AEROSPACE INFORMATION REPORT

AIR6284™	REV. A
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(R) Forced Air or Forced Air/Fluid Equipment for Removal of Frozen Contaminants

RATIONALE

This SAE Aerospace Information Report (AIR) has been revised to include current best practices for removal of frozen contaminants with forced air or forced air/fluid equipment and restructured to improve readability and referencing of information by industry.

FOREWORD

Forced air utilizes an airstream to remove accumulations of frozen contamination from the aircraft with or without fluid. Forced air can provide the option of fluid-assisted or injection of heated or unheated fluid into or in conjunction with the airstream for removal of heavier frozen contamination.

Forced air systems (FAS) have been in development for more than 20 years. The use of forced air to remove contaminants, particularly snow, is a maturing technology with several identified benefits and efficiencies. Of particular interest to industry is the reduction in the amounts of fluid required to deice an aircraft, resulting in economic savings and environmental relief.

Through research initiatives with equipment manufacturers, regulators, and research organizations, and under the auspices of the SAE G-12 Holdover Time Committee, the industry has identified several uses of FAS in the context of aircraft ground icing. These uses include forced air alone to remove the bulk of frozen contaminants, as well as a combination of forced air with deicing or anti-icing fluids, whereby the fluid is either sprayed over or injected into the airstream.

Although the popularity of this technology continues to grow, the technology specifications and uses of the technologies have yet to be fully standardized. As such, AIR6284 provides information on the current best practices and test methods that can serve as screening indicators for compatibility of FAS technologies with deicing and anti-icing fluids and aircraft surfaces.

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1. SCOPE

This SAE Aerospace Information Report (AIR) covers forced air technology including: reference material, equipment, safety, operation, and methodology. This resource document is intended to provide information and minimum safety guidelines regarding the use of forced air or forced air/fluid equipment to remove frozen contaminants.

2. REFERENCES

2.1 Applicable Documents

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

2.1.1 SAE Publications

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

ARP 1247 Aircraft Ground Support Equipment - General Requirements

AS6285 Aircraft Ground Deicing/Anti-Icing Processes

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

2.1.2 Transport Canada Publications

Available from Transport Canada, Tower C, Place de Ville, 330 Sparks Street Ottawa, Ontario K1A 0N5, Tel: 1-800-305-2059, www.tc.gc.ca.

Transport Canada Holdover Time Guidelines (These are published every winter and available online. Always use the latest issue).

2.1.3 FAA Publications

Available from Federal Aviation Administration, 800 Independence Avenue, SW, Washington, DC 20591, Tel: 866-835-5322, www.faa.gov.

FAA Holdover Time Guidelines. (These are published every winter and available online. Always use the latest issue)

2.2 Related Publications

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

2.2.1 Technical Reports and Publications

The following technical reports and publications are available online (www.rheacanada.ca/media/aps-aviation-reports/) and provide historical information related to the research and development supported by regulators and industry into the use of forced air systems as a technology for aircraft ground deicing/anti-icing operations.

TP 12655E Forced Air Deicing Trials for the 1994-95 Winter

TP 13664E Safety Issues and Concerns of Forced Air Deicing Systems (1999-2000)

TP 13999E Three Aircraft Ground Icing Research Activities during the 2001-02 Winter

TP 14153E Endurance Times of Fluids Applied with Forced Air Systems (2002-03)

TP 14380E A Protocol for Testing Fluids Applied with Forced Air Systems (2003-04)

TP 14445E Evaluation of Type IV Fluids Applied Using Forced Air Assist Equipment (2004-05)

2.2.2 SAE Publications

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

AMS1424 Fluid, Aircraft Deicing/Anti-Icing, SAE Type I

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

ARP1971 Aircraft Deicing Vehicle - Self-Propelled

AS4828 Technical Manual Requirements for Ground Support Equipment

SAE J919 Sound Measurement - Off-Road Work Machines - Operator - Singular Type

2.2.3 ANSI Accredited Publications

Copies of these documents are available online at https://webstore.ansi.org/.

ANSI/SAIA A92.2 American National Standard for Vehicle-Mounted Elevating and Rotating Aerial Devices

2.2.4 Code of Federal Regulations (CFR) Publications

Available from United States Government Publishing Office, 732 North Capitol Street, NW, Washington, DC 20401, Tel: 202-512-1800, www.gpo.gov.

29 CFR Part 1910 Occupational Safety and Health Standards

2.2.5 CSA Publications

Available from CSA International, 178 Rexdale Boulevard, Toronto, Ontario, Canada M9W 1R3, Tel: 416-747-4000, www.csagroup.org.

CSA C-225 Vehicle-Mounted Aerial Devices

2.2.6 IATA Publications

Available from International Air Transport Association, Publications Assistant, 800 Place Victoria, P.O. Box 113, Montreal, Quebec H4Z 1M1, Canada, Tel: 1-514-874-0202, www.iata.org.

IATA AHM Airport Handling Manual

2.2.7 NFPA Publications

Available from National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471, Tel: 617-770-3000, www.nfpa.org.

NFPA 70 National Electrical Code

3. GENERAL INFORMATION ON THE USE OF FORCED AIR SYSTEMS

3.1 Background

Forced air is a modern-day refinement of various air systems used over the last 40 years in the frozen contaminant removal process. For example, auxiliary power units (mounted on a truck or cart) are and have been used worldwide since the 1960s.

Forced air utilizes an airstream to remove loose accumulations of frozen contamination from the aircraft with or without fluid. Forced air can provide the option of fluid-assisted or injection of heated or unheated fluid into or in conjunction with the airstream for removal of heavier frozen contamination. Forced air systems (FAS) could also assist in the application of anti-icing fluids when tested and approved by the carrier and manufacturer.

3.2 Limitations of Forced Air Systems

CAUTION 1: Forced air alone may not be sufficient to remove all adhering contaminants from aircraft surfaces. As such, the use of forced air may not eliminate the need for deicing. Therefore, processes must be in accordance with AS6285. Additional fluid-based deicing or contamination checks may be required. Additional information on the use of forced air alone is included in Section 4.

CAUTION 2: Forced air used in conjunction with deicing or anti-icing fluids, whereby the fluid is either sprayed over or injected into the airstream, may not eliminate the need for deicing/anti-icing. Therefore, processes must be in accordance with AS6285. Published holdover time guidelines are not applicable when using forced air/fluid applications unless it is proven for a specific piece of equipment and anti-icing fluid combination that holdover times can be used. Additional fluid-based deicing or contamination checks may be required. Additional information on the use of forced air used in conjunction with deicing or anti-icing fluids is included in Section 4.

3.3 Manufacturers

At the time of writing AIR6284, the following are industry-recognized manufacturers of FAS and related technologies:

- Global Ground Support - www.globalgroundsupport.com
- Ground Support Specialists (GSS) - www.gssonline.com
- Mallaghan Group - www.mallaghangse.com
- Oshkosh AeroTech (Formerly JBT and FMC) - www.oshkoshaerotech.com
- Textron GSE (Formerly Premier and Safaero) - www.textrongse.com
- Vestergaard Company - www.vestergaardcompany.com

NOTE: This is not an endorsement nor a certification of the technology but serves as an aid for interested parties looking to source this type of equipment for their deicing operations.

3.4 General Forced Air System Specifications

FAS are typically powered by a centrifugal air compressor and mounted on the boom of the deicer. If intended to be used with deicing/anti-icing fluid, the configuration will locate the FAS nozzle in close proximity to the deicing fluid nozzles. Table 1 provides the general ranges of technical specifications of FAS.

Table 1 - General ranges of FAS technical specifications

Parameter	Range
Air Velocity	600 to 800 mph (965 to 1287 km/h)
Air Pressure at Nozzle	4 to 15 psi
Fluid Injection Capability	0 to 20 gal/min (0 to 76 L/min)

The resulting pressure distribution that air or air-plus-fluid-injection imparts to a surface will vary depending on angle of incidence and distance from surface. Additional information on how to characterize these forces is included in Section 6.

4. POTENTIAL APPLICATIONS OF FORCED AIR IN DEICING AND ANTI-ICING PROCESSES

The following are potential applications for forced air to assist in the deicing and anti-icing processes. A summary of the potential applications of forced air and related cautions is also included in Table 2. Additional information related to methods and training procedures can be found in AS6285 and AS6286. Additional information on how to evaluate the effects of FAS on fluid performance is included in Section 5.

4.1 FAS Alone, Non-Active Precipitation

Using forced air alone to remove most of the contamination from aircraft surfaces from parked aircraft in non-active precipitation. This approach provides a means of reducing subsequent deicing times and fluid quantities. It neither attempts nor claims to provide clean aircraft surfaces for takeoff, and a thorough contamination check might be required.

4.2 FAS Alone, Prior to Deicing

Using forced air alone to remove most of the contamination from aircraft surfaces prior to deicing the aircraft. This approach provides a means of reducing subsequent deicing times and fluid quantities. It neither attempts nor claims to provide clean aircraft surfaces for takeoff.

4.3 FAS with Type I in Non-Active Precipitation

Using forced air to assist in the application of deicing fluid to clean a wing in non-active precipitation (i.e., later morning frost when ice is no longer accreting). As holdover times do not apply in this case as the precipitation is non-active (i.e., no accretion of precipitation), the condition and thickness of the fluid layer are inconsequential provided that a clean aircraft surface is produced.

4.4 FAS with Type II/III/IV Preventative Anti-Icing

Using forced air to assist in the application of anti-icing fluid on a clean aircraft surface prior to the start of forecasted freezing precipitation. The intent of this approach is to prevent ice or snow from bonding to surfaces and thereby ease the removal of contamination during later deicing. As holdover times do not apply in this case, and as the fluid is subsequently removed during the deicing operation, the condition and thickness of the fluid layer are inconsequential.

4.5 FAS with Type I, First Step of a Two-Step Type I Only Deicing/Anti-Icing

Using forced air deicing as the first step of a two-step Type I only procedure. This approach can use forced air alone or with injected Type I fluid and must satisfy two prerequisites: a clean aircraft surface must be produced, and the cleaned aircraft critical surfaces must remain uncontaminated long enough for application of the second step of Type I anti-icing fluid (without the use of forced air). The minimum interval is typically 3 minutes.

4.6 FAS with Type I, First Step of a Two-Step Deicing/Anti-Icing

Using forced air deicing as the first step of a two-step procedure. This approach can use forced air alone or with injected Type I fluid and must satisfy two prerequisites: a clean aircraft surface must be produced, and the cleaned aircraft critical surfaces must remain uncontaminated long enough for application of the second step Type II/III/IV anti-icing fluid. The minimum interval is typically 3 minutes.

4.7 FAS with Type I, Second Step Anti-Icing (DO NOT USE)

CAUTION: Using forced air deicing as a second step of a two-step procedure is currently not recommended. No procedure currently exists to evaluate HOT for Type I fluids applied with forced air. Heat is a primary contributor to HOT for Type I fluids, and forced air can lead to the diminishment of heat transfer through convection. Therefore, it is expected Type I fluids applied with forced air will not achieve published HOT. Further research is required to validate that this type of application is safe for operations.

4.8 FAS with Type II/III/IV, Second Step Anti-Icing

Using forced air to assist in the application of SAE Type II, III, or IV anti-icing fluid. This approach could be used as the second step of a two-step procedure or as an application on a clean aircraft surface for anti-icing protection. The fluid can be delivered in or on the airstream. This approach must satisfy the following prerequisite: the thickness and condition of the resultant fluid layer on aircraft surfaces must be such that Holdover Time Tables can be used.

Table 2 - Summary of potential applications of forced air and cautions

Process	Situation	Purpose	Cautions
FAS Alone	Non-active Precipitation	Used to push loose snow and ice from critical surfaces of parked aircraft in non-active precipitation.	1. Used to reduce subsequent deicing times and fluid quantities. 2. Does not provide clean aircraft surfaces for takeoff.
	Prior to Deicing	Used to push loose snow and ice from critical surfaces prior to deicing.	1. Used to reduce subsequent deicing times and fluid quantities. 2. Does not provide clean aircraft surfaces for takeoff.
FAS with Type I	Non-active Precipitation	Fluid is used heated to remove any frozen contamination.	1. As holdover times are not required in these non-active conditions, the amount of fluid remaining on the aircraft is inconsequential provided that a clean aircraft surface is produced.
	First Step of a Two-Step Type I Only Deicing/Anti-Icing	To produce an aircraft that has been deiced with heated Type I prior to subsequent Type I anti-icing.	1. A clean aircraft must be produced. 2. The aircraft must remain uncontaminated long enough for the application of the second step (generally accepted as 3 minutes).
	First Step of a Two-Step Deicing/Anti-Icing	To produce an aircraft that has been deiced with a heated fluid prior to standard anti-icing treatment with Type II/III/IV fluid.	1. A clean aircraft must be produced. 2. The aircraft must remain uncontaminated long enough for the application of the second step (generally accepted as 3 minutes).
	Second Step Anti-Icing	DO NOT USE with Type I fluid.	1. No procedure exists to evaluate Type I fluids applied with forced air for their anti-icing properties when the necessary heat is dispersed by the airstream by which it is applied.
FAS with Type II/III/IV	Preventative Anti-Icing	Use of forced air to apply Type II, III, and IV on a clean wing prior to active precipitation to assist in the later deicing process.	1. As holdover times do not apply in this case and the fluid is subsequently removed, the condition and thickness of the fluid layer is inconsequential.
	Second Step Anti-Icing	Use of forced air to assist in distribution of Type II, III, and IV fluids over the aircraft.	1. The fluid can be delivered in or on the airstream. 2. The thickness and condition of the resultant fluid layer on the aircraft surfaces must be such that holdover time tables can be used.

5. EVALUATION OF FAS EFFECTS ON FLUID PERFORMANCE

When testing of the Type I, II, III, and IV fluid applications with FAS, the operator should look for uniformity of application, sufficient thickness of anti-icing fluid, and forced air not causing excessive foam when applying deicing or anti-icing fluids. The following provides detailed evaluation criteria for the different deicing and anti-icing methods.