pool during anti-icing procedures. This fluid pooling would not result in the area being representative of the critical surfaces of the aircraft.
- i) Representative surfaces should be designated for both sides of the aircraft in the event that weather and wind conditions are such that contamination is more likely to form on one side of the aircraft than on the other side of the aircraft.
- j) Representative surfaces that can be clearly observed by flight crew from inside the aircraft may be suitable for judging whether or not critical surfaces are contaminated.
- k) Research has indicated that fluid failure occurs last at the mid chord sections of wings. Therefore, whether painted or not, areas located at mid chord sections of wings and previously used for checking fluid conditions are not suitable alone for evaluating fluid failure and should no longer be used exclusively as representative surfaces. Portions of the leading and trailing edges of the wings should be included.

- l) Pre-take-off contamination inspections should concentrate on the leading edge in conjunction with the trailing edge of the wing. Dependent upon aircraft configuration, wing spoilers may also be used to provide an indication of fluid condition.

11.2.5.3 Guidelines on the use of representative surfaces

- a) The Operator's GIP must specify the ground and flight crew training to be conducted regarding the purpose, procedures and limitations with respect to representative surfaces. Training on the assessment procedures to be followed to determine whether or not the fluid has failed should be included in the program.
- b) This technique may be used when the aircraft manufacturer has identified representative surfaces which can be readily and clearly observed by flight crew during day and night operations, and which are suitable for judging whether or not critical surfaces are contaminated.
- c) Representative surfaces may not be particularly effective during conditions when clear ice is forming on the aircraft's critical surfaces. Clear ice is even difficult to identify under ideal lighting conditions from outside the aircraft. Additional aircraft type specific procedures, such as tactile inspections, may be required.
- d) Other surfaces which are visible from inside the aircraft should also be inspected whenever possible, in addition to the Representative Surfaces. For example, under very good lighting conditions it may be possible to examine the surface of the wing beyond the representative surface.
- e) For large aircraft where it is necessary for one pilot to leave the flight deck in order to accomplish the pre-take off contamination inspection, there is the potential for the disruption of "checklist flow". The operator's ground icing plan should therefore specify at what point the inspection should take place in order to minimize any such disruption.
- f) Flight crew must be made aware that the use of representative surfaces for contamination detection may not be feasible in poor weather under very poor lighting conditions. The presence of contaminants on the cabin or cockpit windows may also make it difficult to properly observe the Representative Surfaces. Under conditions such as these it is prudent to have an external inspection conducted, to return for deicing and anti-icing or to delay the flight until conditions improve and a safe take off can be assured.

CHAPTER 12 Operational Issues

12.1 Meteorological Conditions

This section of the document discusses the typical Canadian meteorological conditions encountered during ground icing operations. Individual holdover time table cell values are capped at 2 hours for all precipitation conditions except freezing fog, freezing mist or ice crystals which are capped at 4 hours.

12.1.1 Freezing Rain Conditions

Aircraft anti-icing fluids holdover times have not been evaluated under moderate and heavy freezing rain conditions.

Aircraft have not been certified to fly in freezing rain conditions. The ability of an aircraft to continue to fly safely in these conditions is questionable.

Operation of an aircraft during freezing rain conditions should be avoided whenever possible.

12.1.2 Ice Pellet Conditions

Holdover time guidelines have not been assessed for ice pellets, since a formal protocol for ice pellet testing has not yet been developed and included in standard SAE testing methodologies and no visual failure criteria have been identified for ice pellet conditions.

However, comprehensive ice pellet research was conducted jointly by the research teams of the FAA and Transport Canada. This research consisted of extensive climatic chamber, wind tunnel, and live aircraft testing with ice pellets (light and moderate) and light ice pellets mixed with other forms of precipitation. Results of this research provide the basis for allowance time tables found within the holdover time guidelines for aircraft operations in light and moderate ice pellets, as well as allowance times for operations in light ice pellets mixed with other forms of precipitation.

12.1.3 Snow Conditions

Snow Column Cells in the HOT Guidelines

- a) During variable snow conditions the most conservative HOT Table cell time should be utilized; that is the lowest time.
- b) The capability of anti-icing fluids to tolerate a heavy snowfall rate has not been fully evaluated; therefore holdover times for heavy snow conditions have not been generated.
- c) Operations should be suspended in heavy snow; holdover times are extremely short and inspections of the surfaces cannot guarantee safety.
- d) Type I fluid is particularly vulnerable to sudden failure and therefore must not be used as an anti-icing fluid during heavy snow conditions.

12.1.4 Wind Effects

If an aircraft encounters conditions of high winds and blowing snow on the ground, it is possible that aerodynamically quiet areas may become contaminated with snow. It may be difficult using normal deicing/anti-icing inspection techniques to detect this condition. It is recommended that specific additional inspections be conducted under such circumstances. It may be necessary to extend the high lift devices to accomplish an inspection in this case.

12.1.5 Freezing Drizzle

The fluids provide greater protection for freezing drizzle than for freezing rain, but similar caution should be exercised.

High winds or high taxi speeds can increase the effective precipitation rate for freezing drizzle. Drizzle can also be very light such that it is almost imperceptible.

12.1.6 Cold Dry Snow (or Ice Crystals) Falling on a Cold Dry Wing

Conditions are encountered whereby cold dry snow (or ice crystals) are falling onto the cold wing of an aircraft. The wind often causes the snow (or ice crystals) to swirl and move across the surface of the wing and it is evident that the snow (or ice crystals) is not adhering to the wing surface. Under these circumstances the application of deicing/anti-icing fluid to the wing of the aircraft would likely result in the snow (or ice crystals) sticking to the fluid. Under such operational conditions it may not be prudent to apply fluids to the wing.

However, if snow or ice crystals have accumulated at any location on the wing surface it must be removed prior to take-off. It cannot be assumed that snow or ice crystals on a wing will “blow off” during the take-off. For example, refueling with fuel warmer than the wing skin temperature may create a condition whereby previously non adhering contaminants may adhere to the wing surfaces.

12.1.7 Frost

Frost occurs frequently during winter operating conditions. Frost due to radiation cooling is a uniform thin white deposit of fine crystalline texture that forms on exposed surfaces that are below freezing generally on calm cloudless nights where the air at the surface is close to saturation. When the deposit is thin enough for surface features underneath the frost such as paint lines, markings and lettering, to be distinguished it is often referred to as hoarfrost. Frost can also form on the upper or lower surfaces of the wing due to cold soaked fuel. Frost has the appearance of being a minor contaminant and therefore does not offer the same obvious signal of danger as do other types of contamination such as snow or ice. However, frost is an insidious threat to the safety of aircraft operations because it always adheres to the aircraft surface, is rough and causes significant lift degradation and increased drag.

12.1.7.1 Active Frost

Active frost is a condition when frost is forming. During active frost conditions, frost will form on an unprotected surface or re-form on a surface protected with de/anti-icing fluid where the holdover time has expired.

Frost forms whenever the exposed surface temperature cools below OAT to, or below, the frost point (not dewpoint). The mechanisms for cooling include:

1. Radiation cooling; or
2. Conductive cooling (due to cold soaked fuel).

If the exposed surface temperature is equal to or below the frost point, frost will begin to accrete on the surface. Once formed, residual accreted frost may remain after the active frost phase if the exposed surface temperature remains below freezing.

12.1.7.2 Dewpoint and Frost Point

The dewpoint is the temperature at a given pressure to which air must be cooled to cause saturation. The dewpoint can occur below or above 0°C.

The frost point is the temperature, at or below 0°C (32°F), at which moisture in the air will deposit as a layer of frost on an exposed surface. The frost point occurs between the OAT and dewpoint.

The METAR does not report frost points; however it does report dewpoint. The frost point is higher (warmer) than the dewpoint for a given humidity in the air. The frost point and the dewpoint are the same at 0°C; at a dewpoint of -40°C, the frost point is 3.2°C warmer (-36.8°C). The following table provides further examples of the correlation between dewpoint and frost point.

Dewpoint Temperature (°C)	Frost Point Temperature (°C)
0	0.0
-5	-4.4
-10	-8.9
-15	-13.5
-20	-18.0
-25	-22.7
-30	-27.3
-35	-32.1
-40	-36.8

12.1.7.3 Radiational Cooling

Radiational cooling will generally occur during clear sky (e.g. SKC, high FEW or high SCT), low wind (e.g. less than 10 knots), and low light (e.g. shade, at night or in low angle / obscured sun) conditions. These conditions will cause the exposed surface temperature to cool below the OAT. Once the exposed surface temperature cools to the frost point or below, active frost occurs.

Certain surface finishes and material compositions may be more susceptible to radiation cooling and as a result, different areas of an aircraft may begin to accrete frost at different times. Radiational cooling can cause an exposed surface to cool several degrees below the OAT, therefore frost can form on an exposed surface at an OAT several degrees above 0°C.

Time to frost formation may range from minutes to hours depending on conditions. As a result, a surface that appears free of frost during an early inspection may become contaminated later. A direct inspection of critical surfaces conducted as close as possible to the departure time is recommended when conditions are favourable for active frost formation.

12.1.7.4 Cold Soaked Fuel Cooling

Cold soaked fuel cooling results from conductive cooling due to very cold fuel on board at destination or from refueling with fuel that may be cooler than the OAT. Cold soaked fuel conditions are highly variable and therefore only direct surface temperature readings are accurate but not available at most stations. Fuel temperature does not accurately predict cold soaked fuel conditions but may provide an initial indication, particularly in the period after landing and prior to fuelling. The presence of frost under the wing is a good indication of cold soaked fuel conditions.

In extreme cases, cold soaking may reduce the surface temperature below the fluid LOU and cause aerodynamic performance degradation due to fluid freezing or the inability of the fluid to adequately flow off the treated surface. The application of this fluid would not be recommended in such a scenario.

12.1.7.5 Combined Radiation and Cold Soaked Fuel Cooling Effects

Cold soaked fuel cooling combined with radiation cooling effects can cause reductions in active frost holdover times. This is importantly true for Type I fluid holdover times as these are shorter in duration, and therefore use of a thickened anti-icing fluid should be considered.

12.1.7.6 De/Anti-Icing in Active Frost Conditions

Frost reforming after removal is an indication of active frost. Anti-icing protection is required during active frost and operations should be conducted in accordance with holdover time guidelines and with minimum fluid quantity and temperature application procedures therein. Applications such as misting or mopping of Type I fluid may not provide adequate heat or fluid quantity to use the holdover times in active frost conditions.

Deicing alone is insufficient in active frost conditions; a preventative anti-icing coating is required once the frost has been removed.

12.1.7.7 Fluid Holdover Times for Active Frost Conditions

Fluid holdover times in active frost conditions differ from holdover times in other conditions as they incorporate an allowance for the temperature differential (typically 6 to 8°C) between the OAT and the

exposed surface temperature due to radiation cooling. As a result of this allowance, the OAT should be used to determine the appropriate active frost holdover time.

NOTE: Changes in OAT over the course of longer frost HOT can be significant; the appropriate HOT to use is the HOT provided for the coldest OAT that has occurred in the time between the de/anti-icing fluid application and takeoff.

NOTE: Active frost holdover times may be reduced in the presence of combined cooling effects or extreme surface cooling. In extreme cases, the surface temperature may be below the fluid LOUT and cause aerodynamic performance degradation due to fluid freezing or the inability of the fluid to adequately flow off the treated surface. The application of this fluid would not be recommended in such a scenario.

12.1.7.8 Frost on the Underside and/or Upperside of the Wing

CAR 602.11(3) states: “Despite subsection (2), a person may conduct a take-off in an aircraft that has frost caused by cold-soaked fuel adhering to the underside or upper side, or both, of its wings if the take-off is conducted in accordance with the aircraft manufacturer’s instructions for take-off under those conditions.”

12.1.7.9 Frost on the Fuselage

Despite the requirement to clean contamination from critical surfaces, it is acceptable for aircraft, including those with aft fuselage mounted engines, to take-off when hoarfrost is adhering to the upper surface of the fuselage if it is the only remaining contaminant, provided all vents and ports are clear. Contact the aircraft manufacturer for further details.

12.1.8 Rain

12.1.8.1 Rain on a Cold Soaked Wing

Cold soaking derives largely from fuel stored in a wing for an extended period of time at high altitude; which often results in the aircraft arriving at an airport with the wings at a below freezing temperature. When rain or warm humid conditions are present at the destination airport ice tends to form on the wing upper surface. There may also be an accumulation of ice at the wing’s cold corner. In addition, there may also be substantial frost or ice forming under the wing. Under such conditions careful checks should be made because this type of ice is often difficult to identify; the wing may only appear to be wet.

12.1.9 Hail and Small Hail

The meteorological conditions “Hail” and “Small Hail” are different. Hail is a more intense condition for which holdover times do not exist. Small hail is a lighter condition, meteorologically equivalent to moderate ice pellets, for which allowance times are provided.

12.1.10 Hail, Small Hail, Ice Pellets, Snow Grains and Snow Pellets (METAR Codes GS, GR, PL, SHGS, SG)

The World Meteorological Organization (WMO) states METAR code GS is used for two meteorological conditions: “snow pellets” and “small hail.” Different holdover times/allowance times apply in these two weather conditions. If the weather condition is snow pellets, the snow holdover times are applicable. If the weather condition is small hail, the ice pellet and small hail allowance times are applicable. Furthermore, the ice pellet and small hail allowance times are applicable if the prevailing weather condition between “snow pellets” and “small hail” cannot be determined given that these are more restrictive than the snow holdover times. This is summarized in the following table:

Weather Condition	Applicable Holdover Times / Allowance Times
Snow Pellets	Snow Holdover Times
Snow Grains	Snow Holdover Times
Ice Pellets	Ice Pellet (and Small Hail) Allowance Times
Small Hail	Ice Pellet (and Small Hail) Allowance Times
Hail	No Holdover Times or Allowance Times

The way some of these precipitation types are reported by METAR varies by country. Different holdover times / allowance times may apply when the same METAR code is reported in different countries. The tables below show the appropriate holdover times or allowance times to be used with METAR codes GS, GR, PL, SHGS, and SG when they are reported in Canada, the United States, or a different country.

CANADA		
METAR Report	Weather Condition	Applicable HOTs / Allowance Times
SG	Snow Grains	Snow Holdover Times
GS	n/a (GS never reported in isolation)	n/a
SHGS without remarks	Snow Pellets Showers	Snow Holdover Times
SHGS with remarks stating diameter of hail	Small Hail	Ice Pellet (and Small Hail) Allowance Times
TSGS without remarks	Snow Pellets with a Thunderstorm	Snow Holdover Times
TSGS with remarks stating diameter of hail	Small Hail with a Thunderstorm	Ice Pellet (and Small Hail) Allowance Times
PL	Ice Pellets	Ice Pellet (and Small Hail) Allowance Times
GR	Hail	No HOTs or Allowance Times

UNITED STATES		
METAR Report	Weather Condition	Applicable HOTs / Allowance Times
SG	Snow Grains	Snow Holdover Times
GS	Snow Pellets	Snow Holdover Times
SHGS	Snow Pellets Showers	Snow Holdover Times
PL	Ice Pellets	Ice Pellet (and Small Hail) Allowance Times
GR with remarks "less than 1/4"	Small Hail	Ice Pellet (and Small Hail) Allowance Times
GR with remarks "1/4 or greater"	Hail	No HOTs or Allowance Times

REST OF WORLD		
METAR Report	Weather Condition	Applicable HOTs / Allowance Times
SG	Snow Grains	Snow Holdover Times
GS or SHGS	Snow Pellets or Small Hail	Ice Pellet (and Small Hail) Allowance Times*
GR	Hail	No HOTs or Allowance Times
PL	Ice Pellets	Ice Pellet (and Small Hail) Allowance Times

**If additional information provided with the METAR makes clear that the weather condition is snow pellets and not small hail then snow holdover times can be used*

While most countries, including the United States and Canada, do not report an intensity with small hail, some countries do (e.g. Japan). If no intensity code (+ or -) is reported with small hail, the intensity is assumed to be moderate and the moderate ice pellet allowance times apply. If an intensity code (+ or -) is reported with small hail, the intensity can be used to determine the applicable allowance times. (Note this logic also applies when small hail is reported mixed with another precipitation condition.) Examples are provided in the below:

Weather Condition	Applicable Allowance Times	Examples	
		Weather Reported	Applicable Allowance Times
Small Hail reported <u>without</u> intensity	Moderate Ice Pellets (or Small Hail)	Small Hail, no intensity	Moderate Ice Pellets
		Small Hail mixed with Rain, no intensity	Moderate Ice Pellets mixed with Rain
Small Hail reported with light (-) intensity	Light Ice Pellets (or Small Hail)	Small Hail, light (-) intensity	Light Ice Pellets
		Small Hail, light (-) intensity, mixed with Rain	Light Ice Pellets mixed with Rain
Small Hail reported with heavy (+) intensity	No Allowance Times (no allowance times exist for heavy conditions)		

12.1.11 Freezing Fog, Freezing Mist, and Ice Crystals

The freezing fog condition is best confirmed by observation. If there is accumulation in the deicing area, then the condition is active and freezing fog accumulation will tend to increase with increasing wind speed. The least accumulation occurs with zero wind. The measured deposition rate of freezing fog at 1 and 2.5 meters per second (m/s) wind speeds are 0.2 and 0.5 mm/h (2 and 5 g/dm²/h), respectively. Higher accumulations are possible with higher wind speeds. Freezing fog can accumulate on aircraft surfaces during taxi since taxi speed has a similar effect as wind speed. Holdover times for freezing fog mixed with snow are provided in the HOT Guidelines.

Freezing mist is never reported by METAR, however it can occur when mist is present at 0 °C (32 °F) and below. Freezing mist is best confirmed by observation. Mist is reported alone or reported as mixed with ice crystals, use the holdover times in the “Freezing Fog, Freezing Mist, or Ice Crystals” column in the holdover time tables. If freezing mist is occurring mixed with another precipitation condition other than ice crystals, these holdover times do not apply.

In addition to having ice crystal holdover times, the HOT Guidelines allow the use of Holdover Times when:

- Ice crystals are mixed with freezing fog or mist
- Ice crystals are mixed with very light, light, or moderate snow

12.2 Cleaning Aircraft Components Other than “Critical Surfaces”

12.2.1 Cabin Windows

Whenever practicable, cabin windows should be free of frozen contaminants. The cabin windows are an important part of the safe operation of an aircraft. The flight crew may be required to look at the wings from a vantage point within the aircraft cabin to determine if the wings are free of frozen contaminants and that the aircraft is safe for take-off.

In the event of an “on ground” emergency requiring rapid passenger evacuation, cabin safety personnel will be required to look out of the cabin windows to assess the situation to determine if it is safe for the passengers to exit from one side or the other of the aircraft. In either of these cases, it is important that the cabin windows be clear.

Therefore, it is considered prudent to ensure that the cabin windows, especially those required for flight crew and cabin safety personnel duties, are free of frozen contaminants.

12.2.2 Emergency Exits

During periods of freezing drizzle and freezing rain in particular, an aircraft on the ground may accumulate a significant thickness of ice on the fuselage. One of the potential effects of a sheet of ice over the entire fuselage of the aircraft is that the ice may prevent normal operation of the emergency exits.

Operators should consider this situation during ground deicing operations, particularly when freezing drizzle or freezing rain has occurred at the airport while the aircraft has been sitting for an extended period of time on the ground.

12.3 Configuration During De/Anti-icing Procedures

It is important for operators to consider the configuration of their aircraft during deicing.

Manufacturers may indicate that their aircraft need to be in a specific configuration during the deicing and anti-icing process. However, if an aircraft is in a clean configuration that is with all high lift devices retracted, during de/anti-icing the operator needs to consider what untreated areas of the wing are subsequently exposed to freezing precipitation once the devices are extended/deployed, during periods of active precipitation.

The areas under a leading edge flap or slat, if not protected by anti-icing fluids, have the potential of becoming a contaminated critical surface prior to take-off.

Operators need to consider this scenario and may need to develop additional procedures to ensure that the aircraft is taking off in an uncontaminated condition.

Two possible options are: delaying slat/flap deployment until just prior to take-off; or deploying the devices prior to de/anti-icing so that the surfaces under these devices are treated. With the second option, the holdover time and allowance time will be reduced due to the steeper angles of the slat/flap in the deployed configuration.

Delaying the slat/flap deployment may be the preferred option for optimum protection from ice buildup. If it is necessary to remove contamination from the slats/flaps, it may be best to deploy the slats/flaps for deicing and anti-icing and then retract them prior to taxi. Consult the aircraft operating manual and/or aircraft manufacturer for more details.

Training and checklist changes may be required.

12.4 APU Lessons Learned

Aircraft design and APU inlet location may allow de/anti-icing fluids to enter the APU inlet in strong winds or if fluid spray is directed near the inlet. When de/anti-icing fluids enter the inlet of a running APU, varying degrees of damage may be incurred ranging from flameout to catastrophic failure. As an example, during the 2000/2001 winter operations season, an aircraft was being deiced in strong winds with engines and APU running. Despite all precautions taken by the crew applying the fluids, some fluid entered the APU inlet which caused an over speed, exceeded its design limits and a rotor burst occurred.

Operators and service providers should ensure that all personnel involved in the application of de/anti-icing fluids are aware of precautions required when applying fluids near the APU inlet. Additional precautions must be taken when strong winds make control of fluid application difficult, and

consideration should be given to asking the flight crew to shut down the APU if there is any doubt that fluid cannot be prevented from entering the APU inlet.

12.5 Extreme Operational Conditions

Extreme operational conditions often require specific solutions. Winter operations in the Canadian North pose their own problems due to the extremes in both weather and temperature. It has been noted that a number of Operators carry Type I fluids with them in the aircraft from station to station so that it is available. The containers in which the fluid is kept resemble the common garden insecticide sprayer. The fluid in this circumstance would appear to be kept at a room temperature. Application of this fluid at ambient temperature with such an applicator will result in limited effectiveness of the fluid, depending upon the conditions. Contact the fluid manufacturer for further details.

12.6 Pilot Issues

The PIC of an aircraft holds the ultimate responsibility for ensuring that the aircraft takes off in a safe manner; and in the case of ground icing conditions, the PIC must ensure that his aircraft's critical surfaces are free of frozen contaminants. It is important therefore that the service provider understand what specific requirements a pilot has in the pursuit of his duties during ground icing conditions.

12.6.1 Sufficient Lead Time

An efficient and reliable method of communication, appropriate to the site, allows pilots to communicate their intentions to the service provider at the earliest possible time. This may include details on: aircraft type, the estimated time of arrival (ETA) at the deicing pad (if off gate deicing operations are in effect), the possible requirement for a ground power unit (GPU), the possible requirement for engine shutdown and treatment of the propellers (if so equipped), the pertinent type of treatment required, the type of any fluid(s) which may be required, or any anomalies specific to the impending operation.

This early exchange of information allows the flight crew to adapt to problems that may come to light as a result of feedback received through early communication with the service provider. For example, if a specific fluid type were found to be unavailable, the pilot would be in a better position to review options and proceed with alternate arrangements if necessary and thereby reduce confusion and delay during ground deicing operations. This scenario will always be preferable to a situation where an aircraft arrives at the deicing location and then, due to a problem unknown to the pilot, is unable to undergo deicing with the likely result that the aircraft will need to return to the gate. This causes a delay and will inconvenience everyone involved, including the passengers and crews of other aircraft waiting in turn to enter the deicing facility or to use the deicing equipment.

If a flight crew receives an early warning of problems such as other aircraft experiencing unusually long delays, the aircraft PIC might elect to change plans. The change of plans may include adjusting fuel uplift, and making additional communications. From an airport perspective this

pre-planning can reduce congestion and improve on time departure success rates and contribute to safe ground operations.

In summary, communication between the pilot and the service provider, as soon as possible in advance of the aircraft arriving at the deicing location, ensures that the deicing operation will be accomplished in the safest and most efficient manner, for both the flight crew and the ground crew.

12.6.2 Taxi Communication

Once an aircraft has received permission to proceed to the deicing location and has begun taxiing, it is important that flight crews be able to receive prompt notification of any changes to the deicing operation, or of problems that arise. This may include notification from the service provider of unserviceable equipment, delays entering the deicing location, unusually slippery conditions at the deicing location operation. The sooner that pilots receive this type of feedback, the earlier they can adjust to the changing situation.

When radio frequency changes are required towards the deicing location, the pilot must clearly understand when and where to change frequency, so that confusion is averted. Erosion of the communication link between the pilot and the service provider could result in an aircraft proceeding to the wrong deicing location, to entering the pad incorrectly or in an unsafe manner. This could jeopardize both the efficiency and the safety of the entire operation, as well as compromising the safety of the deicing personnel working at the deicing location.

One way to ensure that the communication process used for deicing operations is clearly understood by the pilots involved, is to outline the process in the appropriate publication(s). Procedures must be in place to alert pilots to any change in published procedures. In this way, pilots will know what to expect and what is expected of them during normal deicing operations. By maintaining the communication link and providing pilots with reliable frequency handoffs when required, any last minute changes or problems that arise will be less likely to jeopardize operational efficiency and safety.

12.6.3 Procedures for Entry into Deicing Locations

The procedures used by the service provider for entry of aircraft into a deicing location must be made clear to the flight crews. Pilots of aircraft entering the pad must have a clear set of instructions concerning: the point of entry, the required ground track, the required hold short points the meaning of visual signals, the required stop points, the propeller feathering procedure, the engine handling, and other safety oriented instructions. Some of this information will be general and will apply to procedures common to all or most deicing location operations. Other information will be site-specific and will apply to procedures that are applicable to a particular deicing location, at a particular airport. These directives should be included in the pertinent operational literature and made readily available to the flight crews.

Where visual signals, such as, in-ground lighting, message boards, hand signals, are used, the signals should be standardized. Pilots need a clear indication regarding how and when to enter the deicing

location, and the deicing crews need to know the standard configurations at the facility. The safety of the operation is dependent upon clear directions.

An aircraft entering the pad incorrectly could result in injury to personnel, in damage to the aircraft, in damage to ground equipment, in loss of separation between the aircraft and the ground crews, and in possible damage to other aircraft parked or manoeuvring on the pad. When procedures are not clearly defined and confusion exists, combined with inclement weather, slippery conditions and poor visibility, which often accompany deicing operations, there is an increased potential for an accident.

A direct communication link between the aircraft's PIC and the can help reduce the possibility of errors and maintain an efficient aircraft throughput.

12.6.4 Establishing the Pilot / Deicing Coordinator Communication Link

Once an aircraft is parked on the deicing location and preparing to receive a deicing / anti-icing treatment, it is imperative that the PIC of the aircraft establish a communication link with the Deicing Operator coordinator that is responsible for the operation. This link may be established by means of standardized hand signals at airports where hard wire (head set) or radio communications are not available, or by hard wire or radios where these are the standard means of communication. No deicing vehicles should approach the aircraft to begin the deicing process until this communication link has been established.

In summary, as is the case in most aspects of an aircraft's flight operations, whether on the ground or in the air, communication which is clear and concise is vital to a safe airline operation. The communication link which is established between a pilot preparing for deicing, and the Deicing Operator coordinator is an important part of safe operations.

12.6.5 Central Deicing Facilities Operations

In most cases, pilots will want to talk directly to the Deicing Operator responsible for the operation; however, in large centralized deicing facilities a single controller may be required. This arrangement at a CDF will be the safest means of communication since there is a reduced risk of misunderstanding between the pilot and those providing the service. Direct radio communication allows for a flow of operational information, and allows that information to be exchanged more quickly. This factor becomes very important when an emergency arises. For example, a pilot experiencing an engine fire during the deicing procedure can immediately notify the deicing crew and they can quickly take the necessary action in such a time critical situation. One difficulty with relaying this information by means of hand signals or through a third party should be readily apparent. It is possible that the Deicing Operator would not be alerted to the problem, which could jeopardize the safety of the deicing team and the aircraft. The efficiency of a possible passenger evacuation may also be compromised in this scenario.

Once an aircraft is parked on the deicing location and preparing to receive a deicing/anti-icing treatment, it is imperative that the PIC of the aircraft establish a communication link with the Deicing

Coordinator that is responsible for the operation. This link may be established by means of standardized hand signals, hard wire (head set), or radios where these are the standard means of communication. No deicing vehicles should approach the aircraft to begin the deicing process until this communication link has been established.

Once an aircraft has reached the entry point to the facility control MUST be transferred from Air Traffic Services (ATS), Apron control to Pad Control. A communication link between the PIC and Pad Control must be established prior to the aircraft entering a deicing bay.

12.6.6 Exchange of Vital Information Prior to the Deicing/Anti-Icing Fluid Application

Prior to commencement of the deicing/anti-icing operation, certain vital information will need to be shared and acknowledged to ensure that the aircraft is treated correctly, in a safe manner, and with a safe result.

In order to ensure that these basic criteria are met, the following items, should be accomplished prior to commencing the operation:

12.6.6.1 Remote locations:

Between the Deicing Coordinator and the PIC:

- a) Confirmation that brakes are set and aircraft correctly configured for the type of deicing being accomplished (e.g. engines at idle, propellers feathered, bleed systems correct, etc.)
- b) Confirmation of the de/anti-icing methodology being used
- c) Communication of any last minute cautionary or advisory information deemed pertinent to the impending de/anti-icing operation
- d) Confirmation of type of fluid(s) to be applied to aircraft
- e) Confirmation of fluid mixture ratio, if applicable
- f) Communication of any last minute cautionary or advisory information deemed pertinent to the impending de/anti-icing operation
- g) Confirmation from the deicing operator to the PIC that de/anti-icing operations are about to commence;
- h) Time noted at the start of anti-icing fluid application. This is required by the PIC for the commencement of HOT timing. The service provider should note the time and advise the PIC.

12.6.6.2 CDF facilities:

Between Pad Control and the PIC:

- a) Confirmation that brakes are set and aircraft correctly configured for the type of deicing being accomplished (e.g.: engines at idle, propellers feathered, bleed systems correct, etc.)
- b) Confirmation of the methodology being used

- c) Communication of any last minute cautionary or advisory information deemed pertinent to the impending de/anti-icing operation
- d) Confirmation that de/anti-icing operations are about to commence
- e) Confirmation of fluid mixture ratio, if applicable
- f) Communication of any last minute cautionary or advisory information deemed pertinent to the impending de/anti-icing operation
- g) Confirmation from the Deicing Operator to the PIC that de/anti-icing operations are about to commence; and
- h) Time noted at the start of anti-icing fluid application. This is required by the PIC for the commencement of HOT timing. The Deicing Operator should note the time and advise the PIC.

12.6.7 Recommended “Clean Aircraft Concept” practices

The following list, while not exhaustive is intended to indicate the kinds of things that flight crew can do or should consider to improve upon the safety of the operation of their aircraft during ground icing operation conditions.

- a) Perform a pre-take-off inspection just prior to take-off
- b) Be knowledgeable of ground de/anti-icing procedures and practices that are appropriate for your aircraft type; these procedures shall be followed by the service provider
- c) Do not allow de/anti-icing procedures to be performed on the aircraft unless the practices and safety precautions in place are satisfactory
- d) Be aware that the HOT Guidelines are not exact values and rather ranges; as conditions and circumstances change so will the applicable HOT values. Continued vigilance is required at all times during ground icing conditions
- e) The general rule for ground icing procedures is that the de/anti-icing processes must be done symmetrically. To be specific, whatever final treatment is administered on one wing (e.g. fluid brand name, concentration) must be applied to the other wing for aerodynamic symmetry reasons.
- f) Deice and anti-ice the aircraft as close to the take-off location and the take-off time as possible to maximize the chances of safely completing the take-off before expiration of the HOT time.
- g) If the aircraft has leading edge devices that must be retracted during the deicing and anti-icing process, the area under the leading edge devices will remain untreated. Under these circumstances the deployment of the leading edge devices will expose the untreated leading edge to contamination. This factor must be taken into account and may require an amendment or revision to the pre-take-off checklist. The aircraft manufacturer should be consulted on this matter.
- h) Ground icing operations in conditions of blowing snow, slush, and in close proximity to other operating aircraft can cause the critical surface of the aircraft to become contaminated much more quickly than may be expected, due to the deposition of contaminants from the ground onto the surfaces. The PIC must remain vigilant.

- i) Do not attempt a take-off, under any circumstances, if, for any reason, there is doubt as to the condition of the critical surfaces.

12.6.8 Aerodynamic Effects of Contamination

The following information, while not exhaustive, should serve to remind PIC of some of the aerodynamic concerns and/or consequences of ground icing operations and critical surface contamination.

Research has indicated that small amounts of contamination on an aircraft's critical surfaces can have a very large effect on the aircraft's performance and handling qualities. This is particularly true during the take-off phase of flight.

Very slight surface roughness, caused by frozen contaminants, can have extremely significant effects on an aircraft's stalling speed, stalling characteristics, handling qualities and power required due to drag increases. Wing contamination, especially near the leading edge, can cause the wing stalling angle to be reached prior to any indication by the stall warning or stall pusher systems, especially during periods of high angles of attack, such as during the take-off rotation. The pilot will have little or no warning under these conditions. Leading edge roughness, especially during periods of high angles of attack such as during the take-off rotation, has particularly pronounced negative effects on aerofoil performance. Contamination of the leading edge of a wing is therefore of particular concern.

Controllability, especially in the rolling axis, may become extremely difficult or impossible. This lateral control difficulty can occur when the wing is contaminated ahead of the ailerons, thus disrupting the airflow over the aileron and reducing the effectiveness of the aileron. This condition may be exaggerated if the wings are asymmetrically contaminated, that is, if one wing is more contaminated than the other. The consequences of operating an aircraft under these conditions can be grave.

Thickened fluids, such as Types II & IV, are aerodynamically designed for "high take-off speed" aircraft. The pilot should ensure that the fluid being used is suitable for the aircraft.

If the aircraft has leading edge devices, which must be retracted during the deicing and anti-icing process, the area under the leading edge devices will remain untreated. Under these circumstances the deployment of the leading edge devices will expose the untreated leading edge to contamination. This factor must be taken into account and may require an amendment or revision to the pre-take-off checklist. The aircraft manufacturer should be consulted on this matter.

Propeller efficiency and balance are affected by contamination and they are therefore considered critical surfaces and must be cleaned before take-off.

12.6.9 Passenger Pre De/anti-icing Briefing

The CARs 602.11(7) states: "before an aircraft is de-iced or anti-iced, the PIC of the aircraft shall ensure that the crew members and passengers are informed of the decision to do so". Therefore, prior to commencing deicing activities the PIC must advise the passengers.

12.6.10 Final Anti-icing Fluid Application Start Time

The start time of the final application of anti-icing fluid to the aircraft must be relayed to the PIC. The PIC will use this time to establish the beginning of the holdover time (HOT). The start time will be given to the PIC, by the service provider, in a clear and concise manner. If the pilot needs to know which wing was sprayed first in a one truck de/anti-icing operation the pilot should request this information.

12.6.11 Communicating the Existence of Problems to the Pilot

The service provider must routinely provide information to the pilot, which typically includes: the final anti-icing fluid application start time, the type of fluid used, and information on the contamination status of the critical surface (i.e. clean or contaminated).

In addition to routine communications, the following are examples of other times when information of a critical nature needs to be relayed to the pilot. The ground icing training program needs to address circumstances such as these and describe the correct response. Following are examples:

a) Damage or potential damage to the aircraft

The PIC must be informed when any structural piece of equipment used in the deicing operation comes into contact with the aircraft, whether there is apparent damage to the aircraft or not. Fuel tanks, communication and navigation antennas, aircraft control and lifting surfaces, windows and windscreens, static wicks, pitot tubes, angle of attack and stall vanes, radomes, and various other aircraft structures are particularly susceptible to damage, which may not be visible to the naked eye. Contact between the service provider's equipment and any portion of the aircraft will require an inspection in order to assess the damage. In some cases the damage may be obvious. In other cases the damage may be so subtle that there will be no indication of damage apparent to the deicing crew. The PIC must always be advised of the occurrence.

b) The inadvertent spraying of sensitive aircraft parts.

When the Deicing Operator becomes aware that the spray nozzle has been inadvertently directed at an area of the aircraft which should not receive fluid spray, the PIC of the aircraft must be informed of this fact. On some aircraft, when the stream of the deicing spray is directed at door or hatch seals, for example, fluid can enter at that point and result in fluid pooling inside the body of the aircraft. This may not require any action or it may require a "mop up" of the affected area. On some aircraft, this same incident may have an effect that is operationally more consequential.

Deicing fluids should never be directed into engine or APU intakes or exhaust ports. In some cases this may result in a strong and unpleasant smell inside the aircraft, as engine or APU bleed systems carry the odors to the passengers and crew. Deicing spray directed into the inlets of reciprocating engines can cause thermal shock and damage to engine cylinders and

turbo chargers. Spray directed into turbo-jet or turbo-propeller engines may cause flameout or other problems, depending upon the volume of fluid ingested.

Deicing fluids aimed directly at the flight deck or the cabin windows can cause cracking and de-lamination of acrylic layers and penetration damage to the fitting seal; which can further lead to a pressurization incident. Care should be taken to avoid this situation, but when inadvertent spraying of these windows occurs, the deicing operator must inform the PIC.

If windows need to be deiced, direct a spray of fluid on the fuselage above so that the fluid will flow down over the windows.

Deicing crews will not spray fluid directly onto hot brakes, wheels or landing gear, unless cleared to do so. Damage to the brakes and wheel assemblies can occur when deicing fluid comes in contact with hot brakes, due to thermal shock of the brake components. If spraying this area of the aircraft is not authorized, the flight crew must be informed when an inadvertent spray occurs. This is important since braking efficiency while taxiing or during a rejected take-off could be greatly reduced.

- c) Notice of risk or injury to the deicing operator personnel.

The ground deicing personnel may be in the best position to assess potential risks that develop during the deicing operation. By being able to immediately contact the PIC potential incidents and accidents may be averted. Communication to the pilot may involve an urgent request to power down engines in order to reduce propeller or jet blast, or to stop an aircraft that has begun to slide forward on a slippery surface, for example.

The pilot may be requested to shut down an engine or engines when there is risk of injury to Deicing Operator members.

It is important that the Deicing Operator be able to relay instructions to the aircraft PIC quickly and clearly.

12.6.12 General Items Pertinent to the De/anti-icing Operation

The PIC should consider the following when receiving de/anti-icing treatment.

- a) Aircraft alignment during deicing

Most pilots will prefer to align their aircraft into the prevailing wind when preparing for a de/anti-icing operation, in order to reduce or prevent any fluid(s) being used from blowing back onto the flight deck windows.

b) De/anti-icing fluid on the cockpit windscreen

Service providers need to be made aware that even small amounts of deicing fluid covering flight deck windows can cause pilots to lose visual contact with the operation, which is taking place around the aircraft.

The fact that deicing spray can significantly reduce visibility from the cockpit, makes a compelling argument for the use of a hard wire or radio communication link between the Deicing Operator and the aircraft PIC.

c) Adequate night-time flood lighting

De/anti-icing an aircraft in a dimly lit, low visibility environment can be both difficult and unsafe. The lighting should be sufficiently bright to allow for day-like operations to take place. Night-time lighting should be shielded to prevent glare for pilots of aircraft taxiing, landing or taking off in close proximity to the deicing facility.

Good flood lighting, whether permanently fixed, portable or vehicle mounted, should be installed in consideration of the following points:

- i. Adequate nighttime lighting at the deicing facility will allow pilots to see clearly and therefore follow the hand signals of the deicing service provider.
- ii. Deicing crews will require sufficient nighttime flood lighting to enable them to provide the best possible deicing/anti-icing treatment.
- iii. Pilots will also need a well-lit environment within which to conduct a pre-take-off contamination inspection.

12.6.13 Post de/anti-icing considerations**12.6.13.1 Confirmation that the Critical Surface Inspection has been completed**

Once the deicing / anti-icing treatment is complete, the PIC must be advised that the deicing crew has completed the Critical Surface Inspection, and that aircraft critical surfaces are free of contamination.

The “clean aircraft concept” is facilitated, in part, by the Critical Surface Inspection, which is a pre-flight external inspection of critical surfaces conducted by a qualified person, to determine if they are contaminated by frost, ice or snow. Under ground icing conditions, this inspection is mandatory. This inspection must be accomplished upon completion of the deicing/anti-icing operation. A report shall be made to the PIC of the aircraft. The GIP must describe how this inspection will be accomplished, including the lighting conditions required to conduct the inspection.

12.6.13.2 Departure Notification for the Flight Crew

Following a deicing / anti-icing treatment of the aircraft and confirmation that the Critical Surface Inspection has been completed, and that the aircraft is free of frozen contaminants, the PIC will need the following information from the deicing crew:

- a) Confirmation that all staff and equipment are safely away from the aircraft
- b) Authorization to start engines (if applicable)
- c) Authorization to unfetter propellers (if applicable)
- d) Notification to switch to hand signals (if applicable)
- e) The PIC must be notified when it is time to depart the deicing facility.

12.7 Rotorcraft Specific Issues

Rotorcrafts are unique aircraft and the differences between them and fixed wing aircraft go beyond mere appearances.

Many of the principles expressed throughout this document are applicable to a rotorcraft. However, many fixed wing techniques for coping with ground deicing conditions do not suit a rotorcraft and in fact may cause damage to a rotorcraft.

This section of the document is intended to indicate some of the operational similarities, operational differences, operational experiences, and limitations associated with the operation of rotorcraft in ground icing conditions.

12.7.1 Regulatory Application

The operational regulations that govern aircraft operations during ground icing conditions apply to both fixed wing and rotorcraft. In particular, the “clean aircraft concept” applies to both categories of aircraft.

Subpart 602.11 of the CARs states: “No person shall conduct or attempt to conduct a take-off in an aircraft that has frost, ice or snow adhering to any of its critical surfaces”. The associated General Operating Flight Rules Standard (GOFRS 622.11), outlines the requirements of a ground icing program.

12.7.2 Aerodynamics

The principles of aerodynamics apply to both fixed and rotary winged aircraft. Contamination of an aerofoil section will result in reduced lift and an increase in drag. The manner in which these effects manifest themselves in fixed wing aircraft as compared to a rotary winged aircraft do, however, differ considerably.

It can be appreciated that small amounts of frozen contamination on a critical surface of a fixed wing aircraft can result in a significant increase in stall speed, a large increase in drag and produce serious handling difficulties. All of these effects can result in a loss of aircraft control.

Likewise, for a rotorcraft, small amounts of frozen contamination on a critical surface can result in serious performance degradation. There will be a decrease in main and tail rotor thrust, there will be an increase in main and tail rotor drag. The combinations of these effects will result in a demand for increased engine torque. There are quite likely to be handling and control issues that can result in the loss of rotorcraft control. The performance and handling effects for the same amount of contamination will likely be more serious in the rotorcraft case than in the fixed wing case; this is a qualitative notion only.

Frozen contaminants on any of the thrust generating surfaces will likely have negative consequences.

12.7.3 Operational environment

Rotorcraft parked in outside suffer from icing of aerodynamic surfaces, engine inlets and windscreens caused by frost, snow, freezing drizzle and freezing rain. Unless removed, snow and ice may linger after the precipitation ends, grounding the rotorcraft for hours or days, depending upon temperature.

12.7.4 Fluids

Accumulations of frozen precipitation are typically removed from fixed-wing aircraft using heated glycol deicing solutions. Glycol is expensive, and potentially damaging to rotorcraft rotor head components. Composite rotorcraft blades and fuselage components are susceptible to damage from deicing operations because physical impact, scraping, high temperatures, and rapid thermal cycling may cause de-lamination.

12.7.4.1 Ground icing guidance

Guidance developed under the auspices of SAE G-12 Aircraft Ground Deicing committee has mainly been in consideration of fixed wing operations, however there is a Rotorcraft Working Group that is currently in the process of developing a better understanding of rotorcraft-related ground icing issues with the goal to develop a comprehensive set of practices, principles, procedures, and guidance specific to rotorcraft.

12.7.5 Experience

The obvious and most effective method used to maintain the clean helicopter concept is to place the helicopter in a hangar whenever possible. Where operators do not have this option, other measures must be taken. Ideally the person that teaches the subtleties of helicopter deicing and winter maintenance is someone with current practical operational experience on the type of rotorcraft to be used in remote locations.

- a) The preparation for flight in a harsh environment will be a longer process than normal to maintain operational safety. Caution must be used due to slippery upper decks, and due to slippery hand and foot holds. Inspection panels or cowlings should not be forced when fouled with ice or snow, as damage could result in damaged closure mechanisms. The

- delicate balance of rotor assemblies necessitates removal of all ice and snow from all rotor systems to maintain the symmetry of rotating components.
- b) Use waterproof material covers for the main and tail rotors and transmission deck. Ideally, covers will protect the windshield, the pitot static system and a good portion of the fuselage. As well, install inlet and exhaust plugs. Install covers and plugs at the end of each day or whenever the aircraft is not scheduled for use to ensure it is protected during periods of unexpected surface contamination conditions.
 - c) The act of chipping may damage the component that you are removing ice from. Use a combustion heater with sufficient outlet hose to allow the application of heat to the transmission area, rotor components and engine compartment, and to assist in the removal of frozen covers. Thermal methods, including infrared heating and hot air, do not mechanically injure helicopter blade composites, however, they can overheat composites causing delamination and thus must be closely monitored. Consult the rotorcraft manufacturer for advice on the use of such devices.
 - d) Remove the covers and then examine the fuselage for contamination to ensure ice or snow from the covers has not fallen onto the fuselage or into engine intakes. Pooled water a by-product of preheating, has been known to cause control binding, electrical problems, drain line clogs, and many other minor problems when it reverts to the solid state during start up and flight. For this reason pooled water should be dealt with while in the liquid state.
 - e) Remove any contamination adhering to the fuselage or tail boom by any of the procedures outlined by aircraft manufacturers' recommendations. Extreme caution must be exercised for areas such as rotor blade trim tabs, Outside Air Temperature indicators, antennas, and Plexiglas windows. Do not tap thinly covered honeycomb panels to remove ice, as the result may be an expensive repair or replacement.
 - f) Free skids, wheels or any part of the landing gear that is frozen to the ground or snow cover.

12.8 Operational Control Considerations

12.8.1 General

Depending upon the type of operation and the regulation governing the operation, an operational control system may be required. The requirement for such a system is, in particular, relevant to CARs 704 (Commuter Operations) and CARs 705 (Airline Operations) operations.

“Operational Control” is defined as follows: Operational Control is the exercise of authority over the formulation, execution, and amendment of an operational flight plan in respect of a flight.

CASS 725.20 (1) General (ii) states in part...”the flight dispatcher and the PIC share responsibility for Flight Watch and shall share pertinent and related flight information and any proposed changes to the Operational Flight Plan.”

12.8.2 Regulations

CAR 704.15 and CAR 705.20, each state: “No Air Operator shall operate an aircraft unless the Air Operator has an operational control system that meets the Commercial Air Service Standards and is under the control of its operations manager.

12.8.3 Standards & Guidance

- a) CASS 723.16 “Operational Control Systems” describes the requirements of a system to satisfy CAR 703.16.
- b) CASS 724.15 “Operational Control Systems” describes the requirements of a system to satisfy CAR 704.15.
- c) CASS 725.20 “Operational Control System” describes the requirements of a system to satisfy CAR 705.20.
- d) Company Indoctrination Training: 724.115(6) (f) & 725.124(5) (f).

12.8.4 Aeroplane Surface Contamination Training

CASS 725.124(23) “Training Program” outlines the training requirements for “Aeroplane Surface Contamination Training” for all operations personnel, including dispatchers.

12.8.5 References

The following Transport Canada publications have detailed information related to Operational Control and should be referenced:

- a) TP 12513E “Study and Reference Guide – Flight Dispatchers”.
- b) TP 13498E “Generic Dispatchers Training Manual for Air Operators”.
- c) TP 13561E “Generic Operational Control Manual (Dispatcher Manual) for Air Operators”.

12.9 Freezing or Thickening of Residual Fluid in Flight

It is possible for anti-icing fluid to flow back to the trailing edge of aircraft wings after takeoff where the residual fluid can partially freeze or appear thickened. Research indicates that this can occur on a regular basis but poses no risk to safety.

Anti-icing fluids are designed in such a way that most of the fluid will flow off aircraft wings, particularly from the leading edge. The leading edge is the most aerodynamically critical section of the wing whereas its trailing edge can accrue some residual fluid and remain acceptable for safe operations.

CHAPTER 13 Environmental

13.1 Environmental Impact

A portion of the deicing fluid applied to the aircraft surfaces during deicing operations drains onto the apron surface and subsequently enters drainage runoff or percolates into subsurface soils.

Although some glycol has been found in the air and groundwater, the most significant environmental concern is associated with storm water discharges to surface waters. As glycol has a high biochemical oxygen demand (BOD), the discharge of untreated runoff containing aircraft deicing fluids into receiving waters creates an unacceptable pollution problem and a potential hazard to aquatic life.

To ensure that airport effluent does not negatively impact the environment, a number of airports throughout Canada have implemented a program of sampling and analysing storm water. Water quality programs have also been established at Local Airport Authorities and Canadian Airport Authorities. Although existing environmental legislation does not specifically require water monitoring, federal, provincial, and municipal laws do specify water quality standards and guidelines to be followed by industry.

To ensure responsible environmental management of glycol based chemicals used in deicing operations the operator, service provider and local airport authority shall prepare detailed glycol management plans and procedures.

The local or Environment Canada representative may be contacted for information on environmental issues and legislation as it applies to the deicing operation.

13.2 Environmental Standards and Guidelines

13.2.1 Canadian Environmental Protection Act Guidelines

Under the *Canadian Environmental Protection Act, 1999* (CEPA 1999) a total glycol discharge limit of 100mg/L or part per million (ppm) has been established. This is the accepted level of glycol at the discharge point into any receiving waters or surface water resulting from aircraft deicing at airports. The guidelines are applicable to all airports that are owned or operated by the federal government or located on land that is owned by the federal government.

The purpose of these guidelines is to protect human health and the environment by providing a guide for containment and treatment of storm water runoff before it enters the ecosystems. The guidelines create an environmental performance criterion, which will assist in the design and implementation of appropriate infrastructure and operational changes for aircraft deicing activities.

13.2.2 Canadian Council of Ministers of the Environment (CCME): Canadian Water Quality Guidelines

The Canadian Council of Ministers of the Environment (CCME) has prepared water quality guidelines relevant to Canadian conditions. The present water quality guidelines for the three types of glycol are 3 mg/L ethylene glycol, 31 mg/L diethylene glycol, and 74 mg/L propylene glycol. These values are subject to change and the CCME Guidelines should be checked on a regular basis (at least annually) to ensure the current figures are being used.

13.2.3 Guidelines for Effluent Quality from Federal Establishments

Degradation of glycol in water is an oxygen depleting process and this process creates problems for aquatic life if large quantities of oxygen depleting substances, such as glycol and hydrocarbons, enter a natural water body. Watercourses can become oxygen deficient and unsuitable for aquatic life. In order to protect the aquatic environment from glycol degradation, the levels for the acceptable 5 day BOD of storm water samples was set at 20mg/L by the *Guidelines for Effluent Quality and Wastewater Treatment at Federal Establishments, 1976*. These guidelines apply to all effluents discharged for land-based establishments under the direct authority of the Federal Government.

13.2.4 Fisheries Act

The intent of the *Fisheries Act* is to protect the fisheries of Canada by prohibiting activities, which could either directly, or indirectly affect fish, fish habitat, or the use of fish. The sections of the *Act*, which could affect airport operations at any airport in Canada, deal with the destruction of fish passageways, the alteration of fish habitat (Section 35) and the deposit of substances deleterious to fish (Section 36). The *Fisheries Act* stipulates penalties and fines, which may be enacted for violators of the *Act*. This *Act* is far reaching and any violation, even minor violations can have serious consequences with the potential to immediately shut down operations.

13.3 Airports Water Quality Manual

The *Transport Canada Airport Water Quality Manual, TP 12233, January 1995*, provides information concerning the variety of chemicals used for airport operations on a daily basis. Many of the common chemicals used at an airport can find their way into drainage systems and in particular storm water runoff can pick up deicing/anti-icing fluids applied to aircraft.

The Airport Water Quality Manual provides information on water quality legislation and guidelines, monitoring program establishment, sampling methods and equipment, data handling, and quality assurance/quality control, and best management practices. For further information on water quality refer to TP12233.

13.4 Reporting

The CEPA 1999 Glycol Guidelines state that yearly reports containing the results from monitoring glycol must be prepared after each deicing season. The report must be available upon request on or before September 30, following the end of the deicing season.

13.5 Effect of Deicing Fluids on the Environment

13.5.1 Biochemical Oxygen Demand (BOD)

Organic chemicals such as deicing fluids can serve as food (substrate) for micro-organisms. When aerobic bacteria oxidize organic matter, oxygen is consumed during the process. The amount of oxygen required is proportional to the amount of organic material present. As long as oxygen is available, aerobic microbial decomposition of the organic matter will continue until the oxygen demand is satisfied. That is, it will continue until the aerobic microorganisms have oxidized all of the organic material they are capable of oxidizing. The amount of oxygen used during this process is defined as the BOD.

Even if the fluid is readily biodegradable, a large discharge of any biodegradable substances could result in the reduction or depletion of dissolved oxygen levels in the receiving waterway, with the resultant adverse effect on aquatic life. Generally, low winter temperatures and increased dilution from storm water flow during periods of deicing tend to minimize adverse effects on dissolved oxygen levels and aquatic life.

13.6 Collection and Treatment of Effluent from Deicing Operations

All effluents from deicing operations shall be contained, collected and disposed of in accordance with federal, provincial and municipal regulations and guidelines. It should be noted that laws and regulations governing disposal may change. It is the responsibility of the user to assure that the treatment of the effluent is appropriate and is in compliance with legal requirements.

13.7 Glycol Management Plan

The airport operator and service provider shall prepare a Glycol Management Plan (GMP). This plan will detail the deicing operation and the methods used to prevent environmental damage from the deicing operation. The GMP shall be developed with input from the Airport Operator, the deicing service provider, and the operators using the airport, and the companies or individuals responsible for disposal of the used deicing fluid. All parties involved in the preparation of the GMP shall sign the plans.

A typical plan will as a minimum address the following issues:

- a. General information on the companies that will be operating and using the de/anti-icing facility
- b. Details of the area where the deicing operation will take place
- c. Details on the storage and handling of de/anti-icing fluids

- d. Application details including operator training
- e. How the effluent will be contained
- f. How the effluent will be treated
- g. Contingency plans for spills and accidents
- h. Safety issues
- i. De/anti-icing fluid inventory control
- j. Reporting plan - for reporting glycol use

An Emergency Response Plan (ERP) shall be developed and can be a stand-alone plan or included as part of the GMP. The ERP shall include procedures and plans to use all available resources to protect the environment in the event of an emergency, including spills, vehicle accidents involving deicing trucks, and a complete discharge of the largest holding tank at the facility.

13.8 Storage and Handling of De/anti-icing Fluids

De/anti-icing fluids shall be stored, handled and managed in accordance with the requirements detailed in the CCME Environmental Code of Practice for Above Ground and Underground Storage Tank Systems containing Petroleum and Allied petroleum Products (2003). In addition the storage, handling and management of the deicing fluids shall comply with all applicable Provincial and local codes.

CHAPTER 14 Facilities

14.1 Contracted Services

The operator's GIP, when required by the CARs, must be approved by Transport Canada. This approval is a requirement irrespective of which ground deicing and anti-icing service provider is involved. That is, whether the operator contracts out the service or whether the operator employs their own personnel to provide the service, the operator's approved GIP must be followed.

The significance of this approval is that Transport Canada approves an operator's GIP, and the operator is ultimately responsible for ensuring that the program is followed irrespective of whom they contract for elements of the program.

Transport Canada generally does not specifically approve service providers that provide a deicing and anti-icing service. The operator is responsible for ensuring that the service provider is conducting de/anti-icing operations in a safe manner and in accordance with the operator's approved GIP. Transport Canada may, however, from time to time audit these operations to ensure that the operator's GIP is being followed.

14.2 Central Deicing Facilities (CDFs)

14.2.1 General Background

A CDF is an area at an airport that has been designated to manage all deicing and anti-icing activities.

National environmental policies, programs, and concerns together with regulations and guidelines for runoff of glycol based fluids have been largely responsible for the heightened concern regarding activities that occur at Canada's airports and the possible impact that these activities may have upon the environment.

Large airports, in particular, dispense large quantities of deicing and anti-icing fluids during a typical winter icing operations season. The fluids are complex chemicals, which may have an adverse effect upon the environment surrounding the airport and on ground water quality. A mitigation plan for glycol use at airports has become part of the modern day airport management strategy. Provision for the collection of spent glycol, in the area of the deicing activity has become a requirement. See Chapter 13, Environment for further details.

14.2.2 CDF Requirements and Standards

14.2.2.1 CDF Facility Construction and Operation

The Transport Canada airport certification associated with CDFs are stated in the current version of TP312 - *Aerodrome Standards and Recommended Practices*. This document, in general, identifies visual

aids (markings, lighting and signage) required for any apron area, including a CDF. This document should be referenced for these details. Transport Canada's regional office, Aerodromes, where the airport is located should be contacted to discuss the CDF as it relates to airport certification requirements.

The verification of the CDF, as a part of an Airport's infrastructure, must follow the process that is currently used for other parts of the airport facilities.

14.2.2.2 Transport Canada Acceptance of CDF Operations

a) Regulations

There currently are no CARs that specifically address the requirements for operational approval of the services provided at CDFs.

b) Transport Canada Acceptance of Operations

The details of the Transport Canada acceptance process for CDF Operations will be contained in future guidance, which has yet to be published.

Contact Transport Canada, Commercial Flight Standards by e-mail at AARTInfoDoc@tc.gc.ca for further information with the CDF operational acceptance process.

14.2.3 Incorporation of a CDF Program into the Operator's Program

The CDF operation, when Transport Canada approved, has all of the necessary elements to provide an acceptable deicing and anti-icing service.

In the case of Transport Canada approval of a CDF deicing operation, it is understood that the service being provided by the CDF does meet the intent of the CARs and therefore should fulfill the requirements of an operator's GIP.

The Operator should, nonetheless, endeavour to ensure that the CDF is supplying an acceptable service, which meets the intent of their approved ground icing program.

There is no requirement for the entire approved ground icing program document to be carried by the pilot. The approved document should, however, contain a user friendly appendix which may be extracted by the PIC to provide the necessary information for safe CDF operations & communications.

A document with basic communication instructions, other CDF operating details, and maneuvering information, should be provided to the PIC for his reference in the cockpit. This should reduce the chance of error at the CDF and enhance safety.

CHAPTER 15 Emergencies

15.1 Introduction

The emergency planning procedures contained in this section are primarily based upon those of a major Canadian airport. The appropriate emergency procedures for each airport will vary. Consider the procedures offered in this section as pertinent suggestions. While the information will appear to be primarily focused on the service providers there are valuable suggestions that are pertinent to others.

It is understood that each deicing facility must develop detailed emergency procedures, which are suited to the types of operations at a particular airport and are in accordance with that Airport's Emergency Plan.

Deicing and anti-icing procedures, training program and logistic supporting these activities need to be well defined and reflective of the airport characteristics, the operators being served, the deicing facility characteristics, and the service provider's profile.

In addition to identifying the numerous facets of the deicing operation, it is essential that "Emergency Procedures" which are already established, by the deicing service provider, be incorporated into the Airport's Emergency Plan. Given that the possibility of an accident is always present, the importance of "Emergency Procedures" in the overall safety objective cannot be overstated.

The magnitude of the emergency procedures will vary from one airport to another depending upon the size of the operation. The emergency structure, the facilities and the services already available at the airport or in the surrounding communities, will also impact the procedures that will need to be established.

Each deicing service provider operator must develop detailed emergency procedures suited to their type of operation and which can be merged into the Airport Emergency Procedures.

15.2 Operator's Roles and Responsibilities

The emergency procedures must list the participating agencies for each type of emergency identified. The role and responsibilities of each organization must be clearly delineated such that an overall understanding of each organization's function in any given emergency situation is evident.

The service provider should have a clear and concise description of the role and responsibilities for each of the team members. The reporting structure within the organization, in accordance with each type of emergency, needs to be clearly depicted.

The organizations, which may become involved will vary from airport to airport.

The Emergency Plan should describe applicable procedures by type of emergency.

15.3 Communications

An Emergency Plan should identify the communication steps to be followed in the declaration of an emergency. Those personnel listed, as responders should be accessible under all circumstances and should be able to respond within an agreed and specified time frame.

A list of participating organizations and their representatives along with their corresponding phone numbers, or other necessary contact information, must be kept posted in key work place areas for quick reference.

15.4 Deicing Co-ordination Center

At major airports where the movements of aircraft at the deicing center are the responsibility of the service provider, all communications should be channeled through the Deicing Co-ordination Center, or equivalent.

The function, responsibilities and operation of this Center will need to be included in the Airport Operations Plan. The role of the Center in cases of an emergency will also need to be established and thoroughly documented.

15.5 Types of Emergencies

Examples of the emergencies that should be addressed in the Emergency Plan are as follows, but not limited to:

- a) Medical emergency on board the aircraft
- b) Ground equipment fire
- c) Aircraft fire
- d) Aircraft evacuation
- e) Aircraft hijacking
- f) Aircraft bomb threat
- g) Ground vehicle to aircraft contact
- h) Aircraft to aircraft contact
- i) Personnel injury
- j) Major fluid leak
- k) Other situations that may arise and which may be site specific

In case of a deicing facility control center structural fire or alarm, which requires the personnel to evacuate the building, the service provider should have a contingency plan. The plan should address the communication and operational aspects of its activities, under such circumstances, to ensure the safety of operations and the continuity of service for the period of time required to resolve the emergency and resume normal operations.

15.6 Emergency Exercises

Personnel must be thoroughly trained in their role and responsibilities for each type of emergency.

An emergency exercise should be carried out by a deicing service provider, on a regular basis during each year, which involves the various types of identified emergencies, in accordance with the Emergency Plan. The emergency exercises serve to validate the service provider's Emergency Plan and to train key personnel. Not every emergency needs to be exercised every year, however, the emergencies should be scheduled such that over a period of time all emergencies will have been exercised.

The deicing service provider should be part of an Airport Emergency Exercise held by Airport Authorities and/or Transport Canada.

A debriefing session involving all organizations involved in the emergency exercise should take place immediately after the exercise. This will serve to reveal a need to update existing procedures and will validate those procedures that were found to be adequate. Long delays after conducting an exercise, before debriefing, may result in the loss of valuable "lessons learned".

15.7 Equipment Available for a "First Response"

The service provider should have an inventory listing the equipment, which is available for use during a "first response" action to an emergency situation. The "first response" action should be laid out in the Emergency Plan.

15.8 Emergency Response

When a deicing pad related emergency occurs, it is the responsibility of the service provider to initiate the emergency response, in accordance with the Emergency Plan.

15.9 Glycol Spills

In accordance with the plan for such an event, if the fluids cannot be readily contained, the following actions should be taken:

- a) Initiate the service provider Company's Environmental Emergency procedures;
- b) Notify the Airport Emergency Centre;
- c) Deploy all available resources and equipment according to the Emergency Plan;
- d) Notify Environmental Agencies (Municipal, Provincial and Federal);
- e) Take immediate measures to mitigate the consequences of the spill and its effect on surrounding groundwater and surface/underground drainage systems;
- f) Call a company specializing in the recovery of spilled glycol for assistance; and
- g) Log all actions taken.

As a minimum when advising the authorities of the situation, include the following information:

- a) Location of the spill;
- b) Type of glycol fluid involved; and
- c) The quantities of fluid spilled.

An incident report should be completed and forwarded to the Airport Manager.

Following the emergency, the Airport Manager should schedule a meeting with all the departments and agencies involved to review the events, issue recommendations, offer improvements to procedures, or revise the emergency plan, as may be appropriate.

15.10 Aircraft Fuel Spill

When deicing personnel become aware of an aircraft fuel spill, they should immediately advise the appropriate authorities of the situation who should take action in accordance with the Emergency Plan.

Following the emergency, the Airport Manager should consider scheduling a meeting with all the departments and agencies involved to review the events, issue recommendations, offer improvements to procedures, or revise the emergency plan, as may be appropriate.

15.11 Aircraft Fire

When deicing personnel become aware of a fire at the aircraft, they must immediately advise the appropriate authority of the emergency. The coordination and control of the emergency should be accomplished in accordance with the Emergency Plan.

ATS should be advised immediately.

The PIC has the responsibility of moving the aircraft to a safe location or to evacuate the aircraft at the deicing pad. If the aircraft PIC decides to evacuate the passengers, Pad Control should direct the other aircraft away from the deicing area beginning with the aircraft adjacent to the emergency aircraft.

15.12 Deicing Building Structural Fire

The procedures should be followed in accordance with the Emergency Plan.

15.13 Aircraft Bomb Threat

The appropriate authority will advise the Airport Emergency Control Center (ECC), of the situation, who will in turn contact all of the necessary departments and agencies regarding the emergency.

Following the emergency, the Airport Manager, Aviation Services should schedule a meeting with all the departments and agencies involved to review the events, issue recommendations, offer improvements to procedures, or revise the emergency plan, as may be appropriate.

15.14 Aircraft Hijacking

Pad Control will advise the Airport Emergency Control Center (ECC) who will, in turn, contact all of the necessary departments and agencies regarding the emergency in accordance with the Emergency Plan.

15.15 Medical Emergency

Pad Control should advise ATC in accordance with the Airport Emergency Plan.

15.16 Ground Equipment Fire

Pad Control should contact the Airport Emergency Control Center (ECC) who will notify all of the necessary departments and agencies, in accordance with the Airport Emergency Plan.

Following the emergency, the Airport Manager should schedule a meeting with all the departments and agencies involved to review the events, issue recommendations, offer improvements to procedures, or revise the emergency plan, as may be appropriate.

CHAPTER 16 Due Diligence

16.1 Principle of Due Diligence

Due diligence is a defence which may be raised when someone is accused of doing something negligently or, in respect of aviation matters, if someone is accused of having contravened either a provision of the *Aeronautics Act* or a provision of the *Regulations*.

Aeronautics Act - s. 8.5 No person shall be found to have contravened a provision of this Part or of any regulation or order made under this Part if the person exercised all due diligence to prevent the contravention.

Such a measure of prudence, activity, or assiduity, as is properly to be expected from, and ordinarily exercised by, a reasonable and prudent man under the particular circumstances; not measured by any absolute standard, but depending on the relative facts of the special case.

Whether or not a person has exercised an appropriate level of care so as to be able to successfully raise the due diligence defence will always be a matter of fact and will depend on the circumstances of the situation.

CHAPTER 17 Acronyms

For the purposes of this Transport Canada publication, the following acronyms apply.

Abbreviation	Definition
AAF	Aircraft Anti-Icing Fluid
AARTF	Transport Canada, Standards Branch, Commercial Flight Standards
AC	Advisory Circular
ACARS	Aircraft Communications Addressing and Reporting System
ADF	Aircraft Deicing Fluid
AMS	Aerospace Material Specification (SAE)
AO	Operator
AOM	Aircraft Operating Manual
APU	Auxiliary power unit
ARP	Aerospace Recommended Practice (SAE)
AS	Aerospace Standard (SAE)
ASTM	American Society for Testing of Materials
ATC	Air Traffic Control
ATS	Air Traffic Services
CAR	Canadian Aviation Regulations
CASS	Commercial Air Service Standard
CFS	Commercial Flight Standards (Transport Canada)
CCME	Canadian Council of Ministers of the Environment
CDF	Centralized Deicing Facility
CEPA 1999	Canadian Environmental Protection Act, 1999
COHSR	Canadian Occupational Health and Safety Regulations
DSHOT	Degree-Specific Holdover Time
FAA	Federal Aviation Administration
FMVSS	Federal Motor Vehicle Safety Standard

FOD	Foreign Object Damage
FPD	Freezing point depressant (fluid)
GIDS	Ground Ice Detection System
GIP	Ground Icing Program
GOFRS	General Operating and Flight Rules Standard (Transport Canada)
HHET	High Humidity Endurance Test
HOT	Holdover Time
HOTDS	Holdover Time Determination System
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
LOUT	Lowest Operational Use Temperature
mm	millimeter
OAT	Outside Air Temperature
OSH	Occupational Safety and Health
pH	The acid/base rating of a fluid
PIC	Pilot-in-Command
QAP	Quality Assurance Program
SAE	Society of Automotive Engineers
SDS	Safety Data Sheet
SMS	Safety Management System
TC	Transport Canada
TP	Transport Canada Publication
U.S.	United States (of America)
UV	Ultraviolet (light)
WHMIS 2015	Workplace Hazardous Materials Information System 2015
WSET	Water Spray endurance test

CHAPTER 18 Glossary

The following definitions are presented in the context of this document only. These definitions are not necessarily intended to apply universally to other documents.

Aerodynamic Acceptance Test

Laboratory test that establish if deicing and anti-icing fluids meet flow off requirements during takeoff ground acceleration and climb.

Active Frost

Active frost is a condition when frost is forming. Active frost may occur when the aircraft surface is at or below 0° C (32° F) and at or below the frost point.

Aircraft Deicing Facility

Means a facility where:

1. Frost, snow or ice are removed (deicing) from an aircraft in order to provide clean surfaces; and/or
2. Critical surfaces of the aircraft receive protection (anti-icing) against the formation of frost or ice, or the accumulation of snow or slush for a limited period of time;
3. Fluid Storage, Equipment Maintenance, Environmental Mitigation, Control Centre programs are in place.

Aircraft Deicing Pad

A designated area on an aircraft deicing facility intended to be used for parking an aircraft to conduct deicing or anti-icing activities, consisting of an inner area for the parking of an aircraft to receive deicing/anti-icing treatment. On a CDF, the aircraft deicing pad also includes an outer area for maneuvering deicing vehicles (safe zone). The outer area provides the vehicle lane width necessary for deicing vehicles to safely perform during the deicing operation.

Air Operator

The holder of an air operator certificate.

Operator Certificate

A certificate issued under the CARs that authorizes the holder of the certificate to operate a commercial air service.

Anti-icing

Anti-icing is a precautionary procedure that provides protection against the formation of frost and/or ice and the accumulation of slush and/or snow on treated surfaces of an aircraft for a period of time during active frost, frozen precipitation, and freezing precipitation.

The application of a freezing point depressant to a surface either following deicing or in anticipation of subsequent winter precipitation is intended to protect the critical surfaces from ice adherence for a limited period of time. The fluid is capable of absorbing freezing or frozen precipitation until the fluid

freezing point coincides with the ambient temperature. Once this fluid freezing point has been reached, the fluid is no longer capable of protecting the aircraft from ground icing conditions.

Apron

Part of an aerodrome, other than the maneuvering area, intended to accommodate the loading and unloading of passengers and cargo, the refueling, servicing, maintenance and parking of aircraft, and any movement of aircraft, vehicles and pedestrians necessary for such purposes.

Centralized Deicing Facility (CDF)

A Transport Canada approved facility at an airport for the purpose of conducting deicing and anti-icing operations.

Clean Aircraft Concept

When conditions exist during ground operations that are conducive to aircraft icing, no person shall conduct or attempt to conduct a take-off in an aircraft that has frost, ice or snow adhering to any of its critical surfaces.

Cold Soaking

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

Contamination

Means any frost, ice, slush or snow that adheres to the critical surfaces of an aircraft.

Critical Surfaces

Are defined in the CARs to mean the wings, control surfaces, rotors, propellers, upper surface of the fuselage on aircraft that have rear-mounted engines, horizontal stabilizers, vertical stabilizers, or any other stabilizing surface of an aircraft. Aircraft manufacturers may designate other areas of an aircraft as critical surfaces.

Critical Surface Inspection

A critical surface inspection is a pre-flight external inspection of critical surfaces conducted by a qualified person as specified in CAR Part VI, subsection 602.11(5), to determine if they are contaminated by frost, ice, snow or slush. This inspection is mandatory whenever ground icing conditions exist and, if the aircraft is deiced/anti-iced with fluid, must take place immediately after the final, application of fluid or where an approved alternative method of deicing is used, upon completion of this process. After the inspection, a report completed by a qualified individual must be submitted to the PIC.

Critical Surface Inspection Report

This report must be made to the PIC and, if applicable, state the time at which the last full application of deicing or anti-icing fluid began, the type of fluid used, the ratio of the fluid mixture. The sequence in

which the critical surfaces were de-iced or anti-iced must be stated. In addition, the report must confirm that all critical surfaces are free of contamination.

Defrosting

The removal of frost, from an aircraft's critical surfaces, and their subsequent protection.

Deicing

Deicing is a procedure by which frost, ice, slush or snow is removed from an aircraft to render it free of contamination.

Deicing is a general term for the removal of ice, snow, slush or frost from an aircraft's critical surfaces, by mechanical means, by the use of heat, or by the use of a heated fluid or a combination thereof. When frost, snow or ice is adhering to a surface, the surface must be heated and fluid pressure used to remove the contaminant.

Flight Time

The time from the moment an aircraft first moves under its own power for the purpose of flight until the moment it comes to rest at the next point of landing.

Fluid Deicing/Anti-icing Methods

These are methods of using acceptable fluids for the removal of frozen contamination from an aircraft's critical surfaces and then for preventing the formation and/or accumulation of contamination on an aircraft for a limited period of time. The details are contained in SAE International document AS6285: "Aircraft Ground Deicing/Anti-Icing Processes".

Fluid Endurance Time

Endurance times of anti-icing fluids are measured in laboratory and field tests under specific contamination and temperature conditions using flat test plates in accordance with the SAE documents AMS1424 & AMS1428. These tests are considered to replicate the failure of fluid during aircraft operations.

Fluid Failure

Typically, in the case of snow, a layer of snow eventually accumulates on the surface of the fluid and is no longer being absorbed by the fluid. The appearance of a buildup becomes evident. There is a distinct loss of shine or gloss on the surface of the fluid. In the case of freezing precipitation, usually only a reduction in shine or gloss on the surface results, and it is particularly difficult to detect.

Forced Air Deicing Method

This is a method of deicing using a concentrated flow of air under pressure to remove frozen contamination from an aircraft; it may be used in conjunction with deicing fluids.

Freezing Point of a Fluid

The temperature at which a fluid mixture is diluted enough to freeze.

Freezing Rain

Droplets of rain that freeze immediately on contact with structures or vehicles.

Ground Ice Detection System (GIDS)

A ground ice detection system is designed to detect frozen contaminants on an aircraft. These systems can be either ground based or aircraft based systems. GIDS may be either a spot sensor or an area sensor system. If approved by Transport Canada, such a system may be used as an alternative to other inspection methods.

Ground Icing Conditions

With due regard to aircraft skin temperature and weather conditions, ground icing conditions exist when frost, ice, or snow is adhering or may adhere to the critical surfaces of an aircraft.

An Approved Ground Icing Program must specify the procedure for identifying the existence of ground icing conditions and the initiation of ground icing operations.

Ground Icing Conditions also exist when active frost, frozen or freezing precipitation is reported or observed.

Ground Icing Program

A Ground Icing Program consists of a set of procedures, guidelines, and processes, documented in manuals, which ensure that an operator's aircraft does not depart with frost, ice, snow or slush adhering to critical surfaces. This program is mandatory for CAR 705 operations and must be approved by Transport Canada.

Hail

Hail is precipitation consisting of small balls or pieces of ice with a diameter ranging from 5 mm to greater than 50 mm falling either separately or agglomerated.

High Humidity Endurance Test (HHET)

A laboratory test that measures endurance time of anti-icing fluid under conditions of high humidity. This test is intended to simulate frost conditions.

Holdover Time (HOT)

Holdover time is the estimated time that an application of anti-icing fluid is effective in preventing frost, ice, slush or snow from adhering to treated surfaces. Holdover time is calculated as the beginning with the final application of the anti-icing fluid, and as expiring when the fluid is no longer effective, as measured in endurance time tests and published in Holdover Time Guidelines".

Hoarfrost

Hoarfrost is a uniform thin white deposit of fine crystalline texture, which forms on exposed surfaces during below-freezing, calm, cloudless nights with the air at the surface close to saturation but with no precipitation. The deposit is thin enough for surface features underneath, such as paint lines, markings and lettering, to be distinguished.

Holdover Time Guidelines

Holdover Time Tables are referred to as Holdover Time Guidelines because this term more appropriately represents their function in providing guidance to flight crew and the need for the flight crew to use judgment in their interpretation.

Fluid holdover times, as published by Commercial Flight Standards, Transport Canada, are found in “Holdover Time Guidelines” as tables and may be used either as guidelines or decision-making criteria in assessing whether it is safe to take off. When holdover times are used as decision-making criteria, only the lowest time value in a cell shall be used. The procedures to be followed after the holdover time has expired must be clearly documented. The use of holdover time guidelines is mandatory if they are part of the operator’s approved ground icing program.

Ice

The solid form of water. Clear ice is often difficult to detect visually on an aircraft’s critical surfaces. It can be present in a transparent form, which may make the aircraft’s critical surfaces appear to be wet.

Icehouse

A specially equipped control center, located within a Centralized Deicing Facility, to control and monitor all operations associated with the facility.

Ice Pellets

A type of precipitation consisting of transparent or translucent pellets of ice, 5 mm or less in diameter.

They may be spherical, irregular, or (rarely) conical in shape. Ice pellets usually bounce when hitting hard ground, and make a sound upon impact.

Infrared Heat Deicing Method

This is a method of deicing using infrared (IR) thermal energy.

Lowest On-Wing Viscosity

Lowest viscosity of a fluid for which the applicable holdover time table can still be used.

Maneuvering Area

Means that part of an aerodrome to be used for the take-off, landing and taxiing of aircraft, excluding aprons.

Maximum On-Wing Viscosity

Maximum viscosity of a fluid which is still aerodynamically acceptable.

Operations Bulletins

A method of formally advising employees of procedural changes or new information related to local deicing operations.

Operator

In respect of an aircraft, means the person that has possession of the aircraft as owner, lessee or otherwise.

Pilot-In-Command (PIC)

The pilot that is responsible for the operation and safety of an aircraft during flight time.

Precipitation Rate

The rate at which precipitation is either measured or judged to be falling. Precipitation rate is a key factor in estimating the Holdover Time for an anti-icing fluid because it is the indication of moisture content.

Pre-Take-Off Contamination Inspection

A pre-take-off contamination inspection is an inspection conducted by a qualified person, immediately prior to take-off, to determine if an aircraft's critical surfaces are contaminated by frost, ice, slush or snow. This inspection is mandatory under some circumstances.

Pre-Take-Off Contamination Inspection Report

This report must be made to the PIC and must describe how the inspection was conducted. The report must also confirm that all critical surfaces are free of contamination.

Representative Surface

Aircraft representative surfaces are those surfaces which can be readily and clearly observed by flight crew during day and night operations, and which are suitable for judging whether or not critical surfaces are contaminated. Examination of one or more representative aircraft surfaces may be used for the Pre-Take-off Contamination Inspection; if a tactile examination is not required. Transport Canada must approve the use of these aircraft specific surfaces.

Service Provider

The organization providing de/anti-icing related services to operators at a given location. The service provider may be a qualified third party, another airline, or the operator. The service provider must provide a service in accordance with the operator's approved ground icing program, where such a program exists.

Slush

Partially melted snow or ice, with a high water content, from which water can readily flow.

In the ground icing environment slush may include chemicals.

Snow Grains

These are a precipitation comprised of very small white and opaque grains of ice. These grains are fairly flat or elongated; their diameter is less than 1 mm. When they hit hard ground, they do not bounce or shatter.

Snow Pellets

These are a kind of precipitation, which consists of white and opaque grains of ice. These grains are spherical or sometimes conical; their diameter is about 2-5 mm. Grains are brittle, easily crushed. They do bounce and may break on hard ground.

Specimen Sheet

A Specimen Sheet is a master list containing the signatures and the initials of employees. New hire employees are added to the sheet at the completion of training. The purpose of the Specimen Sheet is to verify an employee's signature or initials against what is recorded on the Record of Procedural Changes and other official documentation and therefore the validity of the entry.

Staging Bay

A dedicated area behind and adjacent to each deicing bay, where aircraft await approval to enter the deicing bay.

Tactile Inspection

A tactile inspection requires that a person physically contact specific aircraft surfaces. Tactile inspections, under certain circumstances, may be the only way of confirming that the critical surfaces of an aircraft are not contaminated. For some aircraft, tactile inspections are mandatory, as part of the deicing/anti-icing inspection process, to ensure that the critical surfaces are free of frozen contaminants.

Taxiway

Means a defined path on a land aerodrome established for the taxiing of aircraft and intended to provide a link between one part of the aerodrome and another.

Terminal Deicing Facility

Means a deicing facility for one or several aircraft located at or near the terminal or other location where aircraft loading activity normally takes place.

Water Spray Endurance Test (WSET)

WSET is a laboratory test that measures the endurance time of anti-icing fluids under conditions of light freezing precipitation. This test is used to classify and to certify fluids according to SAE AMS specifications.

CHAPTER 19 References

19.1 General

The references contained herein are not intended to be an exhaustive list; however, they are references considered relevant to this document and to Canadian aircraft deicing operations.

19.2 *Canada Labour Code Part II*

19.2.1 Related Documents

- a) Personal Protective Equipment - Safety Materials, Equipment, Devices and Clothing and Safety Restraining Devices Standards:
 - i. CSA Z94.1-15, Industrial Protective Headwear – Performance, selection, care, and use;
 - ii. CSA Z195-14, Protective Footwear;
 - iii. CSA Z94.3-15, Eye and Face Protectors;
 - iv. NIOSH Certified Equipment List published by the National Institute of Occupational Safety and Health;
 - v. CSA Z94.4-11, Selection, Care and Use of Respirator;
 - vi. CSA Z180.1-13, Compressed Breathing Air and Systems;
 - vii. CSA Z259.1-05 (R2010), Fall-Arresting Safety Belts and Lanyards for the Construction and Mining Industries;
 - viii. CSA Z259.2.2-14, Self-retracting Devices; and
 - ix. CSA Z259.1-05 (R2010), Body Belts and Saddles for Work Positioning and Travel Restraint.
- b) Hazardous Substances Standard

American Conference of Governmental Industrial Hygienists publication entitled 'Manual of Analytical Methods Recommended for Sampling and Analysis of Atmospheric Contaminants or the United States National Institute for Occupational Safety and Health in the NIOSH Manual of Analytical Methods, third edition, volumes 1 and 2;
- c) Materials Handling Equipment

CSA Standard Z150-16, Safety Code on Mobile Cranes.

19.3 Canadian Aviation Regulations (CARs)

19.3.1 Related Documents

TP 10643E: When-In-Doubt..., Small and Large Aircraft, Aircraft Critical Surface Contamination Training for Aircrew and Ground Crew—December 2004

- TP 13946E: The Detection of Frozen Contamination on Aircraft Surfaces—A report on behalf of the SCOUIIC Rep. Surfaces. W.G.—dated, September, 2002
- TP 13832E: Aircraft anti-icing fluid endurance, holdover, and failure times under winter precipitation conditions, a glossary of terms. , November 2001.

Remote Deicing Pad Communications and Design Review—SCOUIIC working group document, August 31, 1997

19.4 Federal Aviation Administration (FAA) Regulations (FARs)

19.4.1 Related Documents

FAA 8100.10 Document—Volume 4, Chapter 8, Section 2—Ground Deicing and Anti-icing programs.

FAA 8100.10 Document—Volume 6, Chapter 2, Section 10—Specific Types of Inspections

FAA Op Spec Job Aid for AO23

FAA AC 20-117 Hazards following ground deicing and ground operations in conditions conducive to aircraft icing. Dated 1982. (AC website:

https://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.information/documentID/22124)

FAA AC 120-60B, dated 20 December 2004: Ground deicing and anti-icing program.

FAA Document DOT/FAA/AR-00/55; History, Processing, and Usage of Recycled Glycol for Aircraft Deicing and Anti-icing. Dated February 2001.

FAA AC 135-16, Ground deicing and anti-icing training and checking. Dated 1994.

FAA AC 150/5300-14C, August 07. 2013: Design of Aircraft Deicing Facilities.

FAA AC 120-58, 30 Sept. 1992: Pilot Guide, Large Aircraft Ground Deicing.

FAA Regulation FAR 121.629; operation in icing conditions.

FAA AC 135-17; Pilot guide small aircraft ground deicing. Dated: December 14, 1994.

FAA document Safe Environmental icing aviation operations. Date October 2000.

19.5 Society of Automotive Engineers (SAE)

The SAE is involved in the production of engineering standards, recommended practices and specification documents. Originally the SAE was primarily focused on the automotive transportation sector; however, in more recent years significant effort has been expended on aerospace related activities.

One of the committees formed by SAE is committee G-12. This committee is focused on aircraft ground de/anti-icing issues. The sub-committees of G-12 include: (1) Equipment; (2) Methods; (3) Fluids; (4) Hold-Over Testing (5) Training; (6) Future Deicing Technology; and (7) Facilities.

The pertinent SAE documents are listed herein with a brief description of their contents.

19.5.1 SAE Address Information

Mailing:

CUST. SALES & SATISFACTION DEPT.

SAE

400 COMMONWEALTH DRIVE

WARRENDALE, P.A., USA

15086-9905D

Phone: 724-776-4970

FAX: 724-776-0790

Net: <http://www.sae.org>

19.5.2 SAE Ground De/anti-icing Related Documents

- a) Document name: Aircraft deicing vehicle - self-propelled.

Document type & number: ARP1971- Aerospace recommended practice.

Brief description of contents:

Covers requirements for a self-propelled, boom type aerial device, equipped with an aircraft deicing fluid spraying system.

- b) Document name: Deicing/anti-icing self-propelled vehicle functional requirements.

Document type & number: ARP4806- Aerospace recommended practice.

Brief description of contents:

Covers the general functional and performance requirements for a self-propelled, boom type aerial device equipped with an aircraft deicing/anti-icing fluid (ADF) spraying system.

- c) Document name: Enclosed Operator's cabin for aircraft ground deicing equipment.

Document type & number: ARP5058- Aerospace recommended practice.

Brief description of contents:

Covers guidelines and design requirements for an enclosed cabin for both mobile and fixed deicing equipment.

- d) Document name: Performance standard for airplane ground ice detection system, airplane/ground based.
- Document number and type: AS5116- Aerospace Standard.
- Brief description of contents:
Covers minimum performance standards for Airplane Ground Ice Detection (AGID) systems. Also, defines functional capabilities, design requirements and test procedures. The AGID system can include ground based and/or airplane mounted devices.
- e) Document name: Training and Qualification Program for Deicing/Anti-icing of Aircraft on the Ground.
- Document type & number: AS6286- Aerospace Standard.
- Brief description of contents:
Establishes the minimum training and qualification requirements for ground based aircraft deicing/anti-icing methods and procedures.
- f) Document name: Deicing/anti-icing fluid, aircraft SAE Type I.
- Document type & number: AMS1424- Aerospace Material Specification.
- Brief description of contents:
A specification for a deicing/anti-icing material in the form of a fluid.
- g) Document name: Fluid, aircraft deicing/anti-icing, non-Newtonian (pseudoplastic), SAE Type II, III and IV.
- Document type & number: AMS1428- Aerospace Material Specification.
- Brief description of contents:
A specification that addresses three types of deicing/anti-icing material, each in the form of a non-Newtonian fluid.
- h) Document name: Aircraft Ground Deicing/Anti-Icing Processes.
- Document type & number: AS6285 - Aerospace Standard.
- Brief description of contents:
This document establishes the minimum requirements for ground based aircraft deicing/anti-icing methods and procedures to ensure the safe operation of aircraft during icing conditions on the ground. This document does not specify the requirements for particular aircraft models.

- i) Document name: Forced Air or Forced Air/Fluid Equipment for Removal of Frozen Contaminants.

Document type & number: AIR6284 - Aerospace Information Report

Brief description of contents:

This document covers forced air technology including: reference material, equipment, safety, operation, and methodology. This document is intended to provide information and minimum safety guidelines regarding use of forced air or forced air/fluid equipment to remove frozen contaminants. During the effective period of this document, relevant sections herein should be considered and included in all/any relevant SAE documents.

- j) Document name: Aircraft Ground Deicing/Anti-icing Quality Management.

Document type & number: AS6332 - Aerospace Standard.

Brief description of contents:

This document defines these areas and their key aspects so they can be practically managed, and that deicing operations can become safer with time. In alignment with AS6285 and AS6286, the primary focus of this standard is on the deicing/anti-icing of aircraft using deicing and anti-icing fluids.

19.6 Other Documents

ATA MSG3—Operator/Manufacturer Scheduled Maintenance Development—Revision 2002.1

ICAO Publications:

- a) Annex 6, Part I
- b) Annex 14, Volume I
- c) Document 9157, Part 2
- d) Document 9376
- e) Document 9640-AN/940; entitled: Manual of Aircraft Ground De/anti-icing Operations.
Dated: third edition—2018