Jacques Leroux is Chair of the SAE G-12 Steering Group on Aircraft Ground Deicing, Co-chair of the SAE G-12 Aircraft Deicing Fluids and Runway Deicing Products Committees and Chair of the SAE/ICAO/IATA Council for Globalized Aircraft Deicing Standards. He holds a Ph.D. in Chemistry from McGill University and is a member of the Quebec Order of Chemists.

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Guide to Aircraft Ground Deicing

Issue 12 – November 2019

This Guide¹ provides an introduction to aircraft ground deicing, a brief description of the standards² published by the SAE G-12 Aircraft Ground Deicing Committee and by other SAE Committees, guidance issued by regulators, the FAA, Transport Canada, EASA and ICAO, documents issued by aircraft manufacturers (e.g., Boeing), a list of abbreviations, an index³, flowcharts for the documents and a list of preferred words and expressions.

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¹ To receive updates of this Guide to Aircraft Ground Deicing (Guide) or to send comments, please communicate with Jacques Leroux, jleroux@dow.com. This Guide is available online: <https://www.sae.org/works/committeeHome.do?comtID=TEAG12ADF>.
² This document is up-to-date as of November 15, 2019.
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Changes in Issue 12

I had planned for the next issue of the Guide to Aircraft Ground Deicing for February 2020. But, the FAA revised its Holdover Time Guidelines Winter 2019-2020 on August 19, 2019 and its guidance material as well on October 7, 2019; Transport Canada issued a Civil Aviation Safety Alert on the use of Type I on November 15, 2019. I thought it would be important readers to be aware of these changes and to update the Guide now (November 2019).

These revised documents replace the earlier published documents:

- FAA Notice N 8900.525 Revised FAA–Approved Deicing Program Updates, Winter 2019–2020
- FAA Holdover Time Guidelines Winter 2019-2020, Revision 1.0: August 19, 2019
- SAE AS5901D Water Spray and High Humidity Endurance Test Methods for SAE AMS1424 and SAE AMS1428 Aircraft Deicing/Anti-icing Fluids

The following document was indexed for the first time:

- Transport Canada, Civil Aviation Safety Alert CASA 2019-09 Use of SAE Type I Fluids as an Anti-icing Fluid, Issue 1, November 15, 2019

The following frequently asked questions were added:

- When does any SAE standard (AMS, AS, ARP, AIR) become effective?
- Does a manufacturer need to retest to all the technical requirements according the latest version of the Aerospace Material Specification (AMS)?
- Is it necessary to wait for the result of the long term stability test before selling a product according to a given AMS specification?
- Can a purchaser waive a requirement?
- Are residual fluid and fluid residue the same?

Jacques Leroux

November 20th, 2019
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Acknowledgments for Issue 12

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Special thanks are due to Stephanie Bendickson and Antoine Lacroix for providing information on the differences between the FAA and Transport Canada Holdover Time Guidelines and to Yvan Chabot for providing the Transport Canada Regression Analysis document.
### Abbreviations and Acronyms

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<td>A4A</td>
<td>Airlines for America</td>
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<tr>
<td>A4E</td>
<td>Airlines for Europe</td>
</tr>
<tr>
<td>AAF</td>
<td>aircraft anti-icing fluid</td>
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<tr>
<td>AARTF</td>
<td>Transport Canada, Standards Branch, Commercial Flight Standards</td>
</tr>
<tr>
<td>AAT</td>
<td>aerodynamic acceptance test</td>
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<tr>
<td>AC</td>
<td>Advisory Circular (FAA and Transport Canada)</td>
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<tr>
<td>ACARS</td>
<td>Aircraft Communications Addressing and Reporting System</td>
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<tr>
<td>ADF</td>
<td>aircraft deicing fluid</td>
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<tr>
<td>ADF/AAF</td>
<td>aircraft deicing/anti-icing fluid</td>
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<tr>
<td>AEA</td>
<td>Association of European Airlines</td>
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<td>AFM</td>
<td>Aircraft Flight Manual</td>
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<tr>
<td>AGIP</td>
<td>approved ground icing program (Transport Canada)</td>
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<td>AFS</td>
<td>Flight Standard Service (FAA)</td>
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<td>AIP</td>
<td>Aeronautical Information Publication</td>
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<td>AIR</td>
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<td>aka</td>
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<tr>
<td>AMC</td>
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<td>anti-oxidant</td>
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<td>Aircraft Operating Manual</td>
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<td>automated surface observing system</td>
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<td>ASR</td>
<td>airport surveillance radar</td>
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<td>above ground storage tank</td>
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<td>American Society for Testing Materials</td>
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<td>AWOS</td>
<td>Automatic Weather Observation System</td>
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<td>air traffic services</td>
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BFU Bundstelle für Flugunfalluntersuchung
BLDT boundary layer displacement thickness
BOD biochemical oxygen demand
C of C certificate of conformance
C Celsius
c circa (approximately)

CA A Civil Aviation Authority
CAAC Civil Aviation Administration of China
CAC clean aircraft concept
CAR Canadian Aviation Regulation
CASA Civil Aviation Safety Alert (Transport Canada)
CASI Civil Aviation Safety Inspector (Transport Canada)
CASS Commercial Air Service Standard (Transport Canada)
CBA Canadian Business Aviation
CBDS computer based deicing simulator
CBT computer-based training
CCME Canadian Council of Ministers of the Environment
CDF centralized deicing facility
CEPA Canadian Environmental Protection Act
CFR Code of Federal Regulations (US)
CFS Commercial Flight Standards (Transport Canada)
CLmax 3D maximum lift coefficient
CML Consumable Materials List (Airbus)
COD chemical oxygen demand
COHSR Canadian Occupational Health and Safety Regulations
CSA Canadian Standard Association
CSFF cold soaked fuel frost
CT check time
CTDS check time determination system
DAQCP Deicing/Anti-icing Quality Control Pool (IATA)
DCT data collection tool (FAA)
DDF designated deicing facility
DEG diethylene glycol
DIS deicing supervisor
DME distance measuring equipment
DO dissolved oxygen
EASA European Aviation Safety Agency
EFB electronic flight bag
EG ethylene glycol
eHOT app electronic holdover time application
eHOT electronic holdover time
e-learning electronic learning
EMB electronic message board
ERP emergency response plan
ET endurance time

4 German Federal Bureau of Aircraft Accident Investigation.
Abbreviations and Acronyms

EU European Union
EUROCAE European Organization for Civil Aviation Equipment
FAA Federal Aviation Administration, United States Department of Transportation
FAQ frequently asked questions
FAS forced air system
FBO fixed base operator
FCOM Flight Crew Operation Manual
FMH-1 Federal Meteorological Handbook No. 1, Surface Weather Observations and Reports (US)
FOD foreign object damage
FPD freezing point depressant
FMVSS Federal Motor Vehicle Safety Standard
FSDO Flight Standards District Office (FAA)
FSIMS Flight Standard Information Management System (FAA)
G-12 ADF G-12 Aircraft Deicing Fluid Committee (SAE)
G-12 AWG G-12 Aerodynamics Working Group (SAE)
G-12 DF G-12 Deicing Facility Committee (SAE)
G-12 E G-12 Equipment Committee (SAE)
G-12 FG G-12 Future Technology Committee (SAE)
G-12 HOT G-12 Holdover Time Committee (SAE)
G-12 M G-12 Methods Committee (SAE)
G-12 RDP G-12 Runway Deicing Product Committee (SAE)
G-12 RWG G-12 Rotorcraft Ground Deicing Working Group (SAE)
G-12 Steering G-12 Steering Group (SAE)
G-12 T G-12 Training and Quality Control Committee (SAE)
GAC glycerine acetate
GIDS ground ice detection system
GIP Ground Icing Program (FAA and Transport Canada)
GM Guidance Material (EASA)
GMP glycol management plan
GOFRS General Operating and Flight Rules Standards (Transport Canada)
GosNII GA State Institute of Civil Aviation (Russia)
GPU ground power unit
GRV glycol recovery vehicle
GTAA Greater Toronto Airport Authority
GUI graphical user interface
HHET high humidity endurance test
HOT holdover time
HOTDR holdover time determination report
HOTDS holdover time determination system
HOWV highest on-wing viscosity
HQ Headquarters (FAA)
HRDC Human Resources Department Canada
HSR high speed ramp
HUPR highest usable precipitation rate
IAC Interstate Aviation Committee
### Glossary

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICA</td>
<td>Instructions for Continued Airworthiness (FAA)</td>
</tr>
<tr>
<td>ICAO</td>
<td>International Civil Aviation Organization</td>
</tr>
<tr>
<td>ISO</td>
<td>International Organization for Standardization</td>
</tr>
<tr>
<td>JAR</td>
<td>Joint Aviation Authorities (European Union)</td>
</tr>
<tr>
<td>JCAB</td>
<td>Japan Civil Aviation Bureau</td>
</tr>
<tr>
<td>KAC</td>
<td>potassium acetate</td>
</tr>
<tr>
<td>KCAS</td>
<td>knots calibrated airspeed</td>
</tr>
<tr>
<td>KFOR</td>
<td>potassium formate</td>
</tr>
<tr>
<td>LAAT</td>
<td>lowest acceptable aerodynamic temperature</td>
</tr>
<tr>
<td>LOUT</td>
<td>lowest operational use temperature</td>
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<tr>
<td>LOWV</td>
<td>lowest on-wing viscosity</td>
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<tr>
<td>LUPR</td>
<td>lowest usable precipitation rate</td>
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<tr>
<td>LSR</td>
<td>low speed ramp</td>
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<tr>
<td>LWE</td>
<td>liquid water equivalent</td>
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<tr>
<td>LWES</td>
<td>liquid water equivalent system</td>
</tr>
<tr>
<td>MANOBS</td>
<td>Manual of Surface Weather Observations (Environment Canada)</td>
</tr>
<tr>
<td>METAR</td>
<td>Meteorological Terminal Aviation Routine Weather Report</td>
</tr>
<tr>
<td>METREP</td>
<td>meteorological report</td>
</tr>
<tr>
<td>MLIT</td>
<td>Ministry of Land, Infrastructure, Transportation and Tourism (Japan)</td>
</tr>
<tr>
<td>MOPS</td>
<td>minimum operational performance specification</td>
</tr>
<tr>
<td>MOWV</td>
<td>maximum on-wing viscosity&lt;sup&gt;5&lt;/sup&gt;</td>
</tr>
<tr>
<td>MSDS</td>
<td>material safety data sheet</td>
</tr>
<tr>
<td>MSR</td>
<td>mid speed ramp</td>
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<tr>
<td>NAA</td>
<td>national aviation authorities</td>
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<tr>
<td>NAAC</td>
<td>sodium acetate</td>
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<tr>
<td>NAFO</td>
<td>sodium formate</td>
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<tr>
<td>NCAR</td>
<td>National Center for Atmospheric Research</td>
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<tr>
<td>NCG</td>
<td>non-conventional glycol</td>
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<tr>
<td>NDT</td>
<td>non-destructive testing</td>
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<tr>
<td>NG</td>
<td>non-glycol</td>
</tr>
<tr>
<td>NOTAM</td>
<td>notice to airmen</td>
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<tr>
<td>NTO</td>
<td>no technical objection</td>
</tr>
<tr>
<td>NTSB</td>
<td>National Transportation Safety Board (US)</td>
</tr>
<tr>
<td>OACI</td>
<td>Organisation de l’aviation civile internationale (ICAO)</td>
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<tr>
<td>OAT</td>
<td>outside air temperature</td>
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<tr>
<td>OEM</td>
<td>original equipment manufacturer</td>
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<tr>
<td>OFA</td>
<td>object free area</td>
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<tr>
<td>OFZ</td>
<td>obstacle free zone</td>
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<tr>
<td>OOS</td>
<td>out-of-service</td>
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<tr>
<td>OSH</td>
<td>occupational safety and health</td>
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<tr>
<td>p</td>
<td>page (plural pp)</td>
</tr>
<tr>
<td>Pa</td>
<td>Pascal</td>
</tr>
<tr>
<td>PANS</td>
<td>Procedure for Air Navigation Services (ICAO)</td>
</tr>
</tbody>
</table>

<sup>5</sup> MOWV stands for maximum on-wing viscosity. HOWV stands for highest on-wing viscosity. There are synonymous. The use of HOWV is preferred because there is a risk of confusion with the MOWV which could erroneously thought of as minimum on-wing viscosity.
Abbreviations and Acronyms

par  paragraph
PG  propylene glycol
PIB  product information bulletin
PIC  pilot-in-command
POI  Principal Operations Inspector (FAA and Transport Canada)
POTW  Publicly Owned Treatment Works (US)
PPE  personal protective equipment
PRI  Performance Review Institute
PTO  power takeoff (for deicing units)
QA  quality assurance
QAP  quality assurance program
QC  quality control
QMS  quality management system
RDF  runway deicing fluid
RDIMS  records, documents, and information management system (Canada)
RDP  runway deicing product
RH  relative humidity
RI  refractive index
RMK  remark
RMSE  root mean square error
RMT  rule making task (EASA)
ROGIDS  remote on-ground ice detection systems
RPZ  runway protection zone
RSA  runway safety area
RVR  runway visibility range
s  second(s)
ss  section (plural ss)
SAE  Society of Automotive Engineers
SAIB  Special Airworthiness Information Bulletin (FAA)
SAS  Safety Assurance System (US)
SCOUIC  Standing Committee on Operations Under Icing Conditions (Transport Canada)
SD  Safety Directive (EASA)
SDS  safety data sheet
SHRP  Strategic Highway Research Program (US)
SIAGDP  Standardized International Aircraft Ground Deicing Program
SIB  Safety Information Bulletin (EASA)
SLD  supercooled large droplets
SMI  Scientific Materials International
SMS  safety management system
SNOWTAM  snow warning to airmen
SOP  standard operation procedure
SP  service provider
SPECI  aviation special weather report
STP  standard teaching plan
TAF  Terminal Aerodrome Forecast
TAT  total air temperature
TC  Transport Canada
TCCA  Transport Canada Civil Aviation
TOD  total oxygen demand
TODR  takeoff distance required
TP  Transport Canada publication
TSA  taxi safety area
TSS  total suspended solids
Type I  SAE AMS1424 Type I Aircraft Deicing/Anti-icing Fluid
Type II  SAE AMS1428 Type II Aircraft Deicing/Anti-icing Fluid
Type III  SAE AMS1428 Type III Aircraft Deicing/Anti-icing Fluid
Type IV  SAE AMS1428 Type IV Aircraft Deicing/Anti-icing Fluid
US  United States of America
UST  underground storage tank
UV  ultraviolet
v  versus
V1  takeoff decision speed
V2  takeoff safety speed
Vlof  lift-off speed
Vmu  minimum unstick speed
VOR  very high frequency omni range
Vr  rotation speed
Vs  start up velocity
Vsig  1-g stall speed
VSR  vehicle service road
VSZ  vehicle safety zone
VTP  vertical tail plane
VCS  very cold snow
VVFCS  very very cold snow
WG  Working Group (SAE)
WHMIS  Workplace Hazardous Materials Information System (Canada)
WMO  World Meteorological Organization
WSET  water spray endurance test
Introduction

Objective. Over the years, documentation on aircraft ground deicing has increased considerably. Those less familiar with the documentation, and even those familiar with the field, sometimes, find it difficult to find specific information in authoritative documentation. The purpose of this document is to index the available current documentation and make it easier to find specific information related to aircraft ground deicing.

Accidents. Accidents occur when there is a) undetected contamination, b) detected contamination but ignored, c) undetected contamination after deicing, d) fluid failure after deicing, e) engine icing after deicing (very costly), f) improper procedures and g) systemic errors. “Improper procedures” is a catch all category encompassing, for example, miscommunications. For instance, if strict communication protocols between flightcrew and ground crew are not implemented, an aircraft can start to taxi with its perimeter not clear resulting in collision with deicing vehicles. This appears innocuous, but fatalities have occurred upon collision between aircraft and deicing vehicles. Below is short description of selected key accidents which changed the way industry deals with ground deicing issues.

Air Florida Flight 90. On January 13, 1982, after a takeoff run with adhering snow and ice to the aircraft, Air Florida Flight 90 hit the 14th Street Bridge near Washington National Airport. It plunged in the Potomac River killing 69. The NTSB conclusions were:

The National Transportation Safety Board determines that the probable cause of this accident was the flightcrew’s failure to use engine anti-ice during ground operation and takeoff, their decision to take off with snow/ice on the airfoil surfaces of the aircraft, and the captain’s failure to reject the takeoff during the early stage when his attention was called to anomalous engine instrument readings. Contributing to the accident were the prolonged ground delay between deicing and the receipt of ATC takeoff clearance during which the airplane was exposed to continual precipitation, the known inherent pitchup characteristics of the B-737 aircraft when the leading edge is contaminated with even small amounts of snow or ice, and the limited experience of the flightcrew in jet transport winter operations.6

NTSB recommendation A-82-9 read as follows:

Immediately require flightcrews to visually inspect wing surfaces before takeoff if snow or precipitation is in progress and the time elapsed since either deicing or the last confirmation that the surfaces were clear exceeds 20 minutes to ensure compliance with 14 CFR121.629(b) which prohibits takeoff if ice, snow or frost is adhering to the wings or control surfaces.  

FAA’s response to recommendation A-82-9 was that reference to such a time as 20 minutes was “not in the best interest of aviation” as ice could form in shorter period.  

As a result of the Air Florida accident, R&D effort was accelerated to understand aircraft ground icing.

Two accidents in the late 1980’s and early 1990’s and the following in-depth investigations profoundly changed the way aircraft ground deicing is understood and performed.

The Dryden Accident. Air Ontario Flight 1363 Fokker F-28 aircraft crashed shortly after departure near Dryden, Ontario, on March 10, 1989. It was snowing that afternoon. The flightcrew did not request deicing. It attempted to takeoff with frozen contamination on the aircraft. Unable to gain altitude, the aircraft crashed killing 24 and injuring 69 on-board. This accident was the subject of a judicial commission of enquiry led by Justice Virgil P. Moshansky. Rather than satisfying himself with the immediate cause of the accident, pilot error, Justice Moshansky sought an understanding of the distant but effective causes of the accident. He launched what was to be a systemic approach to understanding the accident: a thorough analysis of the Canadian aviation system. He attributed the ultimate probable causes of the accident not only to pilot error but a systemic failure of the air transportation system. His recommendation number 167 reads as follows:

That Transport Canada actively participate in the research and development necessary to establish safety effectiveness measurement systems that will lead to

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7 Ibid at p 83.
8 Ibid at p 84.
9 The Honorable Virgil P. Moshansky, Commission of Inquiry into the Air Ontario Crash at Dryden, Ontario: Final Report (Ottawa, Minister of Supply and Services, 1992), online: <http://lessonslearned.faa.gov/ll_main.cfm?TabID=1&LLID=31&LLTypeID=3> [Dryden].
the most efficient use of resources in assuring safety. Cooperation with the United States Federal Aviation Administration and other international groups should be encouraged and resourced to obtain the maximum and most expedient benefits from such programs.\textsuperscript{11}

This incited Transport Canada to a) allocate significant resources to research and development, in close cooperation with the FAA, in the area of aircraft ground deicing and b) participate in the SAE G-12 Committees, resulting to the development of authoritative standards and guidance documentation. The report facilitated the use of anti-icing fluids in Canada by encouraging the regulator to provide the necessary technical evaluation and regulatory framework for their use at large airports across the country.

\textit{USAir Flight 405}. Three years after the Dryden accident, on March 22, 1992, another Fokker F-28 crashed at takeoff from LaGuardia Airport killing 27 due to ice accumulation on critical surfaces, 35 minutes following deicing with Type I fluid only. The National Transportation Safety Board, not unlike the Moshansky Inquiry, attributed probable cause of the accident to failure of the airlines industry and regulator to “to provide flightcrews with procedures, requirements, and criteria compatible with departure delays in conditions conducive to aircraft icing and the decision by the flightcrew to takeoff without positive assurance that the aircraft wings were free of ice accumulation after 35 minutes of exposure to precipitation following de-icing”.

Since 1993, use of anti-icing fluid has become much more prevalent. FAA, in cooperation with Transport Canada, has pursued vigorously the fundamental understanding of aircraft icing and the development and dissemination of guidance, such as the \textit{Holdover Time Guidelines}, and documentation related to aircraft ground deicing. FAA, like Transport Canada, exercises leadership positions in SAE G-12.

\textit{West Wind Flight 282, Fond-du-Lac, Saskatchewan}. On December 13, 2017, West Wind ATR 42 encountered icing upon descent. The aircraft was contaminated. Before takeoff, one of the pilots advised the other pilot that the aircraft had residual ice. No deicing was done. It took-off from Fond-du-Lac Airport and collided with trees 1400 feet from departure. One death. Ten serious

\textsuperscript{11} \textit{Dryden, supra} note 9 Vol. III at 1235.
injuries. A letter\textsuperscript{12} from the Transportation Safety Board of Canada to the Minister of Transport explains that even though deicing equipment was available at Fond-du-Lac, the deicing equipment was inadequate to effectively deicing an aircraft the size of an ATR-42. The letter recommends, \textit{inter alia}, to identify locations with inadequate deicing/anti-icing equipment and take corrective action at Canadian northern remote airports. The final report has not yet been issued.

\textit{Royal Air Maroc Collision at Montreal (Mirabel) Airport}. One should not think, that, in ground deicing, the only danger is frozen contamination on the aircraft. The Royal Air Maroc accident is a tragic example of what can go wrong in the deicing process itself. On January 21, 1995, the Royal Air Maroc 747-400 was parked at the deicing pad at Mirabel airport being deiced by a crew of Canadian Airlines International Ltd. The four engines were running. The flightcrew heard “dégivrage terminé” (deicing completed). The message was not intended for the flightcrew but for the deicing coordinator. The pilot attempted to communicate with the deicing crew without success. The Transportation Safety Board of Canada\textsuperscript{13} concluded that engine noise probably prevented the deicing crew from hearing the pilot. Radio-communication equipment was not designed for engines-on operations. Communications protocols with the ice crew, apron control and flightcrew were inadequate and engines-on deicing training was lacking. The perimeter of the aircraft was not clear. Two deicing vehicles were in front of the horizontal stabilizer of the aircraft. In the communication confusion, the aircraft started to taxi. It hit the deployed booms of the deicing vehicles. The deicing vehicles were overturned. The two deicing vehicle drivers sustained minor injuries. The three occupants of the deicing baskets fell from a height of 15 meters. The three sustained fatal injuries.

Near-misses have occurred at various airports since the Royal Air Maroc fatal accident.

\textit{Iberia IB 3195 Collision at Munich Airport}. In a sequence of events, uncannily similar to the Royal Air Maroc, a collision occurred at Munich airport, twenty-one years later, on January 20, 2016. The Iberia flightcrew was configuring the aircraft for deicing at a deicing pad. The copilot

\textsuperscript{12} Letter from Kathleen Fox, Chair of the TSB of Canada to The Honorable Marc Garneau, Minister of Transport, December 14, 2018, online: <http://www.tsb.gc.ca/eng/recommandations-recommendations/aviation/2018/rec-a1802-a1803.asp>

\textsuperscript{13} Transportation Safety Board of Canada, \textit{Aviation Occurrence Report, Collision with Vehicle, Royal Air Maroc Boeing 747-400 CN-RGA, Montreal (Mirabel) International Airport, Quebec, 21 January 1995}, Report Number A95Q0015, online: <http://www.bst-tsb.gc.ca/eng/rapports-reports/aviation/1995/a95q0015/a95q0015.asp>
Introduction

erroneously pushed the DISCH button on the cargo smoke panel discharging fire suppression product in the cargo hold. He should have pushed the DITCHING button on the cabin pressure panel to appropriately set the air conditioning units. With the fire suppressant discharged, the aircraft would not fly and did not need deicing anymore. The pilot conveyed to the deicing crew there was a technical problem and needed “to go back to the stand”. The ground crew understood there was a mechanical problem but did not understand the aircraft would not need deicing. There was communication confusion between the flightcrew and the deicing crew; standard phraseology was not used. Two deicing unit remained in position, ready to start deicing. Their booms were in front of the winglets. The perimeter was not clear. Iberia flight 3195 Airbus 320 began to taxi, hitting the booms, almost overturning the deicing units. No one was injured. The German Federal Bureau of Aircraft Accident Investigation (BFU)\textsuperscript{14} called it a serious accident.

\textit{Regulations.} Countries issue regulations prohibiting takeoff of aircraft contaminated with adhering frozen deposits. The regulations are enforced by National Aviation Authorities (NAA, also known as regulators) such as the United States Federal Aviation Administration (FAA)\textsuperscript{15}, Transport Canada (TC)\textsuperscript{16}, the Civil Aviation Administration of China (CAAC), the Japan Civil Aviation Bureau (JCAB) or supra national authorities such as the European Aviation Safety Agency (EASA).\textsuperscript{17}

\textit{Guidance and advisory material.} The regulations prohibiting takeoff with frozen contamination require guidance material for compliance. Guidance and advisory material are issued by the


\textsuperscript{15} United States 14 CFR § 121.629 (b) “No person may take off an aircraft when frost, ice, or snow is adhering to the wings, control surfaces, propellers, engine inlets, or other critical surfaces of the aircraft or when the takeoff would not be in compliance with paragraph (c) of this section. Takeoffs with frost under the wing in the area of the fuel tanks may be authorized by the Administrator.”, online: \url{https://www.gpo.gov/fdsys/pkg/CFR-2007-title14-vol2/xml/CFR-2007-title14-vol2-sec121-629.xml}.

\textsuperscript{16} Canadian Aviation Regulations SOR/96-433, s. 602.11 (2) “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”, online: \url{http://laws-lois.justice.gc.ca/eng/regulations/SOR-96-433/section-602.11-20140529.html}.

\textsuperscript{17} EASA CAT.OP.MPA.250 Ice and other contaminants — ground procedures
(a) The operator shall establish procedures to be followed when ground deicing and anti-icing and related inspections of the aircraft are necessary to allow the safe operation of the aircraft.
(b) The commander shall only commence take-off if the aircraft is clear of any deposit that might adversely affect the performance or controllability of the aircraft, except as permitted under (a) and in accordance with the AFM. online: \url{http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:296:0001:0148:EN:PDF}. 
regulators (e.g., EASA, FAA, Transport Canada), ICAO\textsuperscript{18}, IATA, IAC\textsuperscript{19} and aircraft manufacturers such as Boeing\textsuperscript{20} and Airbus.\textsuperscript{21}

**Holdover Time Guidelines.** SAE Type I, II, III and IV fluids, during winter operations, provide a limited period of protection against frozen or freezing precipitations while the aircraft is on the ground. The protection time can be estimated using holdover time guidelines that are published by the FAA or Transport Canada. Holdover time guidelines are derived from laboratory test or outdoor test. The holdover time guidelines published by the FAA and Transport Canada differ slightly, usually in capping of the values. Both the FAA and Transport Canada holdover time values are derived from a unique set of endurance time data which is updated every year taking into consideration the latest laboratory and outdoor tests. The FAA and Transport Canada are the only organizations publishing holdover times and they do from that single set of data.

**Standards.** Detailed standards and recommended practices, including specifications for the fluids used for aircraft deicing and anti-icing, testing procedures, qualification processes, endurance time testing, methods for deicing and anti-icing, training and quality control are published by SAE International. These documents are created, maintained and updated by experts gathering under the auspices of the SAE G-12 Aircraft Ground Deicing Committee which works in close cooperation with the regulators. The FAA, Transport Canada, and more recently EASA, fund and perform icing research. The results are presented to the SAE G-12 members.

**SAE G-12.** The SAE G-12 Aircraft Ground Deicing Committee (SAE G-12) is comprised of 1) the Steering Group, 2) the Aircraft Deicing Fluid Committee (G-12 ADF), 3) the Holdover Time Committee (G-12 HOT)\textsuperscript{22}, 4) the Methods Committee (G-12 M), 5) the Deicing Facility

\textsuperscript{19} E. Petrov et al., Methodical Recommendations: Airplane Protection from Icing Up on the Ground, Revision 3 (Moscow: IAC, September 2017), online: [link]
\textsuperscript{20} Haruiko Oda et al., “Safe Winter Operations”, (2010) Q4 Boeing Aeromagazine 6, online: [link]
\textsuperscript{21} Coming to Grips with Cold Weather Operations, AI/SRA007-01/00 (Toulouse: Airbus Industrie, 2000). For more recent information on Airbus procedures and qualified products (allowed materials) apply to Airbus for access to Airbus Aircraft Maintenance Manuals (AMM) and Consumable Materials List (CML) or raise a query with Airbus Support Engineering Department.
\textsuperscript{22} In 2016, having published all the standards it wished to publish and since activity in the field of ice detection equipment development was minimal, the G-12 Ice Detection Committee decided to become a workgroup that reports to the G-12 Holdover Time Committee until such time that ROGIDS development work becomes active again.
Committee (G-12 DF), 6) the Training and Quality Control Committee (G-12 T), 7) the Future Technology Committee (G-12 FG), 8) the Equipment Committee (G-12 E), 9) the Runway Deicing Product Committee (G-12 RDP) and 10) various \textit{ad hoc} workgroups reporting to the Committees, such as the Aerodynamics Workgroup (G-12 AWG), the Carbon Brake Oxidation Workgroup, etc. A new Rotorcraft Ground Deicing Working Group (G-12 RWG) was added in 2017.

\textit{SAE G-12 Meetings.} All the committees and workgroups that comprise the SAE G-12 Aircraft Ground Deicing Committee meet every May. Meeting locations change every year. The committees and workgroups often hold more working sessions during the year. Over the last few years, several committees have been meeting in late October or early November in Montreal, for the so-called mid-year meeting.

\textit{SAE Documents.} The documents issued by SAE G-12 fall into four categories: Aerospace Material Specification (AMS), Aerospace Recommended Practice (ARP), Aerospace Information Report (AIR) and Aerospace Standard (AS).

\textit{Global Aircraft Deicing Standards.} ICAO, national aviation authorities, (e.g., FAA, Transport Canada and EASA), SAE, and airline associations (e.g., AEA\textsuperscript{23}) have developed recommended practices for aircraft ground deicing/anti-icing with the intention of providing unified standards. Experience has shown that differences are significant enough to prevent operators from adopting any single one of the many standards published.

The issue of multiple standards became more apparent as centralized deicing facilities (CDF) started operating in many countries. For instance, in Toronto, over 80 airlines fly into a centralized facility, each attempting to impose its own standard for deicing on the staff for its own aircraft. Staff would have had to be trained for each procedure resulting in a multitude of procedures, high training costs and a complexity that added to the risk of non-compliance to the multiple procedures. Many CDF faced with impossible tasks of training its staff to many procedures, imposed their own procedures with the approval of the national regulatory authority. Flight crews must learn the

\textsuperscript{23} The Association of European Airlines (AEA) ceased its operations in December 2016. The ex-AEA deicing working group continues its work under the auspices of the Airlines for Europe (A4E).
difference between each CDF, which adds to complexity of their tasks. Service providers are being audited to different standards.

IATA approached the SAE G-12 in San Francisco in May 2011 and explained that IATA had received a mandate from its Operations Committee (OPC) comprised of the major airline members to develop globally harmonized deicing procedures. Safety and costs would be improved by the adoption of such standards.

SAE G-12 welcomed IATA’s request. IATA and SAE agreed to enter into a formal cooperation agreement. SAE and IATA became sponsors of a newly created Council for Globalized Aircraft Deicing Standards.24 At its first meeting in Montreal, on November 10, 2011, ICAO became a sponsor of the Council and entered into a formal agreement with SAE.

Necessity for harmonization was stated to be 1) the improvement of safety by reducing the chance of discrepancy between the deicing performed and the deicing expected by the flightcrew as well as simplifying communication, 2) increase in efficiency by reducing the training required by service providers, reducing the costs of airline audits, and simplifying contracts. Areas to be covered by the globalized standards were deicing/anti-icing methods, training and quality assurance.

Rather than attempting to modify the existing SAE documents, it was decided to start from scratch and create new documents, the so-called “global deicing standards”, to replace the existing SAE documents covering 1) deicing/anti-icing processes including flightcrew/ground crew communications, 2) training and 3) quality assurance.

Table 1 lists cancelled standards and corresponding new global deicing standards.

Table 1 Correspondence of Obsolete SAE Standards and Global Aircraft Deicing Standards

<table>
<thead>
<tr>
<th>Obsolete SAE Standards</th>
<th>Global Aircraft Deicing Standards</th>
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<tbody>
<tr>
<td></td>
<td>ARP6257 Flight and Ground Crew De/Anti-icing Phraseology (issued Oct. 2016)</td>
</tr>
<tr>
<td>ARP5149C Training Program Guidelines for Deicing/Anti-Icing of Aircraft on Ground</td>
<td>AS6286A Training and Qualification Program for Deicing/Anti-icing of Aircraft on the Ground</td>
</tr>
<tr>
<td>(cancelled June 19, 2019)</td>
<td>(issued June 2019)</td>
</tr>
<tr>
<td>ARP5646A Quality Program Guidelines for Deicing/Anti-Icing of Aircraft on the Ground</td>
<td>AS6332 Aircraft Ground Deicing/anti-icing Quality Management (issued August 2017)</td>
</tr>
<tr>
<td>(cancelled June 19, 2019)</td>
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</tbody>
</table>

Research Reports. APS Aviation has prepared over 100 reports related to aircraft ground deicing for Transport Canada and the FAA.25 These reports are not indexed in this Guide to Aircraft Ground Deicing.

Documentation Notification Services. The FAA and Transport Canada offer free email notification services upon publication of aircraft deicing documentation.

FAA:

Transport Canada: http://wwwapps.tc.gc.ca/Comm/5/ListServ/menu.aspx

Members of SAE G-12 receive notification of SAE standard publications. To become a member, please contact Nicole Mattern at nicole.mattern@sae.org or Jacques Leroux at jleroux@dow.com.

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25 Several reports can be found online: <https://www.rheagroup.com/aps-holdover-time-testing/aircraft-ground-icing-research/reports>.
There is no cost to be a member of SAE G-12, to receive committee minutes and review document ballots. People are encouraged to become members of SAE at minimal cost, but this is not required to be a member of SAE G-12.

_Vocabulary_. There is an effort to standardize the vocabulary in SAE G-12 documents. A lexicon of preferred words and expressions can be found under the heading “List of Preferred Words and Expressions”.

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PART ONE: THE AIRCRAFT DEICING DOCUMENTS

Figure 1 (at p 233) provides a visual representation on how the aircraft deicing documents relate to each another.

Documents Issued by SAE

Documents Issued by the SAE G-12 Aircraft Deicing Fluids Committee

AIR6232 Aircraft Surface Coating Interaction with Aircraft Deicing/Anti-Icing Fluids

Issued 2013-08-12 and reaffirmed 2019-04-02 by SAE G-12 ADF.

Aircraft operators in 2012 expressed interest in the use of after-market coatings on aircraft surfaces for various purposes, including appearance enhancement, fuel savings, and ice shedding. The coatings were designed to have hydrophilic or hydrophobic properties that could possibly interfere with the wetting, thickness, holdover time and aerodynamic properties of aircraft deicing/anti-icing fluid. AIR6232 was issued to raise the issue of the potential deleterious effects of these coatings and propose testing to evaluate the aircraft surface coating compatibility with the deicing anti-icing fluids. AIR6232 also provides descriptions of suggested test methods for evaluating aircraft surface coatings with respect to durability, hardness, weathering, aerodynamic drag, ice adhesion, ice accumulation, contact angle, and thermal conductivity. These tests can provide informational data for characterizing the coatings and may be useful to aircraft operators when evaluating the coatings.

Keywords:
advancing contact angle. See contact angle, advancing
Airbus AIMS 09-00-002, s 5
aircraft coating. See aircraft surface coating
aircraft surface coating – after-market, s Foreword at p 1
aircraft surface coating – AMS3090 weathering, s 5.1.2
aircraft surface coating – comparative endurance time test, s 3
aircraft surface coating – compatibility with aircraft surfaces, ss 5.1, 5.1.1, 5.1.2
aircraft surface coating – compatibility with cleaners, s 5.1.1
aircraft surface coating – compatibility with polishes, s 5.1.1
aircraft surface coating – compatibility with waxes, s 5.1.1
aircraft surface coating – definition, s 2.2
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aircraft surface coating – effect of acid rain on, s 5.1.4
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ARP6852C Methods and Processes for Evaluation of Aerodynamic Effects of SAE-Qualified Aircraft Ground Deicing/Anti-icing Fluids

Revised 2018-10-24 by SAE G-12 AWG and SAE G-12 ADF.

AMS1424 and AMS1428 require aircraft deicing/anti-icing fluids to comply to the aerodynamic acceptance test whose purpose is to ensure that the aerodynamic performance of all fluids is no worse than an established accepted standard; this aerodynamic acceptance test is described in detail in AS5900C. Even with successful aerodynamic acceptance qualification, there can be circumstances which require the evaluation of the aerodynamic effect of fluids on specific aircraft. ARP6852 does provide guidance for such aircraft specific evaluation.

ARP6852, prepared by the members of the G-12 Aerodynamics Working Group, describes methods known to have been used by aircraft manufacturers to evaluate specific aircraft aerodynamic performance and handling effects following application of glycol-based SAE AMS Type I, II, III or IV aircraft deicing/anti-icing fluids. Guidance and insight based upon those experiences are provided, including, similarity analyses, icing wind tunnel tests, flight tests, computational fluid dynamics and other numerical analyses.

ARP6852 further presents an historical account of the evaluation of the aerodynamic effects of fluids, including the initial work done by Boeing in the 1980s and 1990s on high speed aircraft and of de Havilland on commuter type aircraft which led to the development of the aerodynamic acceptance test described in AS5900C. ARP6852 provides an extensive bibliography on the effects of fluids on aircraft aerodynamics and reports on the methods used by Bombardier, Cessna and SAAB to evaluate the effects of fluid on their respective aircraft.

Keywords:
aerodynamic acceptance test – Boeing history, s 3.4, Appendix A
aerodynamic acceptance test – Bombardier (de Havilland) history, Appendix B
aerodynamic acceptance test – development by Boeing, s 3.4, Appendix A
aerodynamic acceptance test – development by de Havilland, Appendix B
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aerodynamic acceptance test – high and low speed ramp on Type I and Type III, s 3.3.2
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aerodynamic effect of fluids – bibliography, s 2.1.2
aerodynamic effect of fluids – compensating measures. See aerodynamic effect of fluids – performance adjustments
aerodynamic effect of fluids – critical point at maximum angle of attack, s 3.2.1
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aerodynamic effect of fluids – effect of OAT on fluid flow-off, s 3.2.1
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aerodynamic effect of fluids – effect of rotation speed, s 3.2.1
aerodynamic effect of fluids – effect of speed and time to accelerate to rotation speed, s 3.2.1
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aerodynamic effect of fluids – evaluation methods – process flow chart, s 4.1
aerodynamic effect of fluids – evaluation methods – similarity analysis, ss 4.2, 6.1
aerodynamic effect of fluids – evaluation methods – wind tunnel tests, ss 4.3, 6.1
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aerodynamic effect of fluids – on Mitsubishi YS-11, s 3.2.2
aerodynamic effect of fluids – on specific aircraft [AS6852] – subset of aerodynamic effect of fluids, Foreword at p 1
aerodynamic effect of fluids – on specific aircraft, reasons to evaluate – additional requirements beyond AAT, s 3.4
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aerodynamic effect of fluids – on specific aircraft, reasons to evaluate – report of high stick forces during rotation, s 3.4
aerodynamic effect of fluids – on specific aircraft, reasons to evaluate – report of high wheel forces during rotation, s 3.4
aerodynamic effect of fluids – on specific aircraft, reasons to evaluate – rotation speed different from AAT, s 3.4
aerodynamic effect of fluids – on specific aircraft, reasons to evaluate – takeoff acceleration different from AAT, s 3.4
aerodynamic effect of fluids – on specific aircraft, reasons to evaluate – takeoff speed corrections to compensate for lift loss caused by fluids, s 3.4
aerodynamic effect of fluids – on specific aircraft, reasons to evaluate – variation in wing design, s 3.4
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aerodynamic effect of fluids – performance adjustments – takeoff weight, s 5
aerodynamic effect of fluids – performance adjustments – takeoff technique, s 5
aerodynamic effect of fluids – performance adjustments – to ensure adequate safety margins, s 5
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aerodynamic effect of fluids – performance adjustments. See also Type II/III/IV – aircraft operational considerations
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\textsuperscript{26} AS6852C appears to use the words “transient” and “transitory” as synonyms when referring to the aerodynamic effects of fluid as in “[t]he aerodynamic effects of fluids are transitory…” (s 4.4.3.2.2) or “[c]urrent data suggests that the fluid transient behavior…” (s 3.2.1). Here we index under “transient”. 
AS5900C Standard Test Method for Aerodynamic Acceptance of AMS1424 and AMS1428 Aircraft Deicing/Anti-icing Fluids

Revised 2016-10-25 by SAE G-12 ADF.

This standard provides test methods to ensure acceptable aerodynamic characteristics of the deicing/anti-icing fluids as they flow off aircraft lifting and control surfaces during the takeoff ground acceleration and climb. AS5900C establishes the aerodynamic flow-off requirements for SAE AMS1424 Type I and SAE AMS1428 Type II, III and IV fluids used to deice and/or anti-ice aircraft.

Two aerodynamic acceptance tests are defined:

1- The high speed test simulates the takeoff of large transport jet aircraft\(^{27}\) with speeds\(^{28}\) at rotation exceeding approximately 100 knots and with time\(^{29}\) from brake release to rotation greater than 20 s. This takeoff is simulated using a “high speed ramp” where the test is performed as 65 m/s (126 knots) and a 25 s acceleration at 2.5 m/s\(^2\).

2- The low speed test simulates the takeoff of commuter turbo-prop aircraft\(^{30}\) with speeds at rotation between 60 and 100 knots and with a time from brake release to rotation between 15 and 20 s. The takeoff is simulated using a “low speed ramp” where the test is performed at 35 m/s (70 knots) and a 17 s acceleration at 2.1 m/s\(^2\).

Keywords:
- aerodynamic acceptance test – BLDT – Bernoulli equation, s 6.4.2.2
- aerodynamic acceptance test – BLDT – calculation, s 6.4.2.2
- aerodynamic acceptance test – BLDT, dry – at 35 m/s – 3.3 mm, 4 2.4.2
- aerodynamic acceptance test – BLDT, dry – at 65 m/s – 3.0 mm, s 4.2.4.1
- aerodynamic acceptance test – BLDT, ss 1, 6.2.7.4
- aerodynamic acceptance test – calibration requirements, s 4.1
- aerodynamic acceptance test – commuter aircraft, s 3.1b
- aerodynamic acceptance test – continued acceptance, s 7.4
- aerodynamic acceptance test – description, s 3.1
- aerodynamic acceptance test – facility competency, s 3.3
- aerodynamic acceptance test – facility independence from fluid manufacturer, s 3.3

\(^{27}\) Large jet transport aircraft are also known as high speed aircraft.
\(^{28}\) Takeoff rotation speed or rotation speed are also known as VR.
\(^{29}\) Time from brake release to rotation is also known as takeoff run time or ground acceleration time or brake release to VR.
\(^{30}\) Commuter turbo-prop aircraft are colloquially known as low speed aircraft.
aerodynamic acceptance test – facility independence, s 3.3
aerodynamic acceptance test – facility qualification frequency – 5 years, s 3.3
aerodynamic acceptance test – facility qualification, s 3.3
aerodynamic acceptance test – facility qualification, s 3.3
aerodynamic acceptance test – facility requirements, s 3.3, 4
aerodynamic acceptance test – fluid elimination – Type II/III/IV high speed ramp – 74%, s 6.2.10.2
aerodynamic acceptance test – fluid elimination – Type II/III/IV low speed ramp – 57%, s 6.2.10.2
aerodynamic acceptance test – fluid formulation change, ss 7.4
aerodynamic acceptance test – fluid from licensee, s 7.4
aerodynamic acceptance test – fluid property change, s 7.4
aerodynamic acceptance test – fluid residual thickness – Type I high speed ramp – 600 microns, s 6.2.10.1
aerodynamic acceptance test – fluid residual thickness – Type I low speed ramp – 400 microns, s 6.2.10.1
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aerodynamic acceptance test – high speed ramp – 2.6 m/s², ss 3.1a, 4.3.4.1.1
aerodynamic acceptance test – high speed ramp – 25 s, ss 3.1a, 4.3.4.1.1
aerodynamic acceptance test – high speed ramp – 65 m/s, ss 3.1a, 4.3.4.1.1, 6.2.7.3a
aerodynamic acceptance test – high speed ramp – acceleration, s 6.2.7.2a
aerodynamic acceptance test – high speed ramp – compensating measures for turbo prop aircraft, s 3.1b
aerodynamic acceptance test – high speed ramp – description, 3.1b
aerodynamic acceptance test – high speed ramp – description, ss 3.1a,
aerodynamic acceptance test – high speed ramp – elimination ≥ 74%, s 6.2.10.2
aerodynamic acceptance test – high speed ramp – reference fluid, ss 3.2.1
aerodynamic acceptance test – high speed ramp – speed diagram, Figure 1
aerodynamic acceptance test – high speed ramp, ss 3.1a, 4.3.4.1.1
aerodynamic acceptance test – initial testing, s 7.3.1
aerodynamic acceptance test – large transport jet aircraft, s 3.1a
aerodynamic acceptance test – licensee fluid, s 7.4
aerodynamic acceptance test – low speed aircraft – 60 to 100 knots and 15 to 20 s, s 3.1b
aerodynamic acceptance test – low speed ramp – 17 s, ss 3.1b, 4.3.4.1.2
aerodynamic acceptance test – low speed ramp – 2.1 m/s², ss 3.1b, 4.3.4.1.2
aerodynamic acceptance test – low speed ramp – 35 m/s, ss 3.1b, 4.3.4.1.2, 6.2.7.3b
aerodynamic acceptance test – low speed ramp – acceleration, s 6.2.7.2b
aerodynamic acceptance test – low speed ramp – elimination ≥ 57%, s 6.2.10.2
aerodynamic acceptance test – low speed ramp – reference fluid, s 3.2.2
aerodynamic acceptance test – low speed ramp – speed diagram, Figure 2
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aerodynamic acceptance test – report, s 9
aerodynamic acceptance test – results, s 9
aerodynamic acceptance test – retesting, ss 7.3.2
aerodynamic acceptance test – site. See aerodynamic acceptance test – facility
aerodynamic acceptance test – test duct frost, ss 6.3.2, 6.3.4.1
aerodynamic acceptance test – test fluid age < 3 months, s 5.1
aerodynamic acceptance test – test fluid final thickness, s 6.2.10
aerodynamic acceptance test – test fluid HHET, s 5.1

31 The expressions “test facility”, “facility”, “site/facility” “aerodynamic acceptance test facility” appear to be used interchangeably (ss 3.3, 4, 4.5). Section 3.3 defines qualification of the facility, associated staff and resources as technical suitability and competency.

32 There is no elimination set for Type I fluids but there is a maximum “fluid residual thickness” set for the high speed ramp and the low speed ramp.
AS5901D Water Spray and High Humidity Endurance Test Methods for SAE AMS1424 and SAE AMS1428 Aircraft Deicing/Anti-icing Fluids

Revised 2019-09-04 by SAE G-12 ADF.

The purpose of this standard is to determine the anti-icing endurance, under controlled laboratory conditions, of AMS1424 Type I and AMS1428 Type II, III, and IV fluids. AS5901D establishes a) the minimum requirements for an environmental test chamber and b) the test procedures to carry out anti-icing performance tests according to the current specification for aircraft deicing/anti-icing fluids.

Keywords:
anti-icing performance – HHET and WSET, s 3.1
edge effect. See WSET – failure zone; HHET – failure zone
HHET – air temperature (0.0°C), s 5.4.1, Table 1
HHET – air velocity, horizontal, s 5.4.1, Table 1
HHET – calibration, s 5
HHET – description, ss 3.3, 6.4
HHET – failure criteria, s 3.3
HHET – failure zone, s 3.3, Figure 1
HHET – fluid preparation, s 6.3
HHET – fluid sheared, s 6.3
HHET – fluid temperature (ambient, 15–25°C), s 6.3
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HHET – icing intensity (0.30 g/dm².h), s 4.2.2, 5.4.2, Table 1
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HHET – relative humidity (>80%), s 5.4.1, Table 1
HHET – report, s 6.6
HHET – reproducibility – Type I (20%), s 6.5
HHET – reproducibility – Type II/III/IV (10%), s 6.5
HHET – spray equipment, s 4
HHET – test chamber, ss 4.2, 4.2.2
HHET – test description, ss, 3.3, 6.4
HHET – test method, ss 3.3, 6.4
HHET – test plate cleanliness, s 6.1
HHET – test plate temperature (-5.0°C), s 5.4.1, Table 1
HHET – test plate, s 4.3
HHET – water droplet size, s 5.2.2
water droplet size – laser diffraction method, s 5.3.2
water droplet size – slide impact method with oil, s 5.3.1
WSET – air temperature (-5.0°C), s 5.4.1, Table 1
WSET – calibration, s 5
WSET – description, ss 3.2, 6.4
WSET – failure criterion, s 3.2
WSET – failure zone, s 3.2, Figure 1
WSET – fluid preparation, s 6.3
WSET – fluid sheared, s 6.3
WSET – fluid temperature (ambient, 15–25°C), s 6.3
WSET – icing intensity (5 g/dm².h), ss 4.2.1, 5.4.2, Table 1
WSET – nucleation, no, s 6.1
WSET – report, s 6.6
WSET – reproducibility – Type I (20%), s 6.5
WSET – reproducibility – Type II/III/IV (10%), s 6.5
WSET – spray equipment s 4.2.1
WSET – test chamber, ss 4.2, 4.2.1
WSET – test description, ss 3.2, 6.4
WSET – test plate cleanliness, s 6.1
WSET – test plate temperature (-5.0°C), s 5.4.1, Table 1
WSET – test plate, s 4.3
WSET – water droplet size, s 5.2.1, Table 1
AMS1424P Fluid, Aircraft Deicing/Anti-Icing, SAE Type I

Revised 2018-09-26 by SAE G-12 ADF.

AMS1424P\textsuperscript{33} sets the technical and environmental requirements and quality assurance provisions for aircraft deicing fluids (SAE Type I) that are used to remove frozen deposits from exterior surfaces of aircraft prior to takeoff. SAE Type I fluids do not contain thickeners.

AMS1424P is defined as the foundation specification for SAE Type I fluids. The SAE Type I fluids are divided into two categories: a) SAE Type I fluids based on Glycol freezing point depressants, which include Conventional Glycols and Non-conventional Glycols and b) SAE Type I fluids based on Non-glycol freezing point depressants.

SAE Type I fluids based on Conventional and Non-conventional Glycol freezing point depressants are defined and identified as AMS1424/1 (read AMS1424 slash one) Type I fluids. The purpose of the AMS1424/1 specification, which is called a category specification, is to identify the SAE Type I fluid as a glycol (conventional or non-conventional) based fluid.

*Conventional Glycols* are defined as ethylene glycol, diethylene glycol and propylene glycol.

*Non-conventional Glycols* are defined as organic non-ionic diols and triols, e.g., 1,3-propanediol, glycerine and mixtures thereof and mixtures with conventional glycols.

SAE Type I fluids based on Non-glycol freezing point depressants are defined and identified as AMS1424/2 (read AMS1424 slash two) Type I fluids. The purpose of the AMS1424/2 specification, which is called a category specification, is to identify the SAE Type I fluid as a Non-glycol based fluid.

\textsuperscript{33} Type I – compatibility with Type II/III/IV. When a Type II, III or IV fluid conforming to AMS1428 is used to perform step two in a two-step deicing/anti-icing operation, and the fluid used in step one is often a Type I fluid conforming to AMS1424, section 1.3.6 of AMS1424P explains that users must ensure that the Type I be compatible with the Type II/III/IV. A means of verification is suggested in section 6.3.3.2 of ARP4737H requiring a test be made to confirm that the combination of these fluids does not significantly reduce the WSET performance of the AMS1428 fluid. AS6285C compatibility requirement is set in section 8.7.2. FAA Notice N 8900.525 at s 13.d.(2) tells operators to make sure the Type I and Type IV are compatible by contacting the respective fluid manufacturers.
Non-glycol is defined as all that is not Glycol (Conventional and Non-conventional), such as organic salts, e.g., sodium formate, sodium acetate, potassium formate, potassium acetate and any mixtures thereof.

Mixtures of any Glycol with Non-glycol are defined as Non-glycol.

In summary, there is one foundation specification for Type I fluid, AMS1424P, and two category specifications AMS1424/1 and AMS1424/2.

A significant change brought about by AMS1424P is that colorless Type I fluids no longer fulfil the requirements of AMS1424.

Keywords:
1,3-propanediol. See Glycol, Non-conventional – 1,3-propanediol
aerodynamic acceptance test – Type I requirements, s 3.5.3
aerodynamic acceptance test. See also Type I – aerodynamic acceptance
aircraft manufacturer documentation – fluid restrictions for aircraft type and model, s 1.2.1
alkali metal salts. See also Non-glycol
AMS1424 – performance v composition of matter specification, s 3.1
AMS1424/1, ss 1.1, 1.3.6, 5.1.3
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Brix, s 3.2.4
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color, Type I – orange, s 3.1.4.1
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Conventional Glycol. See Glycol, Conventional
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definition – Glycol, Non-conventional, s 3.1.1.2
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definition – Non-glycol, s 3.1.1.2
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ethylene glycol. See also Glycol, Conventional – ethylene glycol; EG v PG
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fluid compatibility – Type I with Type II/III/IV, s 1.3.6, see footnote 33
fluid manufacturer documentation – aerodynamic acceptance data, ss 1.3.2, 3.5.3
fluid manufacturer documentation – appearance, s 3.1.4
fluid manufacturer documentation – aquatic toxicity, s 3.1.5.4, Appendix A
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fluid manufacturer documentation – flash point, s 3.2.1
fluid manufacturer documentation – fluid stability, s 3.3
fluid manufacturer documentation – freezing point v dilution data, s 1.2.2.1
fluid manufacturer documentation – freezing point, s 3.2.5
fluid manufacturer documentation – glycol, presence of recycled, s 4.4.2.1
fluid manufacturer documentation – hard water stability, s 3.3.3
fluid manufacturer documentation – HHET, s 3.5.2
fluid manufacturer documentation – LOUT for intended dilutions, s 1.2.2
fluid manufacturer documentation – LOUT, s 1.2.2
fluid manufacturer documentation – materials compatibility data, 3.4
fluid manufacturer documentation – pH limits, s 3.2.3
fluid manufacturer documentation – recycled glycol, presence of, s 4.4.2.1
fluid manufacturer documentation – refractive index limits, s 3.2.4
fluid manufacturer documentation – safety data sheet, ss 1.3.1, 4.5.2
fluid manufacturer documentation – shear stability, s 3.3.4
fluid manufacturer documentation – specific gravity, s 3.2.2
fluid manufacturer documentation – storage stability, s 3.3.1
fluid manufacturer documentation – surface tension, s 3.2.6
fluid manufacturer documentation – tendency to foam, s 3.3.5
fluid manufacturer documentation – thermal stability, s 3.3.2
fluid manufacturer documentation – trace contaminants, s 3.1.6
fluid manufacturer documentation – viscosity limits, s 3.2.7
fluid manufacturer documentation – WSET, s 3.5.2
freezing point depressant, Glycol, Conventional and Non-Conventional, s 3.1.1
freezing point depressant, Glycol, Conventional, ss 3.1.1, 3.1.1.1
freezing point depressant, Glycol, Non-conventional, ss 3.1.1, 3.1.1.2
freezing point depressant, Non-glycol, ss 3.1.1, 3.1.1.3, 3.1.3
glycerine. See Glycol, Non-conventional – glycerine
Glycol – definition, s 3.1.1.1
Glycol, Conventional – definition, s 3.1.1.1
Glycol, Conventional – diethylene glycol, s 3.1.1.1
Glycol, Conventional – ethylene glycol, s 3.1.1.1
Glycol, Conventional – propylene glycol, s 3.1.1.1
Glycol, Conventional and Non-conventional – definition, s 3.1.1
glycol, Non-. See Non-glycol
Glycol, Non-conventional – 1,3-propanediol, s 3.1.1.2
Glycol, Non-conventional – definition, s 3.1.1.2
Glycol, Non-conventional – glycerine, s 3.1.1.2
Glycol, Non-conventional – organic non-ionic diols and triols, mixtures of, s 3.1.1.2
Glycol, Non-conventional – organic non-ionic diols and triols, mixtures with Conventional Glycol, s 3.1.1.2
Glycol, Non-conventional – organic non-ionic diols and triols, s 3.1.1.2
glycol, recycled. See Type I – recycled glycol
HHET – Type I – 20 minutes minimum, s 3.5.2
lot – Type I – definition, s 4.3
Non-conventional Glycol. See Glycol, Non-conventional
Non-glycol – definition, s 3.1.1.3
Non-glycol – organic salts mixtures with Glycol, s 3.1.1.3
Non-glycol – organic salts, mixtures of, s 3.1.1.3
Non-glycol – potassium acetate, s 3.1.1.3
Non-glycol – potassium formate, s 3.1.1.3
Non-glycol – sodium acetate, s 3.1.1.3
Non-glycol – sodium formate, s 3.1.1.3
propylene glycol. See also Glycol, Conventional – propylene glycol; EG v PG
recycled glycol. See Type I – recycled glycol
specification, category, ss 1.1, 1.1.1
Dilutions of concentrate SAE Type I aircraft deicing fluid are normally given by volume, the first number being the volume percent of the concentrate fluid and the second number the volume of water. For example, a 70/30 mixture would be 70 parts by volume of the concentrate SAE Type I fluid mixed with 30 parts by volume of water.

AMS1424 refers to initial thickness and final thickness of the fluid in the aerodynamic acceptance test. AMS1428 refers to fluid elimination. The notions are related in that they attempt to quantify the quantity of fluid that is eliminated during the acceleration run.
Type I – corrosion, stress-, s 3.4.4
Type I – crawling, s 1.3.7
Type I – drums, ss 5.1.2, 5.1.5, 8.4
Type I – effect on aircraft materials, s 3.4
Type I – environmental information, s 3.1.5
Type I – exposure, human, s 1.3.1
Type I – field test with deicing unit, s 1.3.7
Type I – film breaks, s 1.3.7
Type I – fire hazard – circuit breakers, s 1.3.4
Type I – fire hazard – direct current, s 1.3.4
Type I – fire hazard – glycol, ss 1.3.4, 3.1
Type I – fire hazard – inhibitor, ss 1.3.4, 3.1
Type I – fire hazard – noble metal coated wiring, ss 1.3.4, 3.1
Type I – fire hazard – silver coated wiring, ss 1.3.4, 3.1
Type I – fire hazard – switches, electrical, s 1.3.4
Type I – fisheyes, s 1.3.7
Type I – flash point, minimum, ss 1.3.3, 3.2.1
Type I – flash point, ss 1.3.3, 3.2.1
Type I – fluid manufacturer to report – all technical requirement results, s 4.5
Type I – fluid manufacturer to report – recycled glycol, presence of, s 4.4.2.1
Type I – fluid manufacturer to report – recycled glycol, source of, s 4.4.2.1
Type I – foam, tendency to, s 3.3.5
Type I – foreign matter, free from, s 3.1.4
Type I – freezing point buffer, s 1.2.2.1
Type I – freezing point curve, s 3.5.1
Type I – freezing point depressant, non-glycol, s 3.1.1
Type I – freezing point of 50/50 dilution, ss 3.2.5, 3.5.1
Type I – freezing point of concentrate form, s 3.2.5.
Type I – freezing point of ready-to-use form, s 3.5.1.1
Type I – Glycol (Conventional and Non-conventional) based fluid – technical requirements, s 3.1.2.1
Type I – Glycol (Conventional) based fluid – technical requirements, s 3.1.2.1
Type I – Glycol (Conventional) based fluid, ss 1.1.1, 3.1.1, 3.1.1.1, 3.1.2.1
Type I – Glycol (Non-conventional) based fluid – technical requirements, s 3.1.2.1
Type I – Glycol based fluid, ss 1.1.1, 3.1.1. 3.1.1.1
Type I – halogens as contaminant, s 3.1.6
Type I – hard water stability, s 3.3.3
Type I – HHET – sample sheared, s 3.5.2
Type I – HHET, s 3.5.2
Type I – hydrogen embrittlement, s 3.4.5
Type I – label – AMS1424/1 or AMS142/2, s 5.1.3
Type I – label – lot number, s 5.1.3
Type I – label – manufacturer’s identification, s 5.1.3
Type I – label – purchase order number, s 5.1.3
Type I – label – quantity, s 5.1.3
Type I – label, ss 4.1, 5.1.3, 5.1.4, 5.1.5
Type I – lead as contaminant, s 3.1.6
Type I – lot acceptance tests, s 4.2.1, 4.3.3
Type I – lot number, s 4.1
Type I – lot rejection, s 4.6
Type I – LOUT – definition, s 1.2.2.1
Type I – LOUT of dilutions, s 1.2.2
Type I – LOUT reporting requirement, s 1.2.2
Type I – LOUT, fluid manufacturer obligation to report, s 1.2.2
Type I – lumps, free from, s 3.1.4
Type I – matter, free from, s 3.1.4
Type I – mercury as contaminant, s 3.1.6
Type I – mixing of fluids from different manufacturers, s 1.3.6
Type I – mold growth, s 3.1
Type I – nitrate as contaminant, s 3.1.6
Type I – nitrogen as contaminant, total, s 3.1.6
Type I – Non-glycol based – technical requirement, additional, ss 3.1.1.2, 3.1.3
Type I – Non-glycol based – technical requirements, s 3.1.2.2
Type I – Non-glycol based, ss 1.1.1, 3.1.1, 3.1.1.3, 3.1.2.2, 3.1.3
Type I – painted surface, effect on, s 3.4.7
Type I – particulate contamination, s 3.1.4
Type I – performance properties, s 3.5
Type I – pH, s 3.2.3,
Type I – phosphorus as contaminant, s 3.1.6
Type I – physical properties, s 3.2
Type I – polycarbonate, effect on, s 3.4.6.2
Type I – precautions, s 1.3
Type I – purchase order, ss 6, 8.4
Type I – qualification results, initial – comparison to subsequent results36, s 4.5.1
Type I – qualification, initial – what: all technical requirement, s 4.2.2
Type I – qualification, initial – when: change in ingredients, s 4.2.2
Type I – qualification, initial – when: change in processing, s 4.2.2
Type I – qualification, initial – when: confirmatory testing, s 4.2.2
Type I – qualification, initial – when: prior to first shipment, s 4.2.2
Type I – qualification, initial37, s 4.2.2
Type I – qualification, multiple location – different from original location, s 4.4.3.1
Type I – qualification, multiple location – same as original location, s 4.4.3.2
Type I – qualification, multiple location – when: once, s 4.4.3.3
Type I – qualification, multiple location, s 4.4.3
Type I – qualification, periodic re- – comparison to initial qualification, s 4.5.1
Type I – qualification, periodic re- – failures, maximum 2, 4.6
Type I – qualification, periodic re- – failures, reporting of, s 4.6
Type I – qualification, periodic re- – what: aerodynamic acceptance, s 4.2.3
Type I – qualification, periodic re- – what: WSET and HHET, s 4.2.3
Type I – qualification, periodic re- – when: 2 years and 4 years thereafter, s 4.2.3
Type I – quality assurance, s 4
Type I – recycled glycol – contaminants, s 4.4.2.1
Type I – recycled glycol – obligation to report presence of, s 4.4.2.1
Type I – recycled glycol – obligation to report source of, s 4.4.2.1
Type I – recycled glycol – quality assurance, s 4.4.2.1
Type I – recycled glycol – source of, s 4.4.2.1

36 In section 4.5.1 “subsequent reports” are defined as the periodic requalification reports. Presumably, the multiple site qualification reports should also be subject to the product consistency check of section 4.5.1.
37 AMS1424P lists three kinds of qualification (my understanding): 1) initial qualification (s 4.2.2), 2) periodic requalification (s 4.2.3) and 3) multiple site qualification (4.4.3). What tests? Initial qualification – all technical requirements; periodic qualification – aerodynamic acceptance, WSET and HHET; multiple site, if methods, materials and handling is different from original site – all technical requirements; multiple site, if same methods, materials and handling as the original site – aerodynamic acceptance, WSET and HHET. When? Initial qualification – prior to first shipment; periodic qualification – for non-recycled and recycled glycols after two years and every 4 years thereafter [AMS1424M required testing every 2 years for recycled glycol]; multiple site – after the first multiple site qualification, there no requirement for further testing at that site, unless there is a change in method, materials or handling.
Type I – refraction, s 3.2.4
Type I – refractive index, s 3.2.4
Type I – rejection, ss 4.6, 7
Type I – reports by independent facilities, ss 4.1, 4.2.3, 4.5
Type I – requalification. See Type I – qualification, periodic re-
Type I – Right to Know Regulation (US), s 5.1.4
Type I – runway concrete resistance, s 3.4.9
Type I – safety data sheet, ss 1.3.1, 4.5.2
Type I – same ingredients, s 4.4.2
Type I – same manufacturing procedures, s 4.4.2
Type I – same methods of inspection, s 4.4.2
Type I – sampling, bulk shipments, s 4.3.1
Type I – sampling, drum shipments, s 4.3.2
Type I – sampling, statistical, s 4.3.5
Type I – sampling, tote shipments, s 4.3.2
Type I – shear, resistance to, s 3.3.4
Type I – skins, free from, s 3.1.4
Type I – slipperiness, s 1.3.5
Type I – specific gravity, s 3.2.2
Type I – specification – AMS1424, Title at p 1
Type I – stability, hard water, s 3.3.3
Type I – stability, storage, s 3.3.1
Type I – stability, thermal, s 3.3.2
Type I – storage stability, s 3.3.1
Type I – sulfur as contaminant, s 3.1.6
Type I – surface tension, s 3.2.6
Type I – suspended matter, s 3.1.4
Type I – testing, autonomous facilities, s 4.2.3
Type I – testing, confirmatory, ss 4.1, 4.2.2
Type I – testing, independent facilities, ss 4.1, 4.2.3, 4.5
Type I – testing, independent laboratories 38, ss 4.1, 4.2.3, 4.5
Type I – thermal stability, s 3.3.2
Type I – thickeners, free from, s 3.1
Type I – totes, ss 4.3.2, 5.1.2, 5.1.5
Type I – transparent plastics, effect on, s 3.4.6
Type I – transportation, s 5.1.5
Type I – unpainted surface, effect on, s 3.4.8
Type I – use of concentrate form, s 1.3.2
Type I – use of dilution, s 1.3.2
Type I – water, composition of hard, s 3.3.3.1
Type I – water, soft, s 3.3.3
Type I – wetting, s 1.3.7
Type I – WSET – 3 minutes minimum, s 3.5.2
Type I – WSET – sample sheared, s 3.5.2
Type I Glycol – (Conventional and Non-conventional) based fluid, ss 1.1.1, 3.1.1, 3.1.2.1
Type II/III/IV – compatibility with Type I, s 1.3.6, see footnote 33
WSET – Type I – 3 minutes minimum, s 3.5.2

38 AMS1424P uses the various terms with apparently similar meaning: “independent laboratory” (s 4.1), “independent facility” (s 4.2.3), “autonomous test facility” (s 4.2.3), “independent testing facilities” (s 4.5). The term facility encompasses laboratory.
**AMS1424/1 Deicing/Anti-Icing Fluid, Aircraft SAE Type I Glycol (Conventional and Non-Conventiona**

Issued 2016-04-18 by SAE G-12 ADF.

SAE Type I fluids based on Conventional and Non-conventional Glycol freezing point depressants are defined and identified as AMS1424/1 (read AMS1424 slash one) Type I fluids. The purpose of the AMS1424/1 specification, which is called a category specification, is to identify the SAE Type I fluid as a Glycol (Conventional or Non-conventional) based fluid. For further information read the description for AMS1424P.

**Keywords:**
AMS1424/1, Title at p 1
category specification, s 1.1.1
foundation specification, s 1.1.1
freezing point depressant – Glycol, Conventional, s.1.1.1
freezing point depressant – Glycol, Non-conventional, s 1.1.1
freezing point depressant – Glycol, s 1.1.1
freezing point depressant – Non-glycol, s 1.1.1
Glycol, Conventional, s 1.1.1
Glycol, Non-conventional, s 1.1.1
specification, category, s 1.1.1
specification, foundation, s 1.1.1
Type I – Glycol (Conventional and Non-conventional) based fluid, Title at p 1, s 1.1.1
Type I – Glycol (Conventional) based fluid, s 1.1.1
Type I – Glycol (Non-conventional) based fluid, s 1.1.1
Type I – specification – AMS1424/1, Title at p 1

**AMS1424/2 Deicing/Anti-Icing Fluid, Aircraft SAE Type I Non-Glycol Based**

Issued 2016-05-05 by SAE G-12 ADF.

SAE Type I fluids based on Non-glycol freezing point depressants are defined and identified as AMS1424/2 (read AMS1424 slash two) Type I fluids. The purpose of the AMS1424/2 specification, which is called a category specification, is to identify the SAE Type I fluid as a Non-glycol based fluid. For further information read the description for AMS1424P.

**Keywords:**
AMS1424/2, Title at p 1
category specification, s 1.1.1
foundation specification, s 1.1.1
freezing point depressant – Non-glycol, s 1.1.1
specification, category, s 1.1.1
specification, foundation, s 1.1.1
AMS1428K Fluid, Aircraft Deicing/Anti-Icing, Non-Newtonian, SAE Types II, III, and IV

Revised 2018-10-24 by SAE G-12 ADF.

AMS1428 sets the technical requirements for deicing/anti-icing fluids (SAE Type II, III and IV) that are used to protect aircraft surfaces against freezing or frozen precipitation for a certain but limited period prior to takeoff. These fluids contain thickeners giving shear thinning properties to the fluids. In other words, the thickeners selected for these fluids are such that viscosity of the thickened fluid decreases when a shear strain is applied to the fluid. SAE Type II, III and IV are often known as thickened anti-icing fluids.

AMS1428 is defined as the foundation specification for SAE Type II, III and IV fluids. The SAE Type II, III and IV fluids are divided into two category specifications: a) SAE Type II/III/IV fluids based on Glycol freezing point depressants, which include Conventional Glycols and Non-conventional Glycols and b) SAE Type II/II/IV fluids based on Non-glycol freezing point depressants.

SAE Type II/II/IV fluids based on Conventional and Non-conventional Glycol freezing point depressants are defined and identified as AMS1428/1 (read AMS1428 slash one) Type II/III/IV fluids. The purpose of the AMS1428/1 specification, which is called a category specification, is to identify the SAE Type II/III/IV fluid as a Glycol (Conventional or Non-conventional) based fluid.

*Conventional Glycols* are defined as ethylene glycol, diethylene glycol and propylene glycol.

*Non-conventional Glycols* are defined as organic non-ionic diols and triols, e.g., 1,3-propanediol, glycerine and mixtures thereof and mixtures with conventional glycols.

SAE Type II/II/IV fluids based on Non-glycol freezing point depressants are defined and identified as AMS1428/2 (read AMS1428 slash two) Type II/III/IV fluids. The purpose of the AMS1428/2 specification, which is called a category specification, is to identify the SAE Type II/III/IV fluid as a Non-glycol based fluid.
Non-glycol is defined as all that is not Glycol (Conventional and Non-conventional), such as organic salts, e.g., sodium formate, sodium acetate, potassium formate, potassium acetate and any mixtures thereof.

Mixtures of any Glycol with Non-glycol are defined as Non-glycol.

In summary, there is one foundation specification for Type II/III/IV fluids, AMS1428K, and two category specifications AMS1424/1 and AMS1424/2.

Holdover Time Guidelines. SAE Type II, III and IV fluids, during winter operations, provide a limited period of protection against frozen or freezing precipitations while the aircraft is on the ground. The protection time can be estimated using fluid-specific holdover time guidelines that are published by the FAA or Transport Canada.

Commercialization Readiness. For fluid manufacturers wishing to commercialize a Type II/II/IV, it should be noted that it is insufficient to meet all the requirements of AMS1428K to be able to use such fluids on aircraft. The fluids must be on the list of qualified fluid published by the FAA or Transport Canada, obtain holdover time guidelines, also published by the FAA and Transport Canada, and preferably, perform full scale spray test. This process to prepare for commercialization of SAE Type II/III/IV fluids is described in ARP5718A.

Keywords:
1,3-propanediol. See Glycol, Non-conventional – 1,3-propanediol
aerodynamic acceptance test – Type II/III/IV requirement, s 3.2.5.2
aerodynamic acceptance test. See also Type II/III/IV – aerodynamic acceptance
alkali metal salts. See also Non-glycol
AMS1428 – performance v composition of matter specification, s 3.1
AMS1428/1, ss 1.1.1, 2.1.1
AMS1428/2, ss 1.1.1, 2.1.1
anti-icing performance39, s 3.2.4.1
Brix 40, s 3.2.1.4
Brookfield LV viscometer. See viscometer, Brookfield LV
Buehler test41, s 3.2.2.4, Appendix A
color uniformity, s 3.1.5
color, Type II – yellow, s 1.1.2
color, Type III – bright yellow, s 1.1.2

39 Anti-icing performance, as defined in AMS1428 (latest version), is comprised of WSET and HHET.
40 Brix is a unit of refraction. A table of conversion from Brix to index of refraction is available in Robert C. Weast, ed, Handbook of Chemistry and Physics, 49th ed (Cleveland OH, Chemical Rubber Co., 1968-1969) at E-225.
41 The successive dry-out and rehydration test is sometimes referred to as the Buehler test after Mr. Rolf Buehler who developed it.
color, Type IV – green, s 1.1.2
Conventional Glycol. See Glycol, Conventional
definition – fluid, non-Newtonian, s 1.1.3
definition – fluid, pseudoplastic, s 1.1.4
definition – Glycol, Conventional and Non-conventional, s 3.1.1
definition – Glycol, Conventional, s 3.1.1.1
definition – Glycol, Non-, s 3.1.1.3
definition – Glycol, Non-conventional, s 3.1.1.2
definition – Glycol, s 3.1.1.1
definition – HOWV, s 4.2.3.1 42
definition – lot, Type II/III/IV, s 4.3
definition – LOUT, Type II/III/IV, s 1.3.1
definition – Non-glycol, s 3.1.1.3
definition – pseudoplastic, s 1.1.4
fluid commingling. See Type I – commingling; Type II/III/IV commingling
fluid manufacturer documentation – aerodynamic acceptance data, ss 1.1.2, 3.2.5.2
fluid manufacturer documentation – aquatic toxicity, s 3.1.4
fluid manufacturer documentation – biodegradability, s 3.1.6.3
fluid manufacturer documentation – BOD, s 3.1.6.1
fluid manufacturer documentation – cold storage stability, 3.2.2.10
fluid manufacturer documentation – dry-out exposure to cold dry air, s 3.2.2.3
fluid manufacturer documentation – exposure to dry air, s 3.2.2.2
fluid manufacturer documentation – flash point, s 3.2.1.1
fluid manufacturer documentation – fluid stability, s 3.2.2
fluid manufacturer documentation – hard water stability, s 3.2.2.8
fluid manufacturer documentation – HHET, s 3.2.4.1
fluid manufacturer documentation – LOUT for intended dilutions, s 1.3.1
fluid manufacturer documentation – LOUT, s 1.3.1
fluid manufacturer documentation – materials compatibility data, 3.3.2
fluid manufacturer documentation – pavement compatibility, s 3.3.5
fluid manufacturer documentation – pH limits, s 3.2.1.3
fluid manufacturer documentation – physical properties, s 3.2
fluid manufacturer documentation – refractive index limits, s 3.2.1.4
fluid manufacturer documentation – safety data sheet, ss 1.3.2.4, 5.2
fluid manufacturer documentation – specific gravity, s 3.2.1.2
fluid manufacturer documentation – storage stability, s 3.2.2.6
fluid manufacturer documentation – successive dry out and rehydration, s 3.2.2.4
fluid manufacturer documentation – surface tension, s 3.2.1.5
fluid manufacturer documentation – tendency to foam, s 3.2.2.9
fluid manufacturer documentation – thin film thermal stability, s 3.2.2.5
fluid manufacturer documentation – TOD or COD, s 3.1.6.2
fluid manufacturer documentation – toxicity data, s 3.1.4
fluid manufacturer documentation – trace contaminants, s 3.1.7
fluid manufacturer documentation – Type I, Type II or Type IV, s 1.1.2
fluid manufacturer documentation – viscosity limits, s 3.2.3.3
fluid manufacturer documentation – WSET, s 3.2.4.1
fluid, neat. See also Type II/III/IV – neat fluid
fluid, non-Newtonian – definition, s 1.1.3
fluid, non-Newtonian, Title at p 1, ss 1.1, 1.1.3, 3.2.3, 3.2.3.1
fluid, pseudoplastic – definition, s 1.1.4

42 See footnote 5.
fluid, pseudoplastic, Title at p 1, ss 1.1.4, 3.2.3
fluid, thickened. See Type II/III/IV
freezing point depressant, Glycol, Conventional and Non-Conventional, ss 3.1.1, 3.1.2.1
freezing point depressant, Glycol, Conventional, ss 3.1.1, 3.1.1.1
freezing point depressant, Glycol, Non-conventional, ss 3.1.1, 3.1.1.2
freezing point depressant, Non-glycol, ss 3.1.1, 3.1.1.3, 3.1.2.2, 3.1.3
glycerine. See Glycol, Non-conventional – glycerine
Glycol – definition, s 3.1.1.1
Glycol, Conventional – definition, s 3.1.1.1
Glycol, Conventional – diethylene glycol, ss 3.1.1.1, 3.1.2.1
Glycol, Conventional – ethylene glycol, ss 3.1.1.1, 3.1.2.1
Glycol, Conventional – propylene glycol, ss 3.1.1.1, 3.1.2.1
Glycol, Conventional and Non-conventional – definition, s 3.1.1
glycol, Non-. See Non-glycol
Glycol, Non-conventional – 1,3-propanediol, s 3.1.1.2
Glycol, Non-conventional – definition, s 3.1.1.2
Glycol, Non-conventional – glycerine, s 3.1.1.2
Glycol, Non-conventional – organic non-ionic diols and triols, mixtures of, s 3.1.1.2
Glycol, Non-conventional – organic non-ionic diols and triols, mixtures with Conventional Glycol, s 3.1.1.2
Glycol, Non-conventional – organic non-ionic diols and triols, s 3.1.1.2
HHET – Type II 50/50 – 0.5 hours minimum, s 3.2.4.1
HHET – Type II 75/25 – 2 hours minimum, s 3.2.4.1
HHET – Type II neat – 4 hours minimum, s 3.2.4.1
HHET – Type III 75/25 – determine and report, s 3.2.4.1
HHET – Type III 50/50 – determine and report, s 3.2.4.1
HHET – Type III neat – 2 hours minimum, s 3.2.4.1
HHET – Type IV 50/50 – 0.5 hours minimum, s 3.4.2.1
HHET – Type IV 75/25 – 2 hours minimum, s 3.4.2.1
HHET – Type IV neat – 8 hours minimum, s 3.4.2.1
LOUT – Type II/III/IV – definition, s 1.3.1
maximum on-wing viscosity. See HOWV
neat. See Type II/III/IV – neat fluid
Non-conventional Glycol. See Glycol, Non-conventional
Non-glycol – definition, s 3.1.1.3
Non-glycol – organic salts mixtures with Glycol, ss 3.1.1.3, 3.1.2.2, 3.1.3
Non-glycol – organic salts, mixtures of, ss 3.1.1.3, 3.1.2.2, 3.1.3
Non-glycol – potassium acetate, ss 3.1.1.3, 3.1.2.2, 3.1.3
Non-glycol – potassium formate, ss 3.1.1.3, 3.1.2.2, 3.1.3
Non-glycol – sodium acetate, ss 3.1.1.3, 3.1.2.2, 3.1.3
non-Newtonian fluid. See fluid, non-Newtonian
propylene glycol. See also Glycol, Conventional – propylene glycol; EG v PG
pseudoplastic fluid. See fluid, pseudoplastic
refractometer – Brix scale, s 3.2.1.4
shear thinning. See Type II/III/IV – shear thinning
Type II 50/50 – HHET 0.5 hours minimum, s 3.2.4.1
Type II 50/50 – WSET 5 minutes minimum, s 3.2.4.1
Type II 75/25 – HHET 2 hours minimum, s 3.2.4.1
Type II 75/25 – WSET 20 minutes minimum, s 3.2.4.1
Type II color – yellow, s 1.1.2

43 Thickened fluid is a generic term for Type II/III/IV fluids as all these fluids contain thickeners.
Type II neat – HHET 4 hours minimum, s 3.2.4.1
Type II neat – WSET 30 minutes minimum, s 3.2.4.1
Type II. See also Type II/III/IV; Type II/IV
Type II/III/IV – aerodynamic acceptance of highest viscosity dilution sample, s 3.2.5.3
Type II/III/IV – aerodynamic acceptance of sheared sample, s 3.2.5.1
Type II/III/IV – aerodynamic acceptance of unsheared sample, s 3.2.5.1
Type II/III/IV – aerodynamic acceptance, ss 1.1.2, 3.2.5
Type II/III/IV – anti-icing performance, s 3.2.4.1
Type II/III/IV – apparent viscosity ss 1.1.3, 1.1.4
Type II/III/IV – appearance s 3.1.5
Type II/III/IV – application s 1.2
Type II/III/IV – approval by purchaser s 4.4.1
Type II/III/IV – approval, re- ss 4.2.3, 4.4.2
Type II/III/IV – aquatic toxicity, s 3.1.6.4
Type II/III/IV – biodegradability, s 3.1.6.3
Type II/III/IV – BOD, s 3.1.6.1
Type II/III/IV – Brix, s 3.2.1.4
Type II/III/IV – Brookfield LV viscometer, s 3.2.3.2.1
Type II/III/IV – cadmium reporting requirement, s 3.1.7
Type II/III/IV – carbon brake compatibility, s 1.3.6
Type II/III/IV – certificate of analysis, s 4.2.1
Type II/III/IV – change in formulation, ss 4.2.3, 4.4.2
Type II/III/IV – change in ingredients, ss 4.2.3, 4.4.2
Type II/III/IV – change in production method, ss 4.3.2, 4.4.2
Type II/III/IV – chromium reporting requirement, s 3.1.7
Type II/III/IV – circuit breakers, defective, s 1.3.3
Type II/III/IV – classification, ss 1.1.2, 3.2.4.1
Type II/III/IV – COD s 3.1.6.2
Type II/III/IV – cold storage stability, s 3.2.2.10
Type II/III/IV – color – mandatory, Rationale, s 3.1.5
Type II/III/IV – color, ss 1.1.2, 3.1.5
Type II/III/IV – commingling, s 1.3.4
Type II/III/IV – compatibility with brake material, s 1.3.6
Type II/III/IV – composition, s 3.1
Type II/III/IV – contaminants, s 3.1.7
Type II/III/IV – corrosion resistance, stress, s 3.3.2.4.1
Type II/III/IV – corrosion, aluminum alloy, s 3.3.2.2
Type II/III/IV – corrosion, low embrittling cadmium plate, s 3.3.2.3
Type II/III/IV – corrosion, sandwich, s 3.3.2.1
Type II/III/IV – corrosion, stress-, s 3.3.2.4
Type II/III/IV – corrosion, total immersion, s 3.3.2.2
Type II/III/IV – degradation, thermal – heated leading edge dry-out, s 3.2.2.5
Type II/III/IV – direct current hazard, s 1.3.3
Type II/III/IV – dry-out exposure to cold dry air, s 3.2.2.3
Type II/III/IV – dry-out exposure to dry air, s 3.2.2.3
Type II/III/IV – dry-out, heated leading edge, s 3.2.2.5
Type II/III/IV – dry-out, successive test. See Type II/III/IV – successive dry-out and rehydration test
Type II/III/IV – dry-out, successive. See Type II/III/IV – residue; Type II/IV – residue
Type II/III/IV – effect on acrylic plastics, s 3.3.2.6
Type II/III/IV – effect on aircraft materials, s 3.3.2
Type II/III/IV – effect on painted surfaces, s 3.3.3
Type II/III/IV – effect on polycarbonate, s 3.3.2.6.1
Type II/III/IV – effect on transparent plastics, s 3.3.2.6
Type II/III/IV – effect on unpainted surfaces, s 3.3.4
Type II/III/IV – electrochemical dehydrolysis, s 1.3.3
Type II/III/IV – environmental information, s 3.1.6
Type II/III/IV – exposure to cold dry air, s 3.2.2.3
Type II/III/IV – exposure to dry air, s 3.2.2.2
Type II/III/IV – exposure, human, s 1.3.2
Type II/III/IV – FAA/TC list of fluids
Type II/III/IV – fire hazard inhibitor, s 1.3.3
Type II/III/IV – fire hazard, s 1.3.3
Type II/III/IV – flash point, s 3.2.1.1
Type II/III/IV – fluid elimination, s 3.2.5.4
Type II/III/IV – fluid list (FAA/TC), s 1.5
Type II/III/IV – foam, tendency to, s 3.2.2.9
Type II/III/IV – freezing point buffer, s 1.3.1
Type II/III/IV – freezing point, s 3.3.1
Type II/III/IV – friction, s 1.3.5
Type II/III/IV – glycol dehydrolysis, s 1.3.3
Type II/III/IV – halogen reporting requirement, s 3.1.7
Type II/III/IV – hard water composition, s 3.2.2.8.1
Type II/III/IV – hard water stability, s 3.2.2.8
Type II/III/IV – HHET requirements, s 3.4.2.1
Type II/III/IV – high viscosity sample, ss 3.2.5.3, 4.2.3.1
Type II/III/IV – highest viscosity dilution, s 3.2.5.3
Type II/III/IV – HOWV, s 4.2.3.1
Type II/III/IV – HOWV, s 4.2.3.1
Type II/III/IV – hydrogen embrittlement, s 3.3.2.5
Type II/III/IV – label – AMS1428/1 or AMS1428/2, s 5.1.2
Type II/III/IV – label – fluid manufacturer’s identification, s 5.1.2
Type II/III/IV – label – lot number, s 5.1.2
Type II/III/IV – label – purchase order number, s 5.1.2
Type II/III/IV – label – quantity, s 5.1.2
Type II/III/IV – lead reporting requirement, s 3.1.7
Type II/III/IV – leading edge dry-out, heated, s 3.2.2.5
Type II/III/IV – licensee manufacturing, s 4.4.3
Type II/III/IV – list of qualified fluids, s 1.5
Type II/III/IV – lot – definition, s 4.3
Type II/III/IV – lot acceptance, s 4.2.1
Type II/III/IV – lot, ss 4.1, 4.2.1, 4.3, 4.5.1.1, 5.1.1.1, 5.1.2
Type II/III/IV – LOUT – fluid manufacturer obligation to report, s 1.3.1
Type II/III/IV – LOUT, s 1.3.1
Type II/III/IV – low embrittling cadmium plate, s 3.3.2.3

Both the FAA and Transport Canada issue a list of fluids. If a document refers to both, it will be indexed as “fluid list (FAA/TC)”. If the document refers to only one list, it will be indexed as “fluid list (FAA)” or “fluid list (TC)”, as the case may be.

ARP5718B recommends to fluid manufacturers to carefully select the viscosities of the high viscosity sample and low viscosity sample before submitting to the testing laboratories, as these viscosities will be used to establish the quality control limits for the fluid delivered. The viscosity of the high viscosity sample will become the highest on-wing viscosity (HOWV), also known as the maximum on-wing viscosity (MOWV).

See footnote 5

Section 1.5 of AMS1428J refers to the FAA’s and Transport Canada’s list of qualified fluids. FAA and Transport Canada no longer use the term “qualified” for the fluid list published in their holdover time guidelines.
Type II/III/IV – Low Viscosity sample, s 4.2.3.2
Type II/III/IV – magnesium alloy, corrosion of, s 3.3.2.2
Type II/III/IV – materials compatibility, s 3.3.2
Type II/III/IV – maximum on-wing viscosity. See Type II/III/IV – HOWV
Type II/III/IV – mercury reporting requirement, s 3.1.7
Type II/III/IV – mixing with fluid from different manufacturers, s 1.3.4
Type II/III/IV – mixture with other fluids, s 1.3.4
Type II/III/IV – multiple location manufacturing, s 4.4.3
Type II/III/IV – neat, ss 1.3.1, 3.2.1
Type II/III/IV – nitrate reporting requirement, s 3.1.7
Type II/III/IV – noble metal coated wiring, s 1.3.3
Type II/III/IV – non-glycol based, ss 3.1.1, 3.1.1.3, 3.1.3
Type II/III/IV – non-Newtonian, ss 1.1, 1.1.3
Type II/III/IV – overnight exposure to dry air, s 3.2.2.2
Type II/III/IV – packaging, s 5.1
Type II/III/IV – pavement compatibility, s 3.3.5
Type II/III/IV – pH, s 3.2.1.3
Type II/III/IV – phosphate reporting requirement, s 3.1.7
Type II/III/IV – polycarbonate, effect on. See Type II/III/IV – effect on transparent plastics
Type II/III/IV – preproduction tests, ss 3.2.2.2.2, 3.2.5.3.1, 4.2.3, 4.2.3.1, 48, 4.5.2, A.4, A.5.1, A.6.4
Type II/III/IV – pseudoplastic, s 1.1.4
Type II/III/IV – qualification, initial – report, s 4.5.1.1
Type II/III/IV – qualification, initial, ss 4.2.3.3, 4.2.3.1, 4.2.3.2, 4.5.1.3
Type II/III/IV – qualification, periodic re- – 50/50, ss 4.2.2, 4.5.1.2
Type II/III/IV – qualification, periodic re- – 75/25, ss 4.2.2, 4.5.1.2
Type II/III/IV – qualification, periodic re- – comparison to initial qualification, s 4.5.1.2
Type II/III/IV – qualification, periodic re- – neat, ss 4.2.2, 4.5.1.2
Type II/III/IV – qualification, periodic re- – sample, ≤ 6 months, s 4.2.2
Type II/III/IV – qualification, periodic re- – test facility, approved, s 4.5.1.3
Type II/III/IV – qualification, periodic re- – test facility, independent, s 4.5.1.3
Type II/III/IV – qualification, periodic re- – test variability, s 4.5.1.3
Type II/III/IV – qualification, periodic re- – what: viscosity, s 4.2.2, 4.5.1.2
Type II/III/IV – qualification, periodic re- – what: WSET and HHET, ss 4.2.2, 4.5.1.2
Type II/III/IV – qualification, periodic re- – when: every 2 years, s 4.2.2
Type II/III/IV – qualification, periodic re-, ss 4.2.2, 4.5.1.2
Type II/III/IV – quality assurance, s 4
Type II/III/IV – reaction, exothermic, s 1.3.3
Type II/III/IV – re-approval, ss 4.2.3, 4.4.2
Type II/III/IV – refractive index, s 3.2.1.4
Type II/III/IV – rejection, ss 4.6, 7
Type II/III/IV – requalification. See Type II/III/IV – qualification, periodic re-
Type II/III/IV – resampling, s 4.6
Type II/III/IV – residue – effect on flight safety, s 1.3.7
Type II/III/IV – residue – in aerodynamically quiet areas, s 1.3.7
Type II/III/IV – residue – in cavities, s 1.3.7
Type II/III/IV – residue – in gaps, s 1.3.7
Type II/III/IV – residue formation – first step application of Type II/III/IV in two-step application, s 1.3.7
Type II/III/IV – residue formation – one-step application of Type II/III/IV, s 1.3.7
Type II/III/IV – residue formation test. See Type II/III/IV – successive dry out and rehydration test

48 Several sections refer to preproduction samples or tests. The initial qualification tests of ss 4.2.3, 4.2.3.1, 4.2.3.2 are performed on preproduction samples. This is made explicit in ss A.4, A.5.1, A.6.4.
Type II/III/IV – residue formation, s 3.2.2.4  
Type II/III/IV – residue formation. See also Type II/IV – residue formation  
Type II/III/IV – residue. See also Type II/IV – residue  
Type II/III/IV – retesting, s 4.6  
Type II/III/IV – rheological properties, s 3.2.3  
Type II/III/IV – runway concrete scaling, s 3.3.5.1  
Type II/III/IV – sales specification, s 3.2.3.3  
Type II/III/IV – same ingredients, s 4.4.2  
Type II/III/IV – sample selection, ss 4.2.3, 4.2.3.1, 4.2.3.2  
Type II/III/IV – sample selection. See also HOT, process to obtain – sample selection  
Type II/III/IV – shear stability, s 3.2.2.7  
Type II/III/IV – shear stress, effect on apparent viscosity, ss 1.1.3, 1.1.4  
Type II/III/IV – shear thinning⁴⁹, s 1.1.4  
Type II/III/IV – silver coated wiring, s 1.3.3  
Type II/III/IV – slipperiness, s 1.3.5  
Type II/III/IV – specific gravity, s 3.2.1.2  
Type II/III/IV – specification – AMS1428, Title at p 1  
Type II/III/IV – storage stability waived, s 4.2.3  
Type II/III/IV – storage stability, cold, s 3.2.2.10  
Type II/III/IV – storage stability, s 3.2.2.6  
Type II/III/IV – storage, long term, s 3.2.2.1  
Type II/III/IV – stress-corrosion resistance, s 3.3.2.4  
Type II/III/IV – subcontractor manufacturing, s 4.4.3  
Type II/III/IV – successive dry out and rehydration test, s 3.2.2.4, Appendix A  
Type II/III/IV – sulfur reporting requirement, s 3.1.7  
Type II/III/IV – surface tension, s 3.2.1.5  
Type II/III/IV – switches, defective, s 1.3.3  
Type II/III/IV – technical requirements, s 3  
Type II/III/IV – temperature cycling, s 3.2.2.10  
Type II/III/IV – thermal stability, accelerated aging, s 3.2.2.1  
Type II/III/IV – thermal stability, thin film, s 3.2.2.5  
Type II/III/IV – thickened fluid, s 3.2.3  
Type II/III/IV – titanium corrosion resistance, s 3.3.2.2  
Type II/III/IV – TOD, s 3.1.6.2  
Type II/III/IV – toxicity, s 3.1.4  
Type II/III/IV – trace contaminants, s 3.1.7  
Type II/III/IV – transportation, s 5.1.3  
Type II/III/IV – U.S Military procurement, s 4.2.3.3  
Type II/III/IV – undiluted fluid, ss 1.3.1, 3.2.1  
Type II/III/IV – viscosity limits, s 3.2.3.3  
Type II/III/IV – viscosity measurement, s 3.2.3.2  
Type II/III/IV – wiring, defective, s 1.3.3  
Type II/III/IV – WSET limits, s 3.2.4.1  
Type III – color – bright yellow, s 1.1.2  
Type III 50/50 – HHET determine and report, s 3.2.4.1  
Type III 50/50 – WSET determine and report, s 3.2.4.1  
Type III 75/25 – HHET determine and report, s 3.2.4.1  
Type III 75/25 – WSET determine and report, s 3.2.4.1  
Type III neat – HHET 2 hours minimum, s 3.2.4.1  
Type III neat – WSET 20 minutes minimum, s 3.2.4.1

⁴⁹ Shear thinning is generally considered a synonym of pseudoplastic, that is a fluid whose viscosity is decreased when subjected to shear strain (excluding time dependent effects).
Type III. See also Type II/III/IV
Type IV – color – green, s 1.1.2
Type IV 50/50 – HHET 0.5 hours minimum, s 3.2.4.1
Type IV 50/50 – WSET 5 minutes minimum, s 3.2.4.1
Type IV 75/25 – HHET 2 hours minimum, s 3.2.4.1
Type IV 75/25 – WSET 20 minutes minimum, s 3.2.4.1
Type IV neat – HHET 8 hours minimum, s 3.2.4.1
Type IV neat – WSET 80 minutes minimum, s 3.2.4.1
Type IV. See also Type II/III/IV; Type II/IV
viscometer, Brookfield LV – cold storage stability, s 3.2.2.10
viscometer, Brookfield LV – highest viscosity dilution, s 3.2.5.3.1
viscometer, Brookfield LV – small sample adapter, ss 3.2.3.2, 3.2.5.1
viscometer, Brookfield LV – Type II/III/IV viscosity measurement, ss 3.2.3.2, 3.2.3.2.1
WSET – Type II 50/50 – 5 minutes minimum, s 3.2.4.1
WSET – Type II 75/25 – 20 minutes minimum, s 3.2.4.1
WSET – Type II neat – 30 minutes minimum, s 3.2.4.1
WSET – Type III 50/50 – determine and report, s 3.2.4.1
WSET – Type III 75/25 – determine and report, s 3.2.4.1
WSET – Type III neat – 20 minutes minimum, s 3.2.4.1
WSET – Type IV 50/50 – 5 minutes minimum, s 3.2.4.1
WSET – Type IV 75/25 – 20 minutes minimum, s 3.2.4.1
WSET – Type IV neat – 80 minutes minimum, s 3.2.4.1

AMS1428/1 Fluid, Aircraft Deicing/Anti-icing, Non-Newtonian (Pseudoplastic), SAE Type II, III and IV Glycol (Conventional and Non-Conventional) Based

Issued 2017-02-14 by SAE G-12 ADF.

SAE Type II, II and IV fluids based on Conventional and Non-conventional Glycol freezing point depressants are defined and identified as AMS1428/1 (read AMS1428 slash one) Type II, III and IV fluids. The purpose of the AMS1428/1 specification, which is called a category specification, is to identify the SAE Type I fluid as a Glycol (Conventional or Non-conventional) based fluid. For further information, read the definition of Glycol Conventional and Non-Conventional in AMS1428K, which is defined as the base specification.

Keywords:
AMS1428/1, Title at p 1
category specification, s 1.1.1
foundation specification, s 1.1.1
freezing point depressant – Glycol, Conventional, s.1.1.1
freezing point depressant – Glycol, Non-conventional, s 1.1.1
freezing point depressant – Glycol, s 1.1.1
freezing point depressant – Non-glycol, s 1.1.1
Glycol, Conventional, s 1.1.1
Glycol, Non-conventional, s 1.1.1
specification, category, s 1.1.1
specification, foundation, s 1.1.1
AMS1428/2 Fluid, Aircraft Deicing/Anti-icing, Non-Newtonian (Pseudoplastic), SAE Type II, III and IV Non-Glycol Glycol Based

Issued 2017-02-09 by SAE G-12 ADF.

SAE Type II, II and IV fluids based on Non-Glycol freezing point depressants are defined and identified as AMS1428/2 (read AMS1428 slash two) Type II, III and IV fluids. The purpose of the AMS1428/2 specification, which is called a category specification, is to identify the SAE Type II, III and IV fluids as a Non-Glycol based fluid. For further information, read the definition of Glycol Conventional and Non-Conventional in AMS1428K, which is called the base specification.

Keywords:
AMS1428/2, Title at p 1
category specification, s 1.1.1
foundation specification, s 1.1.1
freezing point depressant – Glycol, Conventional, s.1.1.1
freezing point depressant – Glycol, Non-conventional, s 1.1.1
freezing point depressant – Glycol, s 1.1.1
freezing point depressant – Non-glycol, s 1.1.1
Glycol, Conventional, s 1.1.1
Glycol, Non-conventional, s 1.1.1
specification, category, s 1.1.1
specification, foundation, s 1.1.1
Type II/III/IV – Glycol (Conventional and Non-conventional) based, Title at p 1, s 1.1.1
Type II/III/IV – Glycol (Conventional) based, s 1.1.1
Type II/III/IV – Glycol (Non-conventional) based, s 1.1.1
Type II/III/IV – purchase documents, ss 2, 9.2
Type II/III/IV – specification – AMS1428/1, Title at p 1

AS9968 Laboratory Viscosity Measurement of Thickened Aircraft Deicing/Anti-icing Fluids with the Brookfield LV Viscometer

Issued 2014-07-22 by SAE G-12 ADF.
AS9968 describes a standard laboratory method (as opposed to a field method) for viscosity measurements of thickened (SAE Type II, III and IV) anti-icing fluids. Many fluid manufacturers 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 size, speed of rotation, time after beginning of rotation, container size and temperature) must have been used to obtain those viscosities.

Keywords:
- fluid manufacturer documentation – viscosity measurement method, s 1
- Type II/III/IV – viscosity measurement, Title at p 1, Rationale at p 1
- viscometer, Brookfield LV, Title at p 1, Rationale at p 1, ss 3.1, 3.3.8.1
- viscosity measurement method – air bubble free sample s 3.3.2
- viscosity measurement method – air bubble removal by centrifugation s 3.3.2
- viscosity measurement method – AS9968 v fluid manufacturer, s 1
- viscosity measurement method – AS9968, Title at p 1, s 1
- viscosity measurement method – Brookfield LV viscometer, Title at p1, Rationale at p
- viscosity measurement method – fluid manufacturer, Rationale at p 1, s 1
- viscosity measurement method – precedence of fluid manufacturer method over AS9968, s 1
- viscosity measurement method – report, s 8
- viscosity measurement method – Type II/III/IV, Title at p1, Rationale at p 1

**AIR5704 Field Viscosity Test for Thickened Aircraft Anti-Icing Fluids**

Reaffirmed 2016-06-09 by SAE G-12 ADF.

AIR5704 provides a description of a field screening method (or field “viscosity” check) for verifying an SAE Type II, III or IV anti-icing fluid is above its minimum low shear viscosity as published with holdover time guidelines. The test will determine if the fluid is (a) satisfactory, (b) unsatisfactory, or (c) borderline needing more advanced viscometry testing. Other field tests may be required to determine if an anti-icing fluid is useable, such as refractive index, pH, appearance or other tests as may be recommended by the fluid manufacturer.

This field viscosity test is not suitable for all Type II/II/IV.

Keywords:

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50 *Viscosity measurement methods and viscosity field check.* There are three ways of verifying that an SAE Type II/III/IV is above its lowest on-wing viscosity (LOWV): a) viscosity measurement method provided by the fluid manufacturer (the “manufacturer method”), b) viscosity measurement method described in AS9968 (the “AS9968 method”) and c) “viscosity” field check (or field test) as described in AIR5704 or provided by the fluid manufacturer, such as a falling ball method. Here, we attempt to make a distinction between the laboratory viscosity measurement methods which use a Brookfield LV viscometer where the result is a numerical viscosity value in mPa·s and viscosity field checks where the result is generally a pass/fail result without a numerical viscosity value.
air bubble removal by centrifugation, s 3.2
Stony Brook apparatus for viscosity field check, s 3.3
viscosity field check – air bubble removal by centrifugation, s 3.2
viscosity field check – air bubbles, s 3.2
viscosity field check – screening method, Rationale at p 1
viscosity field check – Stony Brook apparatus, s 3.3
viscosity field check – Type II/III/IV, Title at p 1
viscosity field check – v fluid manufacturer method, Foreword at p 1, see footnote 50
viscosity field check, Title at p 1
viscosity field test. See viscosity field check
viscosity measurement method – v field check see footnote 50
Documents Issued by the SAE G-12 Holdover Time Committee

ARP6207 Qualification Required for SAE Type I Aircraft Deicing/Anti-icing Fluids

Issued 2017-10-10 by SAE G-12 HOT.

The purpose of ARP6207 is to explain to fluid manufacturers and users, at a high level, the steps required for an experimental fluid i) to become a commercially useable fluid, ii) to be allowed to use the generic Type holdover times, and iii) to be listed on the FAA and Transport Canada list of fluids.

Meeting all the technical requirements of AMS1424P is insufficient for a Type I deicing fluid to be used on an aircraft. ARP56207 explains that there are four conditions to commercialize an SAE Type I fluid, the first three are mandatory, the fourth one is highly recommended: 1) meet the technical requirements of AMS1424, 2) be identified on the FAA/Transport Canada fluid list and 3) have a performance such that it can be used with generic Type I holdover time guidelines published by the FAA/Transport Canada and 4) running a field spray test to demonstrate operational performance.

ARP6207 a) describes the preparatory steps to test an experimental fluid according to AMS1424, b) advises fluid manufacturers on sample selection issues for experimental fluids, c) provides a suggested protocol for field spray testing, d) details the protocol to demonstrate that an experimental Type I can be used with the FAA/Transport Canada generic Type I holdover time guidelines, e) explains the process for inclusion and exclusion of fluids on the FAA/Transport Canada fluid list, f) describes the role of the SAE G-12 ADF and HOT Committees and g) the publication process for Type I holdover time guidelines.

Its sister document for AMS1428 fluids, is ARP5718B whose title is Qualifications Required for SAE Type II/III/IV aircraft Deicing/Anti-Icing Fluid.

Keywords:
aerodynamic acceptance – definition, s 2.3
aircraft manufacturer documentation – list fluid types allowed on aircraft, footnote 1 at p 1
alkali organic salt based Type I – effect on Type II/III/IV protection time, s 3.2
alkali organic salt based Type I – exclusion from the fluid list (FAA/TC), s 3.2
alkali organic salt based Type I – HOT – invalid, s 3.2
allowance time – definition, s 2.3
allowance time – failure mode – aerodynamic and visual, s 2.3
allowance time – Type I – none, s 3.5
allowance time – Type II – none, s 3.5
allowance time – Type III neat, s 3.5
allowance time – Type IV neat, s 3.5
allowance time – wind tunnel testing, s 3.5
allowance time. See also wind tunnel testing
AMS1424 – purpose – minimum requirements for Type I, s 3.3.1
AMS1424/1 – purpose – identity of freezing point depressant, s 3.2
AMS1424/2 – purpose – identity of freezing point depressant, s 3.2
AOS. See alkali organic salt
color intensity, evaluation of – field spray test, s 4.3d
definition – aerodynamic acceptance, s 2.3
definition – allowance time, s 2.3
definition – endurance time, s 2.3
definition – FAA/TC list of fluids. See definition – fluid list (FAA/TC)
definition – fluid list (FAA/TC), s 2.3
definition – HOT guideline, fluid-specific, s 2.3
definition – HOT guideline, generic, ss 2.3, 5.5
definition – HOT guideline, s 2.3
definition – HOT table. See definition – HOT guideline
definition – HOT, s 2.3
definition – LOUT, Type I, s 2.3
definition – WSET, s 2.3
endurance time – definition, s 2.3
endurance time tests – Type I – glycol based – none, s 3.4.1
endurance time tests – Type I – non-glycol based – test required, s 3.4.1
endurance time tests – Type I – sample selection, s 3.4.2
FAA/Transport Canada list of fluids. See fluid list (FAA/TC)
failure mode, allowance time – aerodynamic and visual, s 2.3
failure mode, endurance time – visual, s 2.3
failure mode, HOT – visual, s 2.3
field spray test. See spray test, field
fluid list (FAA/TC) – addition of new Type I fluid, ss 5.6.2, 5.7
fluid list (FAA/TC) – definition, s 2.3
fluid list (FAA/TC) – fluid expiry dates, s 5.7c
fluid list (FAA/TC) – fluid manufacturer deadline to provide data – June 01, ss 5.6.1, 5.6.2, 5.6.3, 9
fluid list (FAA/TC) – obsolete data, removal of, ss 5.7b, 5.8
fluid list (FAA/TC) – publication process, ss 5.7, 5.8, 8, 9
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ARP5945A Endurance Time Tests for SAE Type I Aircraft Deicing/Anti-icing Fluids

Revised 2017-10-10 by SAE G-12 HOT.

ARP5945A provides sample selection criteria and test procedures for SAE Type I aircraft deicing/anti-icing fluids, required for the generation of endurance time data of acceptable quality for review by the SAE G-12 HOT. Specifically, ARP5945A describes laboratory endurance procedure testing for freezing fog, freezing drizzle, light freezing rain, rain on cold soaked wing, and snow (two methods, NCAR/APS method and the AMIL method). It describes natural outdoor procedures for snow and frost.

A significant body of previous research and testing has indicated that all Type I fluids formulated with propylene glycol, ethylene glycol, and diethylene glycol perform in a similar manner from an endurance time perspective. Type I deicing/anti-icing fluids whose freezing point depressant is one of those three glycols do not require testing for endurance times. Fluids formulated with 1) glycol freezing point depressants other than those listed above, and 2) all non-glycol freezing point depressants, must be tested for endurance times using the methods described in this ARP5945A.

Its sister document for AMS1428 Type II/III/IV fluids is ARP5485B whose title is Endurance Time Test Procedures for SAE Type II/III/IV Aircraft Deicing/Anti-Icing Fluids.

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51 Field spray trial (p 1) and field spray test (s 4.1) appear to be used interchangeably in ARP6207.
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**ARP5718B Qualifications Required for SAE Type II/III/IV Aircraft Deicing/Anti-icing Fluids**

Revised 2017-12-07 by SAE G-12 HOT.

In its version B, the document name changed. The version A name was ARP5718A Process to Obtain Holdover Times for Aircraft Deicing/Anti-Icing Fluids, SAE AMS1428 Types II, III, and IV.

The purpose of ARP5718B is to explain to fluid manufacturers and users, at a high level, the steps required for an experimental fluid i) to become a commercially useable fluid, ii) to obtain allowance and holdover times, and iii) to be listed on the FAA and Transport Canada fluid list.

Meeting all the technical requirements of AMS1428 is insufficient for a Type II, III or IV de/anti-icing fluid to be used on an aircraft. For such a fluid to be used commercially, it must be associated to holdover time guideline and be identified on the fluid list published by the FAA and Transport Canada. It is further recommended that a field spray trial be conducted with the fluid to demonstrate acceptable operational performance.

ARP5718B a) describes the preparatory steps to test an experimental fluid according to AMS1428, b) advises fluid manufacturers on sample selection issues, particularly in selecting viscosity parameters for experimental fluids, c) offers a short description of wind tunnel testing for obtaining data to generate allowance times, d) provides a suggested protocol for field spray testing, e) details the protocol used to generate holdover time guidelines form endurance time data, including the format of the holdover time tables, e) explains the process for inclusion and exclusion of fluids on the FAA/Transport Canada fluid list, f) describes the role of the SAE G-12 ADF and HOT Committees and g) the publication process for the Type III/IV allowance and Type II/III/IV holdover time guidelines.

Its sister document for AMS1424 Type I fluids is ARP6207 Qualifications Required for SAE Type I Aircraft Deicing/Anti-icing Fluids.
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AMIL, “Anti-icing Fluids Gel Residue Testing Results”, online: <http://amillaboratory.ca/aircraft-deanti-icing-fluids/aaa/>. Type II/II/IV upon evaporation may leave residue on aircraft surface, particularly in aerodynamically quiet areas. The residues may upon rehydration form gels that are susceptible to freezing and which may hinder the movement of critical parts of the aircraft. Different Type II/II/IV fluids have different propensity to form such residues. AMIL conducted a study where several fluids were tested for the propensity for form rehydrated residues. The results are published online.
The requirement for fluid manufacturers to provide data for each manufacturing location was an explicit requirement of s 5.7.3 of ARP5718A. The section 5.7.3 became section 5.9.3 in ARP5718B but the sentence requiring the provision of data for each manufacturing location is no longer present in that section. We believe it is an implicit obligation as there is no statement excluding multiple sites from reporting.
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There are four conditions to commercialize an SAE Type II/III/IV fluid, the first three are mandatory, the fourth one is highly recommended: 1) meet the technical requirements of AMS1428, 2) be identified on the FAA/Transport Canada list of fluids and 3) have a holdover time guideline published by the FAA/Transport Canada and 4) running a field spray test to demonstrate operational performance (see ARP5718B p 1).

Field spray trial (p 1) and field spray test (s 4.1) appear to be used interchangeably in ARP5718B.

See footnote 5.
ARP5485B Endurance Time Test Procedures for SAE Type II/III/IV Aircraft Deicing/Anti-icing Fluids

Revised 2017-10-10 by SAE G-12 HOT.

ARP5485B provides the sample selection and endurance time test procedures, for SAE Type II, III, and IV aircraft deicing/anti-icing fluids, required for the generation of endurance time data of acceptable quality for review by the SAE G-12 HOT. Specifically, ARP5485B describes laboratory endurance procedure testing for freezing fog, freezing drizzle, light freezing rain, rain on cold soaked wing, and snow (two methods, NCAR/APS Aviation method and the AMIL method). It describes natural outdoor procedures for snow and frost.

Snow tests can be performed by three methods: 1) outdoors with natural snow, 2) indoors with artificial snow or collected natural now, storing the artificial snow or collected natural snow, and distributing either systematically over the test plates\(^{57}\) or 3) indoors with artificial snow made as the test is being performed\(^{58}\). Artificial snow is made by a) spraying fine water droplets in a cold chamber resulting in fine solid ice crystals that are collected on the cold chamber floor (used in method 2) or b) shaving ice cores into ice shavings with a so-called snowmaker (used in method 3). Outdoor tests are performed under uncontrolled weather conditions, which means all desired temperature/snow precipitation rate combinations may not be tested during a given winter; indoor tests are performed under controlled conditions.

Its sister document for AMS1424 Type I fluids is ARP5945A whose title is *Endurance Time Test Procedures for SAE Type I Aircraft Deicing/Anti-Icing Fluids*.

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\(^{57}\) The collected snow process and subsequent distribution method were developed at AMIL.

\(^{58}\) The instantaneous shaving core snowmaker method was developed at NCAR and extensively used by APS Aviation.
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AS5681B Minimum Operational Performance Specification for Remote On-Ground Ice Detection Systems

AS5681B revised 2016-05-17 by SAE G-12 Ice Detection, now part of SAE G-12 HOT.

AS5681B specifies the minimum operational performance specification (MOPS) of remote on-ground ice detection systems (ROGIDS). ROGIDS are ground-based systems that indicate whether frozen contamination is present on aircraft surfaces.

ROGIDS are intended to be used during aircraft ground deicing operations to inform ground crews or flight crews about the condition of the aircraft.
AS5681B presents a functional description of ROGIDS, design requirements, minimum performance requirements, laboratory tests conditions to evaluate the ROGIDS, recommended test procedure to demonstrate compliance with the minimum requirements and operational evaluation requirements to verify the performance of in-service ROGIDS.

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\(^59\) Frozen contaminants and frozen contamination are generally used as synonyms.
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This document sets the procedures to perform deicing and anti-icing of aircraft subject to any form of freezing or frozen precipitation.

It distinguishes the responsibilities of the pilot-in-command, the aircraft operator, the service provider, the airport authority, the regulator and air traffic control.

It covers methods to deice and anti-ice aircraft using AMS1424- and AMS1428-qualified fluid and processes not using fluids. It provides procedures to deal with frost prevention with cold soaked aircraft and spot deicing.

It informs on the checks to be performed to ascertain if deicing is required or to verify for the presence of frozen contamination after deicing. It describes the how communications should be done.

It explains the requirement for quality program, quality assurance and quality control. It states that staff must be trained and qualified.

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60 AS6285C is not explicit about the need to communicate with the flightcrew if deicing/anti-icing is performed in its absence. See s 13.a. of FAA Notice N 8900.525 for more information.
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61 Pre-season and start-of-the-season appear to be used interchangeably.
62 See footnote 65.
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\(^6\) Section 4.3.1.1 calls for a “fluid appearance”. Section 4.3.2.1 and 4.3.2.2 only refers to “visual examination” which should include an assessment of appearance (color and form, e.g., green liquid) and suspended matter, aka foreign body. In this guide we index “visual examination” as “visual check” which should probably be broken down as appearance test and suspended matter test.
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64 When the surface is below the frost point, frost is formed by sublimation (also known as deposition), that is from the water vapor in the atmosphere directly to solid phase on the surface, without going through a liquid phase. Sublimation: “Direct evaporation from ice. In meteorology, the term is also applied to the reverse process, in which water vapour changes directly to the solid phase.”. Deposition: “The formation of ice on a surface directly from water vapour, without passing through a liquid phase. See sublimation” Source: oxfordreference.com.
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pretakeoff check – definition, s 2.2.2.2
pretakeoff check, ss 2.2.2.2, 7.4, 7.5, 8.5.3
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65 Although not listed in section 4.3.6c of AS6285C, the following should appear on a sample label: name of the airline or company sending the sample and hazard category of the fluid, a mandatory requirement for shipping chemicals.
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service provider – responsibility – deicing facility, safety of, s 3.3
service provider – responsibility – documentation of deicing processes, s 3.3
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service provider – responsibility – remote facility instructions, s 3.3
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spray directly, no – cabin windows, s 8.7.10
spray directly, no – cockpit windows, s 8.7.10
spray directly, no – control surface openings, s 8.4.5.1
spray directly, no – electrical components, ss 6.5, 8.7.7
spray directly, no – engine core, ss 8.4.5.7, 8.7.6, 8.7.9
spray directly, no – engine probes, s 8.7.9
spray directly, no – engine, ss 8.4.5.7, 8.7.9,

66 Although not covered in AS6285C, a complete sampling procedure should cover safety precautions, personal protective equipment, special hazards at airport such as movement of trucks and aircraft, specific procedure for sampling delivery trucks, storage tanks, deicing unit tanks, drums, totes, warning about the possible high temperature of fluid (fluid heat hazard), disposal of excess fluid taken during sampling, site clean up after sampling, specific sampling equipment (e.g., zone sampler), specific type of sample bottle.
spray directly, no – exhausts, ss 6.5, 8.7.7
spray directly, no – folding wing bushings, s 8.7.11
spray directly, no – folding wing hinges, s 8.7.11
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spray directly, no – static ports, s 8.7.8
spray directly, no – thrust reversers, ss 6.5, 8.7.7
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Type I – degradation, thermal – upon low fluid usage (turnover), s 10.3
Type I – degradation, thermal – water loss, s 10.3
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Type I – formate based, s 8.5
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Type II/III/IV – degradation, thermal – heating, direct, s 4.3.4
Type II/III/IV – degradation, thermal – heating, indirect, s 4.3.4
Type II/III/IV – degradation, thermal – HOT reduction, s 10.3
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Type II/III/IV – degradation, thermal – viscosity reduction, s 10.3
Type II/III/IV – degradation, thermal – water loss, s 10.3
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Type II/III/IV – residue inspection, ss 8.7.1, 8.7.2, 8.7.17
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Type II/III/IV – use as deicing fluid – residue inspection and cleaning program required, ss 8.7.1, 8.7.2
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Type II/III/IV – use in one-step deicing – residue inspection and cleaning program required, s 8.7.2
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ARP6257 Aircraft Ground De/Anti-icing Communication Phraseology for Flight and Ground Crews

ARP6257 issued 2016-10-25 by SAE G-12 M.
AS6287 contains standardized scripts for communication between aircraft flight and ground crews during aircraft deicing operations. It covers contact protocols, aircraft configuration, de/anti-icing treatment needed and post deicing reporting requirements.

Keywords:
anti-icing code, s. 3.2.1
communication with flightcrew – aircraft configuration confirmation, s 3.2.1
communication with flightcrew – all clear signal, s 3.2.1
communication with flightcrew – anti-icing code, s 3.2.1
communication with flightcrew – before starting deicing/anti-icing, s 3.2.1
communication with flightcrew – deicing unit proximity sensor activation s 3.2.2.1a
communication with flightcrew – emergency, s 3.2.2.1b
communication with flightcrew – interrupted operations, s 3.2.2.2a
communication with flightcrew – phraseology, need for standard, s 1.1, 1.2
communication with flightcrew – phraseology, Rationale at p 1, ss 1, 3
communication with flightcrew – post deicing/anti-icing check completion, s 3.2.1
communication with flightcrew – proximity sensor activation s 3.2.2.1a
emergency – communications, s 3.2.2.1b
phraseology, Rationale at p 1, ss 1, 3
phraseology, use of standard, ss 1.1, 1.2

AS5537 Weather Support to Deicing Decision Making (WSDMM) Winter Weather Nowcasting System

AS5537 issued 2004-05-04 by SAE G-12 M.

AS5537 provides guidelines for the deployment of WSDMM nowcasting weather system which is a form of holdover time determination system (HOTDS). This system converts real-time snow data and other precipitation data into liquid water equivalent data which is matched to endurance time data using appropriate regression equation. The system provides a check time for an aircraft treated with Type I/II/II/IV fluids. The check time is used to determine the fluid protection capability in varying weather conditions.

Keywords:
GEONOR, s 4
HOTDS – WSDMM, Foreword at p 1
LWES, Foreword at p 1
METAR snowfall intensity underestimation. See snowfall intensity, METAR – underestimation.
nowcasting, Title at p 1
snow gauge – hotplate, s 4
snow gauge – precipitation, s 4
snow gauge, Foreword at p 1, s 4
snowfall intensity, METAR – underestimation in heavily rimed snow, Foreword at p 2, s 1.2
snowfall intensity, METAR – underestimation in snow containing single crystals of compact shape, Foreword at p 2, s 1.2
snowfall intensity, METAR – underestimation in wet snow, Foreword at p 2, s 1.2
snowfall rate – liquid water equivalent, Foreword at p 2, s 1.2
weather support to deicing decision making, Title at p 1
wind shield – single alter, s 4.1
WSDMM, Title at p 1
Documents Issued by the SAE G-12 Deicing Facilities Committee

ARP5660A Deicing Facility Operational Procedures

ARP5660A revised 2011-01-06 by SAE G-12 DF.

ARP5660A provides guidelines for the standardization of safe operating procedures to be used in performing the services and maintenance at designated deicing facilities (DDF), centralized deicing facilities (CDF) or remote deicing facilities. AIR5660A should be used by regulators and airport authorities to develop and standardize approvals and permits for the establishment and operation of a DDF. The coordination of stakeholders is required prior to the approval of design plans for a deicing facility. Operating procedures must be agreed to, in writing, by all air operators, airport authorities, regulators and service providers prior to commencing deicing operations.

Keywords:
AC 150/5300-13, s 3.2.1.1
ACARS – definition, s 2.3
CDF – definition, s 2.3
CDF – subset of DDF, Foreword at p 1
CDF. See also DDF
central deicing facility. See CDF
centralized deicing facility. See CDF
contamination [frozen] – removal with forced air at DDF, s 3.3
contamination [frozen] – removal with infrared at DDF, s 3.3
contamination [frozen] – removal with steam at DDF, s 3.3
control point – definition, s 2.3
control point. See also transfer point
DDF – approval, s 14
DDF – control boundaries, s15.2
DDF – definition, s 2.3
DDF – design of, s 1.2
DDF – documentation, s 11
DDF – emergency action plans, s 7
DDF – emergency communications protocol, Table A3
DDF – engines-on deicing, Rationale at p 1, ss 3.2, 4.1.4, 4.2.5.1
DDF – environmental considerations, s 5
DDF – fluid acceptance, ss 12.2.3, 12.2.4
DDF – fluid management, s 12
DDF – fluid testing, ss 12.2.5, 12.2.6
DDF – operational procedure, ss 1.1, 3
DDF – phraseology, Appendix A
DDF – pilot brief sheet, Appendix B
DDF – pre-storm planning, s 15.1, Table 1
DDF – quality control, s 13
DDF – safety, s 9
DDF – service provider, single, s 4.3.1
DDF – service providers, several, s 4.3.2
DDF – snow removal, s 8
DDF – spent deicing fluid, s 5.9
DDF – superset of centralized deicing facility, s 1.1
DDF – superset of remote deicing facility, s 1.1
definition – ACARS, s 2.3 sub verbo “Aircraft Addressing and Reporting system”
definition – CDF, s 2.3 sub verbo “Central Deicing Facility”
definition – control point, s 2.3
definition – DDF, s 2.3 sub verbo “Designated Deicing Facility”
definition – deicing bay, s 2.3
definition – deicing coordinator, s 2.3
definition – deicing crew, s 2.3
definition – deicing facility, s 2.3
definition – deicing lead, s 2.3
definition – deicing operator, s 2.3
definition – deicing pad, s 2.3
definition – deicing vehicle operator, primary, s 2.3
definition – ground coordinator, s 2.3
definition – icehouse, s 2.3 sub verbo “Deicing Crew”
definition – iceman, s 2.3
definition – pad control point, s 2.3 sub verbo “control point”
definition – pad control, s 2.3
definition – pad leadership, s 2.3
definition – pink snow, s 2.3
definition – primary deicing vehicle operator, s 2.3 sub verbo “Deicing Lead”
definition – remote deicing facility, s 2.3 sub verbo “Central Deicing Facility”
definition – slot management, s 2.3
definition – snow desk, s 2.3
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definition – staging area, s 2.3
definition – transfer point, s 2.3
definition – windrows, s 2.3
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deicing coordinator – definition, s 2.3
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deicing facility, designated. See DDF
deicing lead – definition, s 2.3
deicing operator – definition, s 2.3
deicing lead – definition, s 2.3
deicing pad – definition, s 2.3
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designated deicing facility. See DDF
engines-on deicing, Rationale at p 1, ss 3.2, 4.1.4, 4.2.5.1
fluid acceptance – DDF, ss 12.2.3, 12.2.4
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ground coordinator – definition, s 2.3
hand signals, ss 4.2.1, 4.2.6
icehouse – definition, s 2.3 sub verbo “Deicing Crew”
iceman – definition, s 2.3
message boards – use at DDF, s 4.1.4
pad control – definition, s 2.3
pad control point – definition, s 2.3
pad leadership – definition, s 2.3
pink snow – definition, s 2.3
primary deicing vehicle operator – definition, s 2.3
remote deicing facility – definition, s 2.3
remote deicing facility – subset of DDF, s 15.2
remote deicing facility. See also DDF (designated deicing facility)
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snow removal – DDF, s 9
snow, pink – definition, s 2.3
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transfer point – definition, s 2.3
windrows – definition, s 2.3

**ARP4902C Design of Aircraft Deicing Facilities**

Revised 2018-02-15 by SAE G-12 DF.

ARP4902C provides guidance material to assist in assessing the need for and feasibility of developing deicing facilities, the planning (size and location) and design of deicing facilities including environmental and operational considerations.

Keywords:
14 CFR 77 Subpart C, s 3.2.1.1.1
AC 150/5300-13, ss 3.2.1.1, 3.2.1.1.1, 4.3.2, 4.3.4, 4.4.1.1, 6.2.1
AC 150/5300-14, ss 4.1, 4.2.4.2, 4.3.1, 4.4.1.2.2, 5.5.1
ADF, spent. See spent deicing fluid; see also deicing facility – spent deicing fluid
aircraft deicing facility. See deicing facility
aircraft deicing pad. See deicing pad
common fluid, s 6.1.3
definition – deicing facility, remote, s 2.2.1.2
definition – deicing facility, s 2.2.1
definition – deicing facility, terminal, s 2.2.1.1
definition – deicing pad, s 2.2.2
definition – deicing, primary, s 4.2.2
definition – deicing, secondary, s 4.2.2
definition – spent deicing fluid, compliant, s 5.3.3
definition – spent deicing fluid, high concentration, s 5.3.3
definition – spent deicing fluid, low concentration, s 5.3.3
definition – storm water, clean, s 4.1.2
definition – storm water, contaminated, s 4.1.2
deicing facility – accident reporting, s 6.9.1c
deicing facility – aircraft dimensions, s 3.2.2.3
deicing facility – aircraft failure, s 6.5.1.5

⁶⁷ Section 2 of ARP4902C defines staging area, yet the deicing pad definition refers to staging bay.
deicing facility – aircraft fleet mix, s 4.2.3.1
deicing facility – aircraft ground movement complexity, s 3.3.2
deicing facility – aircraft marshaling plan, s 6.5.1.1
deicing facility – aircraft parking area, s 2.2.2
deicing facility – aircraft queueing, ss 3.3.2.2, 3.3.2.2.1, 3.3.2.2.2
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deicing facility – aircraft wait times, s 3.3.2.2
deicing facility – airport security, s 3.3.5.2
deicing facility – airport utility master plan, s 3.5.1
deicing facility – airspace analysis, s 3.2.1.4
deicing facility – airway facilities, s 3.2.1.1.1f
deicing facility – all clear signal, s 6.4.1
deicing facility – apron perimeter, s 4.5.2
deicing facility – arrival/departure priority during deicing events, s 3.3.2.2.4
deicing facility – ATC line-of-sight limitations, s 3.2.1.3
deicing facility – ATC workload, s 3.3
deicing facility – ATC, coordination with, ss 3.3.1, 6.2, 6.2.1, 6.2.2
deicing facility – building code, s 3.2.1.4
deicing facility – bypass taxiing capability, s 3.2.2.2
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deicing facility – clean aircraft concept, s 6.4.2
deicing facility – clearance standards, ss 3.2.1, 3.2.1.1, 3.2.1.1.1
deicing facility – common fluid, s 6.1.3
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deicing facility – communications with flightcrew, ss 6.4, 6.4.1, 6.4.2
deicing facility – communications with ground crew, ss 6.4.3, 6.9.1
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deicing facility – containment, s 5.3.1
deicing facility – definition, s 2.2.1
deicing facility – deicing agreement, s 6.4.2
deicing facility – deicing contract, s 6.4.2
deicing facility – deicing fluid transfer system, s 3.3.6.3
deicing facility – deicing pad safety, s 6.7.1
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AS5635 Message Boards (Deicing Facilities)

AS5635 issued 2005-02-16 by SAE G-12 DF.

AS5635 establishes the minimum standard requirements for message boards deicing facilities including the minimum content and appearance of the display, functional capabilities, design, inspection, and testing requirements

Keywords:
- deicing facility – message boards, Title at p 1
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- message boards – aircraft positioning, s 3.4.3.2
- message boards – deicing/anti-icing information, s 3.4.3.3
- message boards – design requirements, s 3
- message boards – inspection and testing, s 4
- message boards – minimum design requirement, s 3.5
- message boards – precedence of verbal communications, s 3.4.3
- message boards – purpose, s 3.2
- message boards – safety requirements, s 3.6
- message boards – system malfunction, s 3.6.2
- message boards – technical requirements, s 3.3
- message boards, Title at p 1
ARP1971D Aircraft Deicing Vehicle - Self-Propelled

Revised 2019-02-13 by SAE G-12 E.

ARP1971D covers requirements for a self-propelled, boom type aerial device, equipped with an aircraft deicing/anti-icing fluid spraying system, with open basket or enclosed cabin.

Keywords:
aircraft deicing vehicle – self-propelled. See deicing unit
anti-icing truck. See deicing unit
basket. See deicing unit – basket
boom. See deicing unit – boom
cabin. See deicing unit – basket; deicing unit – cabin, enclosed
deicing truck. See deicing unit
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deicing unit – fluid degradation test, s 3.9.1
deicing unit – fluid delivery pressure, s 3.2.4
deicing unit – fluid delivery rate, s 3.2.4

68 ARP1971D does not offer an exhaustive list of potential sources of chemical contamination, for example when new equipment is placed into service, it may have been shipped with an antifreeze solution in the pump and piping system. This antifreeze solution is an unwanted contaminant and needs to be cleaned off. Rain can enter through covers, so can melted snow. Often deicing trucks tanks are filled with water in the summertime for training purpose; care should be taken to drain the water before the deicing truck is put back into service.
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decing unit – nozzle – flow rate adjustment, s 3.5.11
decing unit – nozzle – fluid degradation test, s 3.9.1
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decing unit – nozzle – ground level, s 3.5.2
decing unit – nozzle – gun type, s 3.5.10
decing unit – nozzle – pressure gauge, s 3.9.23
decing unit – nozzle – spray patterns, s 3.5.11
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decing unit – nozzle – Type II/III/IV, ss 3.9.1–3.9.3
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Forced air is a process by which an air stream is utilized to remove accumulation of frozen contamination from the aircraft. Forced air can be used with or without deicing fluid, heated or unheated. AIR6284 provides information on equipment, safety, operation, and methodology for use of deicing vehicles equipped with forced air.

**Keywords:**
- air stream, Rationale at p 1, ss 3, 4.3.2, 5.1.3
- contamination [frozen] – removal with forced air and fluid, Rationale at p 1
- contamination [frozen] – removal with forced air, Title at p 1
- deicing unit – forced air. See forced air
ARP5058A Enclosed Operator's Cabin for Aircraft Ground Deicing Equipment

Revised 2004-06-21 by SAE G-12 E.

ARP5058A sets guidelines and design requirements for an enclosed cabin for both mobile deicers and fixed deicing equipment.

Keywords:
Documents Issued by the SAE G-12 Training and Quality Control Committee

AS6286A Aircraft Ground Deicing/Anti-Icing Training and Qualification Program

Revised 2019-06-26 by SAE G-12 T.

This document sets the standard for the qualification and training programs as well as evaluations for personnel involved in aircraft ground deicing.

A standard teaching plan with theoretical and practical elements is proposed in sections 6.2 and 6.4.

Appendix A provides background to the theoretical elements of the standard teaching plan (Appendix A chapter heads not provided in the document, provided here for convenience):

A.1 Introduction
A.2 Trainer and course introduction
A.3 Basic knowledge of aircraft performance
A.4 Effects of frozen contamination on aircraft performance
A.5 The clean aircraft concept, regulatory bodies and recommendations
A.6 General weather conditions of aircraft ground icing
A.7 General techniques for removing frozen deposits from an aircraft
A.8 Deicing/anti-icing by fluids
A.9 Basic characteristics of aircraft deicing/anti-icing fluids
A.10 Type of fluid checks required and the equipment for doing this
A.11 Deicing/anti-icing equipment operating procedures
A.12 Fluid application and the use plus limitations of holdover time tables
A.13 The deicing codes and communications procedures
A.14 Aircraft in general and common critical surfaces and instruments
A.15 Safety precautions and human factors
A.16 Environmental impact and mitigation
A.17 Deicing facility operations
A.18 Operational quality management, audit findings and updating procedures
A.19 The special requirements for the local situation

Appendix B provides aircraft diagrams with showing zones where deicing/anti-icing fluids may be applied, areas where fluids should be applied indirectly and where fluid should not be applied (no-spray zones). It also provides wing surface area, horizontal surface area, wingspan, aircraft category and suggested anti-icing fluid quantities for several commonly used aircraft.

Keywords:
accountable executive – definition, s 2.3.1 sub verbo “winter program manager”
accountable person – definition, s 2.3.1 sub verbo “winter program manager”
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Airbus A220-100 dimensions, s B.2.2.1.9
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Airbus A300 spray area diagram, s B.1.4
Airbus A310 dimensions, s B.2.2.1.5
Airbus A310 spray area diagram, s B.1.5
Airbus A318/319 spray area diagram, s B.1.6
Airbus A318/319/320/321 dimension, s B.2.2.1.6
Airbus A320 spray area diagram, s B.1.7
Airbus A321 spray area diagram, s B.1.8
Airbus A330 dimensions, s B.2.2.1.2
Airbus A330 spray area diagram, s B.1.9
Airbus A340 dimensions, s B.2.2.1.1
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BAe 146/Avro RJ spray area diagram, s B.1.15
BAe 748/HS 748 spray area diagram, s B.1.16
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BAe Jetstream 31/41 spray area diagram, s B.1.17
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AS6332 Aircraft Ground Deicing/Anti-icing Quality Management

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This document sets the requirements for aircraft deicing/anti-icing quality management system. It comprises quality system, documentation, control of records, management responsibility, resource management, measurement and analysis of results, and process for continual improvement.

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Documents Issued by Regulators

The FAA and Transport Canada publish yearly holdover time guidelines, extensive guidance material, a list of fluids that have qualified themselves for anti-icing performance and aerodynamic acceptance and their respective lowest aerodynamic acceptance temperature. The FAA and Transport Canada do not verify that the fluids meet all the technical requirements of AMS1424 (latest version) and AMS1428 (latest version) other than anti-icing performance and aerodynamic acceptance. Users must verify if the fluids to be used meet all other technical requirements of AMS1424 (latest version), AMS1424/1, AMS1428 (latest version) and AMS1428/1.

EASA and ICAO also publish guidance material.

Documents Issued by the Federal Aviation Administration

FAA Notice N 8900.525 Revised FAA–Approved Deicing Program Updates, Winter 2019–2020

Effective date: 2019-10-07; cancellation date: 2020-10-07. Issued by the FAA. 70

Replaces FAA Notice N 8900.519 which had an effective date of 2019-08-06.

This notice is meant to provide FAA inspectors information on holdover time and guidance on various several operational issues related to aircraft ground deicing. It is revised every year is to be used in conjunction with the FAA Holdover Time Guidelines, also issued annually.

It provides information and guidance, not only to the FAA inspectors, but to airlines seeking FAA approval of ground deicing/anti-icing programs. 71

In the 2019-2020 there were further clarifications on the use of METAR codes GR, PL, SG, GS, and SHGS. Careful reading of section 8.f. is suggested.

70 Online: <https://www.faa.gov/documentLibrary/media/Notice/N_8900.525.pdf>

71 Regulators have different names for the programs that airlines and service providers must have in place to deal with ground icing. FAA calls it “FAA-Approved Deicing Program” in document N 8900.xxx and “Ground Deicing/Anti-Icing Program” in AC 120-60B, Transport Canada uses the terms “Approved Ground Icing Program” and “ground icing operations program”, ICAO calls it “ground de-icing/anti-icing programme”, and SAE refers to ground deicing program in AS6285. To facilitate indexing, these programs are indexed as ground deicing program, e.g. ground deicing program (FAA), ground deicing program (TC), etc.
There is a new guidance section (8.h.) on mixed precipitation conditions. A mixed precipitation condition occurs when multiple precipitation types are simultaneously reported. Section 8.h was further amended in this latest F 8900.525 with respect to METAR obscuration.

A section allowing takeoff under mixed precipitation within 5 minutes after a contamination check was deleted.

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73 There is no Type III generic HOT table. There was a mention to that effect in N 8900.326, but the note does not appear in subsequent N 8900 documents.
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74 It may be useful for users under FAA jurisdiction to consider that FAA appears to make distinction between 4 kinds of conditions conducive to icing: 1) conditions with holdover time, e.g., freezing fog, ice crystals, very light snow, very light snow grains, very light snow pellets, light snow, light snow grains, light snow pellets, moderate snow, moderate snow grains, moderate snow pellets, freezing drizzle, light freezing rain, rain on cold soaked wing, very light snow mixed with light rain, light snow mixed with light rain, active frost, 2) conditions without holdover time but with an allowance time, e.g., light ice pellets, light ice pellets mixed with light snow, light ice pellets mixed with moderate snow, light ice pellets mixed with light or moderate freezing drizzle, light ice pellets mixed with light freezing rain, light ice pellets mixed with light rain, light ice pellets mixed with moderate rain, moderate ice pellets or small hail, moderate ice pellets or small hail mixed with moderate freezing drizzle, moderate ice pellets or small hail mixed with moderate rain, and 3) conditions without holdover time but where, with special dispatch procedures, takeoff can occur, e.g., heavy snow and 4) conditions without holdover time, e.g. moderate freezing rain, heavy freezing rain, hail, heavy ice pellets.
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75 “If additional information provided with the METAR makes clear that the weather condition is snow pellets and not
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76 Heating Type I is necessary but will result in some water loss and corresponding increase in glycol concentration. One must take care not to exceed the highest glycol concentration that was tested and passed aerodynamic acceptance. If Type I is repeatedly or continuously heated without replenishment of fresh material or heated at extreme temperatures, there can be oxidation of the glycol, usually the color will fade and pH will decrease below the its accepted specification range.
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\textsuperscript{77} Color should be looked at when checking for appearance. Suspended matter is a form of contamination. It is virtually impossible to exclude all suspended matter. Small amounts of iron particles (not rust) are generally thought to be acceptable. The criterion of acceptability is sometimes formulated as “substantially free from suspended matter”.

\textsuperscript{78} For example, contamination with other fluids, silicone oil, rust, RDP, jet fuel, diesel fuel, rain water, melted snow, etc.

\textsuperscript{79} Repeated or prolonged heating of Type II/III/IV can lead to a) water evaporation causing significant viscosity reduction or increase and b) thermal oxidation of the thickener system resulting in viscosity loss.

\textsuperscript{80} Neat fluid. The user of a Type II, III or IV HOT guideline needs to know the concentration of the fluid. Guidance material found in section 7.b.(2) of FAA Notice N 8900.525 reads as follows: “For Types II, III, and IV fluids, the fluid concentration (percent mixture) is the amount of undiluted (neat) fluid in water. Therefore, a 75/25 mixture is 75 percent FPD fluid and 25 percent water.” The following may be less prone to misinterpretation: “For Types II, III, and IV fluids, the fluid concentration is expressed as the volume ratio of neat (undiluted) fluid to water. Therefore, a 75/25 fluid concentration is a mixture by volume of 75 parts neat fluid and 25 parts water.”

More examples: “100/0 fluid concentration” means neat fluid; a “50/50 fluid concentration” means a mixture by volume of 50 parts neat fluid and 50 parts water. “Neat” means as-delivered by the fluid manufacturer, without added water by the user. Type II/III/IV fluids, as-delivered by the manufacturer, always contain a freezing point depressant and water. The 100 in “100/0” and the 75 in “75/25” do not refer to the weight or volume concentration of the freezing point depressant in the fluid. By analogy, when a drinker says, “I drink my Scotch neat”. It means she wants her Scotch served without added water. It does not mean that there is 100% alcohol (the freezing point depressant) in the Scotch.
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wingtip devices – Boeing B757, s 13.j.(3)
wingtip devices – Boeing B767, s 13.j.(3)

81 See footnote 80
82 Color should be looked at when checking for appearance. Suspended matter is a form of contamination. It is virtually impossible to exclude all suspended matter. Small amounts of black iron particles (not rust) are generally thought to be acceptable. The criterion of acceptability is sometimes formulated as “substantially free from suspended matter”.  

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wingtip devices – scimitar, s 13.j.
wingtip devices – scimitar, split, s 13.j.
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FAA Holdover Time Guidelines Winter 2019-2020, Revision 1.0: August 19, 2019

Issued 2019-08-19 by the FAA.\(^\text{83}\)

This document provides the holdover time guidelines and allowance times for generic and specific fluids. It is considered by the FAA to be official guidance on the use of the holdover time guidelines and allowance times. It includes a list of fluid tested for anti-icing performance and aerodynamic acceptance. It is designed to be used with FAA N 8900.525 Revised FAA-Approved Deicing Program Updates, Winter 2019-2020.

Keywords:
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APS Aviation, p B-2

\(^{83}\)Online: <https://www.faa.gov/other_visit/aviation_industry/airline_operators/airline_safety/media/FAA_2019-20_HoldoverTables_Rev1.pdf>
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84 None published.
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visibility – rounding of, Table 43 at note 5


Issued 2019-08-06 by the FAA.86

This document, updated every year, provides the regression coefficients to calculate holdover times under various weather conditions.

Typically, real-time weather data is fed to a holdover time determination system (HOTDS) which uses the real time weather data and best-fit power law curves with the appropriate regression coefficients to calculate holdover times.

A similar document is issued by the Transport Canada:

**Keywords:**
check time determination system87, pp 6-7
HOT – 76% adjusted – regression calculations, p 6
HOT – regression information – changes in 2019-2020, p 5
HOT – regression limitations – caution outside precipitation rate limits, p 7–8

85 *Snowfall intensity v snowfall rate.* Snowfall intensity is expressed as very light snow, light snow, moderate snow and heavy snow whereas snowfall rates are expressed in g/dm²/h or liquid water equivalent rates in mm/h or in/h.
86 Online: <https://www.faa.gov/other_visit/aviation_industry/airline_operators/airline_safety/media/FAA_2018-19_Regression_Information.pdf>
87 The Transport Canada HOT Regression Information document does not mention check time determination systems.
HOT – regression limitations – no allowance times, p 8
HOT – regression limitations – no interpolation for Type II/III/IV non-standard dilutions, p 7
HOT – regression limitations – no regression coefficients for frost, p 8
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HOT – Type I generic – regression calculations, p 6
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HOT – Type IV generic – HOT minimum (worst case) values of all Type IV, p 7
HOT – Type IV generic – regression calculations, pp 6–7
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LUPR, snow, p 6, Table 5
regression coefficient tables, interpretation of, p 6
regression coefficients – best fit power law, p 7

**FAA Advisory Circular AC 120-60B Ground Deicing and Anti-icing Program**

Issued 2004-12-20 by the FAA. 88

This document provides guidance to obtain FAA approval of ground deicing/anti-icing programs in accordance to Title 14 of the Code of (US) Federal Regulations (14 CFR) part 12, section 121.629.

Keywords:
14 CFR § 121.629, s 1
AC 120-60B, Title at p 1
anti-icing – definition, s 3.a.
anti-icing fluid – definition ss 3.a.(1–5)

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check, icing. See preflight check; post deicing/anti-icing check; pretakeoff check; pretakeoff contamination check. See post deicing/anti-icing check; post deicing anti-icing check; pretakeoff contamination check (FAA). See pretakeoff contamination check (FAA). communications – flightcrew and ground crew, s 6.f.
communications. See also anti-icing code; phraseology anti-icing code, s 6.f.(3)
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critical surface – engine inlets, s 6.d.(a)
critical surface – fuel vents, s 6.d.(a)
critical surface – fuselage on aircraft with center mounted engine, s 6.d.(a)
critical surface – instrument sensor pick up points, s 6.d.(a)
critical surface – pitot tubes, s 6.d.(a)
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critical surface – wings, s 6.d.(a)
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definition – anti-icing fluid, ss 3.a.(1–5)
definition – deicing fluid, ss 3.b.(1–6)
definition – deicing, s 3.b.
definition – frozen contaminants, s 3.c.
definition – hard wing, s 6.e.(2)(a)
definition – HOT range, s 6.c.(3)
definition – HOT, s 3.d.
definition – post deicing/anti-icing check (FAA), ss 3.g., 6.e.(3)
definition – pretakeoff check (FAA), s 3.e.
definition – pretakeoff contamination check (FAA), s 3.f.
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contamination [frozen] – effect on control, s 6.g.(2)(a)
contamination [frozen] – effect on drag, s 6.g.(2)(a)
contamination [frozen] – effect on engine foreign object damage, s 6.g.
contamination [frozen] – effect on instrument pick up points, s 6.g.(2)(a)
contamination [frozen] – effect on lift, s 6.g.(2)(a)
contamination [frozen] – effect on buffet or stall before activation of stall warning, s 6.g.(2)(a)
contamination [frozen] – effect on hard wing aircraft (without leading edge device), s 6.g.(2)(a)
contamination [frozen] – effect on ram air intakes, s 6.g.(2)(a)
contamination [frozen] – effect on stall at lower-than-normal angle of attack, s 6.g.(2)(a)
contamination [frozen] – effect on weight, s 6.g.(2)(a)
contamination [frozen] – effect on winglets s 6.g.(2)(a)

89 The appears to be four kinds of icing checks: 1) preflight check (aka contamination check) performed by the flightcrew or ground crew to establish the need to deicing/anti-icing), 2) post deicing/anti-icing check (aka post deicing check, post application check), an integral part of the deicing/anti-icing process, 3) pretakeoff check performed within the holdover time and 4) the pretakeoff contamination check performed after the holdover time has expired.
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ground deicing/anti-icing program (FAA). See ground deicing program (FAA)
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pretakeoff check (FAA) – definition, s 3.e.
pretakeoff check (FAA) – flightcrew situational awareness, s 6.e.(1)
pretakeoff check (FAA) – guidance, s 6.e.(1)
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pretakeoff contamination check (FAA) – definition, s 3.f.
pretakeoff contamination check (FAA) – guidance ss 3.f., 6.e.(2)
pretakeoff contamination check (FAA) – regulation 14 CFR § 121.629(c)(3)(i), ss 3.f., 6.e.(2)
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pretakeoff contamination check (FAA) – within 5 minutes of takeoff, ss 3.f., 6.e.(2)
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training – FAA requirements s 6.g.

FAA Advisory Circular AC 120-112 Use of Liquid Water Equivalent System to Determine Holdover Times or Check times of Anti-icing Fluids

Issued 2015-07-14 by the FAA.91

Although the FAA does not certify or approve specific liquid water equivalent system (LWES),
some US aircraft operators (§ 121.629(c) category) may be required by US law to seek FAA
authorization to rely on the use of LWES. This document provides the FAA minimum standard
for use of LWES and guidance to those proposing to design, procure, construct, install, activate or
maintain LWES. An LEWS is an automated system that measures the liquid water equivalent rate

90 AC 120-60 appears to use different terms for the check that is an integral part of the deicing/anti-icing process: “post deicing check” s 3.g., “post deicing/anti-icing check” s 6.e.(3), 6.f.(3)D, “post application check” s 6.f.(3)D.
SAE documents usually call it “post deicing/anti-icing check” such as, AS6285C s 7.3 and AS6286 A.13.5, although
for short it is sometimes called “post deicing check”.
91 Online: <
of freezing or frozen precipitation. The LEWS system, using the measured LEW rate and endurance time regression equations, calculates holdover time (HOT) or check time (CT).

Keywords:
anti-icing fluid – definition, Appendix 2a.
check time – definition, Appendix 2b.
check time determination system – guidance (FAA), s 1-1
check time determination system – subset of LWES, s 1-1
definition – anti-icing fluid, Appendix 2a.
definition – check time, Appendix 2b.
definition – deicing fluid, Appendix 2c.
definition – endurance time regression analysis, Appendix 2e.
definition – endurance time, Appendix 2d.
definition – glycol pan measurement, Appendix 2f.
definition – HOT tables, Appendix 2h.
definition – HOT, Appendix 2g.
definition – LWE rate, Appendix 2i.
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HOT – start of, Appendix 2g.
HOT – tables – definition, Appendix 2h.
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LWE – sampling time – definition, Appendix 2k.
LWES – activation – guidance (FAA), s 1-1
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LWES – authorization for snow (FAA), s 3-8
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LWES – design – guidance (FAA), s 1-1
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LWES – HOT, s 1-1
LWES – installation – guidance (FAA), ss 1-1, 2-7
LWES – maintenance – guidance (FAA), ss 1-1, 2-8
LWES – maintenance log – guidance (FAA), s 2-6
This document provides guidance and recommendations of the designing of deicing facilities. It covers the sizing, siting, environmental considerations and operational requirements to maximize deicing capacity while maintaining safety and efficiency. There is emphasis on centralized deicing facilities and the issues associated with such facilities. Design considerations for infrared deicing facilities are discussed.

Keywords:
14 CFR § 139, s 2. at p i, s 4.b. at p i
AC 150/5300-14C, Title at p i
aircraft deicing facility. See deicing facility
aircraft parking area length, s 3.1a.(2)
aircraft parking area width, s 3.1a.(1)

FAA Advisory Circular AC 150/5300-14C Design of Aircraft Deicing Facilities

Revised 2013-08-07 by the FAA.

Infrared deicing facilities were built at JFK airport in NY, Buffalo NY, Newark NJ, Rhinelander NY, and Oslo, Norway. Buffalo, Newark, and Oslo facilities were dismantled. JFK and Rhinelander are not operational. The builder of infrared facilities is no longer offering them for sale [FAA private communications. June 2016].

AC 150/5300-14C has an introductory section at pp i to iv that uses the same section numbering as the main document. When the referring to a section in the introductory part, the pages are indicated.
aircraft parking area, deicing pad – definition, s 1.2c.(1)
Airport Certification Manual (US), s 2. at p i
Airport Improvement Program (US), s 2. at p i
airport, certificated (FAA), s 2. at p i
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CDF – aircraft access routes, s 4.
CDF – benefits – aircraft re-treatment near departure runway, s 2.1b.
CDF – benefits – avoiding changing weather along long taxiing routes, s 1.1b.(2)
CDF – benefits – improved airfield flow, s 2.1b.
CDF – benefits – reduced taxing time, s 1.1b.(2)
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CDF – components – deicing unit ss 2.1c., 2.5b.
CDF – components – environmental runoff mitigation ss 2.1c., 2.5e.
CDF – components – fluid storage and handling ss 2.1c., 2.6
CDF – components – lighting system ss 2.1c., 2.7
CDF – control center, ss 4.c. at p i, 2.1c.
CDF – definition, s 1.2b.
CDF – deicing pad, factors affecting number of – deicing procedure, s 2.4a.
CDF – deicing pad, factors affecting number of – peak hour departure rate, s 2.4
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CDF – deicing pad, factors affecting number of – type of aircraft, s 2.4a.(3)
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\textsuperscript{95} AC 150/5300-14C defines all off-gate deicing facilities as centralized deicing facilities, see s 1.1.
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\(^{90}\) In AC 150/5300-14C, the term “centralized aircraft deicing facility” includes “remote aircraft deicing facility” and the expression “remote deicing facility” was dropped from the definition (s 4a at p i). In the Guide, we abbreviate centralized deicing facility as CDF.
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**FAA Policy Statement: Type Certification Policy for Approval of Use of Type II, III, and IV Deicing/Anti-icing Fluids on Airplanes Certificated Under 14 CFR Parts 23 and 25, Policy No: PS-ACE-23-05, PS-ANM-25-10.**

Issued 2015-05-03 by the FAA.

This FAA policy describes the testing and approval process for aircraft manufacturer to enable the use of SAE Type II, III and IV on aircraft certificates under 14 CFR parts 23 and 25.

This document seeks to determine if using Type II, III or IV fluids will result in significant or unusual flight or ground handling characteristics. This is determined by flight tests or by showing similarity to previously tested models.
The policy addresses takeoff performance, lift loss determination, takeoff angle-of-attack margin tests, controllability, vibration and buffeting, post-flight inspections, effect on aircraft systems, and maintenance instructions, including cleaning, lubrication and how to deal with fluid residues and rehydrated residues.

A less detailed similar document was published by Transport Canada entitled *Guidelines for Aeroplane Testing Following Deicing/Anti-icing Fluid Application*, Working Note No. 38, Initial Issue.

**Keywords:**
- aerodynamic effect of fluids – aircraft certification, FAA, s Title
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- aerodynamic effect of fluids – not addressed by AS5900 – control forces, p 4 par 2
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- aerodynamic effect of fluids – operational limitations – increased rotation speed, p 4 par 3
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- aircraft certification – Type II/III/IV – flight tests, p 6 par 3, p 13
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Documents Issued by Transport Canada

Transport Canada Holdover Time Guidelines Winter 2019-2020, Original Issue:
August 6, 2019

Issued 2019-08-07 by Transport Canada.\(^97\)

This document, updated every year, provides the holdover time guidelines as published by Transport Canada. The Transport Canada Holdover Time Guidelines are meant to be used in conjunction with Guidelines for Aircraft Ground Icing Operations, TP 14052E (fourth edition, August 2019) where additional guidance on aircraft ground deicing can be found.

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- aerodynamic acceptance test – results – low speed ramp, Tables 44, 46
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98 None published.
99 Snowfall intensity v snowfall rate. Snowfall intensity is expressed as very light snow, light snow, moderate snow and heavy snow whereas snowfall rates are expressed in g/dm²/h or liquid water equivalent rates in mm/h or in/h.
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\textbf{Transport Canada Holdover Time (HOT) Guidelines Regression Information Winter 2019-2020 Issue: August 6, 2019}

Issued 2019-08-06 by Transport Canada.

This document, updated every year, provides the regression coefficients to calculate holdover times under various weather conditions.

Typically, real-time weather data is fed to a holdover time determination system (HOTDS) which uses the real time weather data and best-fit power law curves with the appropriate regression coefficients to calculate holdover times.

A similar document is issued by the FAA.

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\textsuperscript{100} Although the FAA and Transport Canada harmonize most of the information contained in their respective Holdover Time Guidelines, the Snowfall Intensity as a Function of Prevailing Visibility tables are different. See the FAQ at p 227.
This document clarifies the use of Type I fluid as a deicing fluid and as an anti-icing fluid.

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Transport Canada Advisory Circular AC 700-030 Electronic Holdover Time (eHOT) Applications

Issued 2014-11-18 by Transport Canada.102

This document provides guidance regarding 1) the implementation and use of eHOT applications in electronic flight bags, 2) the process to obtain authorization from Transport Canada to incorporate eHOT in deicing and anti-icing programs and 3) recommendations to principal

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operations inspectors and civil aviation safety inspectors when reviewing submission for incorporation of eHOT apps.

Keywords:
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Revised 2019-08 by Transport Canada.103

This document provides guidance to those who are involved in aircraft ground deicing. It is meant to be used in conjunction with the Transport Canada Holdover Time Guidelines which are issued every year.

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\textsuperscript{106} \textit{Transport Canada Holdover Time Guidelines Winter 2015-2016} spelled out clearly that there were no Type III generic HOT guidelines. There is no Type III generic HOT guideline in the 2019-2020 version, but it is not specified as such.
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107 The note in s 11.2.4 states that the “pre-take-off contamination [inspection] must be conducted from outside if the aircraft if the Air Operator does not use the HOT guidelines”, yet s 11.4.2 says the “procedure should only be applied to Type II, III and IV anti-icing fluids and then only when the pertinent minimum holdover time exceeds 20 minutes.” If the air operator does not use HOT guidelines, how is the pilot to know what the holdover time is?
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108 Section 10.5 f) calls cabin windows a no-spray zone whereas section 8.7.1.2 c) call for indirect spraying.
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Transport Canada Exemption from Sections 1.0, 3.0, 6.0, 6.2 and 7.111 of Standard 622.11 Ground Icing Operations Made Pursuant for Subsection 602.11(4) of the Canadian Aviation Regulations

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This regulatory exemption authorizes air operators to use HOT generated by HOTDS using best-fit power law equations and regression coefficients as part of their ground icing operations program. The document sets the minimum standards for use of the HOTDS.

Keywords:
anti-icing fluid – definition, Appendix B
definition – anti-icing fluid, Appendix B
definition – deicing fluid, Appendix B
definition – glycol pan measurement, Appendix B
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HOT – regression limitations – capping for rain on cold soaked wing 2 h (TC), s 5.1.19
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HOTDS continuously integrated measurement system – definition, Appendix B
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HOTDS – technical requirements (TC), s 5
regression analysis (TC) – definition, Appendix B

**Barry B. Myers, Aircraft Anti-icing Fluid Endurance, Holdover, and Failure Times Under Winter Precipitations Conditions, Transportation Development Centre, Transport Canada, TP 13832, November 2001**

This document is a glossary prepared by Mr. Barry Myers, an aerodynamicist and Transportation Development Centre (Transport Canada) subject matter expert on matters related to aircraft ground deicing. Mr. Myers, for a long time, headed research and development on aircraft ground deicing and anti-icing for Transport Canada.

This document (TP 13832) was his effort to clarify definitions related to the hazards of ice, snow and frost on aircraft surfaces and the use to anti-icing fluids to protect against frozen and freezing precipitation. His glossary is particularly interesting as it differentiates between visual, adhesion and aerodynamic failures.

Keywords:
aerodynamic effect of canard contamination, s 6.3
aerodynamic effect of clear-ice, s 6.2
aerodynamic effect of contamination, s 6
aerodynamically quiet area – *superset of* aerodynamically quiet cavities, s 6.7
aerodynamically quiet area – *superset of* aerodynamically quiet surface, s 6.7
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definition – deicing/anti-icing, s 5.3
definition – defrosting, s 5.4
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cold soaking – reason for above freezing HOT, s 6.10
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definition – HOT, s 4.3
definition – ice, s 5.5
definition – nucleation site, s 3.3
definition – plate, frosticator, s 3.2
definition – plate, standard test, s 3.1
definition – precipitation rate for HOT tables, s 3.4
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definition – precipitation rate, 20-minute average, s 3.6
definition – precipitation rate, 40-minute average, s 3.6
definition – precipitation rate, 5-minute average, s 3.6
definition – precipitation rate, peak, s 3.5
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deicing – definition, s 5.1
deicing/anti-icing – definition, s 5.3
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precipitation rate, 5-minute average – definition, s 3.6
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In this document, Transport Canada considers that the aerodynamic acceptance test described in SAE AS5900 establishes a standard to ensure acceptable aerodynamic characteristics of aircraft deicing/anti-icing fluids during the takeoff ground roll and initial climb.

The aerodynamic acceptance test measures the boundary layer thickness over a flat plate covered with fluid during a simulated takeoff run. The premise is that the boundary layer thickness over the flat plate correlated to the boundary layer over a curved aerodynamic surface.

Transport Canada considers that aircraft configurations, airfoil sections and fluid continue to evolve and recommends limited flight tests on individual aircraft types. These flight tests, can be used 1) to establish system operation characteristics, 2) identify operational procedures and 3) maintenance procedures for deicing/anti-icing.

This document provides guidance for these aircraft tests.

The purpose of this document appears similar to the of FAA Policy Statement: Type Certification Policy for Approval of Use of Type II, III, and IV Deicing/Anti-icing Fluids on Airplanes Certificated Under 14 CFR Parts 23 and 25, Policy No: PS-ACE-23-05, PS-ANM-25-10.

Keywords:
aerodynamic effect of fluids – aircraft certification, ss 1.4, 1.5
aerodynamic effect of fluids – not addressed by AS5900 – handling issues during takeoff, ss 1.3, 2.2
aerodynamic effect of fluids – not addressed by AS5900 – performance issues during takeoff, ss 1.3, 2.2
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aircraft certification – Type II/III/IV – AFM – takeoff distance, s 4.1
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aircraft certification – Type II/III/IV – buffeting, s 3.6.2
aircraft certification – Type II/III/IV – effect in visibility of windshield, s 3.7
aircraft certification – Type II/III/IV – effect of heated surfaces, s 2.5
aircraft certification – Type II/III/IV – effect on air data probes, s 3.7
aircraft certification – Type II/III/IV – effect on airspeed probe, s 3.7
aircraft certification – Type II/III/IV – effect on altitude probe, s 3.7
aircraft certification – Type II/III/IV – effect on angle-of-attack sensors, s 3.7
aircraft certification – Type II/III/IV – effect on APU, s 3.7
aircraft certification – Type II/III/IV – effect on engine anti-ice system, s 3.7
aircraft certification – Type II/III/IV – effect on environmental control system, s 3.7
aircraft certification – Type II/III/IV – effect on fluid baking, ss 2.5, 3.5.1
aircraft certification – Type II/III/IV – effect on temperature probe, s 3.7
aircraft certification – Type II/III/IV – Flight Crew Operating Manual – deicing/anti-icing procedures, s 3.3
aircraft certification – Type II/III/IV – Flight Crew Operating Manual – cleaning procedures, s 3.1
aircraft certification – Type II/III/IV – flight tests, s 3.5
aircraft certification – Type II/III/IV – fluid application, ss 3.4.2-3.4.6
aircraft certification – Type II/III/IV – fluids to be tested, s 3.4.1
aircraft certification – Type II/III/IV – maintenance instructions – residue removal, s 3.1
aircraft certification – Type II/III/IV – maintenance instructions – residue cleaning procedures, s 4.3
aircraft certification – Type II/III/IV – regulatory requirements110, ss 1.4, 1.5
aircraft certification – Type II/III/IV – residue – inspection, s 3.1
aircraft certification – Type II/III/IV – residue – maintenance instructions, s 3.1
aircraft certification – Type II/III/IV – takeoff angle-of-attack margin tests, s 3.5.3
aircraft certification – Type II/III/IV – takeoff at fixed pitch angle, s 3.5.2
aircraft certification – Type II/III/IV – takeoff performance, s 3.5.4
aircraft certification – Type II/III/IV – test day temperature, s 3.4.3
aircraft certification – Type II/III/IV – test deicing/anti-icing procedures, s 3.4.5
aircraft certification – Type II/III/IV – training, s 3.5.6
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leading edge, heated. See Type II/III/IV – degradation, thermal – heated leading edge dry-out
Type II/III/IV – baking. See Type II/III/IV – degradation, thermal – heated leading edge dry-out
Type II/III/IV – degradation, thermal – heated leading edge dry-out, s 2.5
Type II/III/IV – residue – dried, s 2.4

110 This Transport Canada document refers to SAE Type I/II/II/IV. However, testing is recommended on Type III/IV fluids. Since the equivalent FAA document focuses more on the effects of Type II/III/IV, to simplify indexing, we index this document referring to Type II/III/IV.
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Type II/III/IV – residue – effect on flight control systems, s 2.4
Type II/III/IV – residue – flight control restrictions, s 2.4
Type II/III/IV – residue – frozen, s 2.4
Type II/III/IV – residue – in aerodynamically quiet areas, s 2.4
Type II/III/IV – residue – rehydrated, s 2.4
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Type II/III/IV – residue inspection – periodic, s 4.3
Type II/III/IV – residue reduction – aircraft design modifications, s 2.4
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Type II/III/IV – residue reduction – specific deicing/anti-icing procedures, s 2.4

Transport Canada, Commercial and Business Aviation Inspection and Audit (Checklists) Manual, 1st ed, TP 13750E

Issued by 2000-10 by Transport Canada.¹¹¹

TP 13750E is a ground icing operations program checklist issues by Transport Canada.

Only the ground icing operations section is indexed.

Keywords:
audit checklist (TC) – aircraft deicing/anti-icing procedures, pp 88, 90
audit checklist (TC) – aircraft inspection and reporting procedures, pp 88, 90–91
audit checklist (TC) – aircraft specific procedures, p 89
audit checklist (TC) – communications with flightcrew, p 94
audit checklist (TC) – contamination [frozen], effects of, pp 93, 94
audit checklist (TC) – contamination [frozen], recognition of, pp 90, 93
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audit checklist (TC) – FOD, p 95
audit checklist (TC) – flightcrew responsibilities, p 88
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audit checklist (TC) – fluids, identification of, p 93
audit checklist (TC) – fluids, use of, p 95
audit checklist (TC) – ground icing operations, send of, pp 89–90
audit checklist (TC) – ground icing operations, start of, pp 89–90
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audit checklist (TC) – ground icing program – chain of command, p 89
audit checklist (TC) – ground icing program – dissemination, p 89
audit checklist (TC) – ground icing program – publication, p 89

¹¹¹ Online: <https://www.tc.gc.ca/eng/civilaviation/publications/tp13750-menu-2404.htm>
audit checklist (TC) – ground icing program – revisions, p 95
audit checklist (TC) – ground icing program – service provider’s v operator’s, p 96
audit checklist (TC) – HOT for decision making, p 94
audit checklist (TC) – HOT, approval of, p 90
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audit checklist (TC) – HOT, use of, p 93
audit checklist (TC) – inspection reporting, p 92
audit checklist (TC) – management responsibilities, p 88
audit checklist (TC) – management supervision, p 88
audit checklist (TC) – operational procedures, p 88
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audit checklist (TC) – operator’s management plan, pp 88, 89
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audit checklist (TC) – personnel, sufficient, p 89
audit checklist (TC) – pretakeoff contamination inspection, p 91
audit checklist (TC) – representative surfaces, pp 91, 93
audit checklist (TC) – sensors, use of, p 91
audit checklist (TC) – service providers, supervision of, s 93
audit checklist (TC) – service providers, training of, p 96
audit checklist (TC) – tactile check, p 91
audit checklist (TC) – training and testing, pp 88, 92–96
audit checklist (TC) – training records, p 96
audit checklist (TC) – training – recurrent, p 93–96
audit checklist (TC) – training – initial, p 93–96
audit checklist (TC) – weather, p 90
Documents Issued by EASA


Issued 2015-12-16 by EASA.

Advisory information explaining the potentially deleterious effects of alkali metal organic salt salts (non-glycol based) as freezing point depressants in the formulation of Type I aircraft deicing fluids. These alkali salt based deicing fluids can have two adverse effects: 1) when used in the first step of a two-step deicing anti-icing, the organic slat based Type I fluid can interfere with the thickener system of Type II/II/IV fluids and reduce expected holdover time, with consequences affecting safety and 2) can facilitate galvanic corrosion of aircraft parts or the catalytic oxidation of aircraft carbon brakes.

Keywords:
alkali organic salt based Type I – guidance (EASA), pp 1–2
non-glycol based Type I – guidance (EASA), pp 1–2
Type I – Non-Glycol based – effect on Type II/III/IV, pp 1–2
Type I – Non-Glycol based – galvanic corrosion of metal parts, pp 1–2
Type I – Non-Glycol based – need for inspections, pp 1–2
Type I – Non-Glycol based – need for maintenance , pp 1–2


Issued 2017-11-14 by EASA.

As the AEA documents are no longer published, EASA Safety Information Buleting (SIB) 2017-11 recommends to European air operators the use the latest version of the global standards (SAE AS6285, AS6286, AS6286/1, AS686/2, AS6286/3, AS6286/4, AS6286/5, AS6285/6, AS6332, and AS6257), the FAA Holdover Time Guidelines and the FAA 8900.xxx documents to establish their ground deicing procedures.

Keywords:
AEA recommendations – publication discontinuation, p 2
EASA recommendation to use – FAA Holdover time Guidelines, pp 2–3
EASA recommendation to use – FAA Notice N 8900.xxx FAA-Approved Deicing program Updates, Winter 20xx-20yy, pp 2–3
EASA recommendation to use – global aircraft deicing standards, p 3
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FAA Holdover Time Guidelines – EASA recommendation to use, pp 2–3
FAA Notice N 8900.xxx FAA-Approved Deicing program Updates, Winter 20xx-20yy – EASA recommendation to use, pp 2–3
global aircraft deicing standards, pp 1–3
global aircraft deicing standards – EASA recommendation to use, p 3
global aircraft deicing standards – list, p 1
HOT (FAA) – recognition – EASA, p 2

EASA GM1 CAT.OP.MPA.250 Ice and Other Contaminants – Ground Procedures: Terminology

Issued 2012-10-25 by EASA.

Guidance Material (GM) issued by EASA consists of three sections labeled GM1, GM2 and GM3 of the Annex to Executive Director Decision ED 2012/018/R: Acceptable Means of compliance (AMC) and Guidance Material (GM) to Part-CAT.

Keywords:
aircraft icing, conditions conducive to, s (c) at 121
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anti-icing fluid – definition, s (a) at p 121
check, contamination. See contamination check
check, post-treatment (EASA), s (j) at p 122
check, pretakeoff (EASA). gate departure check pretakeoff check (EASA)
check, pretakeoff contamination (EASA). See pretakeoff contamination check (EASA)
clear ice – definition, s (b) at p 121
clear ice – conditions conducive to, s (b) at p 121
contamination – definition, s (d) at p 121
contamination check – definition, s (a) at p 121
definition – anti-icing fluid, s (a) at p 121
definition – clear ice, s (b) at p 121
definition – contamination check, s (a) at p 121
definition – contamination [frozen], s (d) at p 121
definition – deicing fluid, s (f) at p 121–122
definition – deicing/anti-icing procedure, s (g) at p 122
definition – GIDS, s (h) at p 122
definition – LOUT, s (i) at p 122
definition – pretakeoff contamination check (EASA), s (l) at p 122
definition – ROGIDS, s (h) at p 122
deicing fluid – definition, s (f) at p 121–122
deicing/anti-icing procedure – definition, s (g) at p 122
GIDS – definition, s (h) at p 122
GIDS. See also ROGIDS
ground ice detection system. See also ROGIDS

112 EASA uses the term GIDS (ground ice detection system), SAE uses the term ROGIDS (remote on-ground ice detection system for what appears to be the same reality.
ground ice detection system. See GIDS
LOUT – definition, s (i) at p 122
pretakeoff check (EASA), s (k) at p 122
pretakeoff contamination check (EASA) – definition, s (l) at p 122
ROGIDS – definition, s (h) at p 122

EASA GM2 CAT.OP.MPA.250 Ice and Other Contaminants – Ground Procedures: De-icing/Anti-icing Procedures

Issued 2012-10-25 by EASA.

Keywords:
anti-icing code, s (d) at p 125
check, contamination. See contamination check
check, post-treatment (EASA), s (a) at p 123, s (b) at p 124
check, tactile, s (b) at p 124
clear ice – detection of, s (a) at p 123
commander. See pilot-in-command
contamination check, s (a) at p 123, s (b) at p 124
definition – deicing/anti-icing, one-step, s (b) at p 123
definition – deicing/anti-icing, two-step, s (b) at p 123
deficing/anti-icing, one-step – definition, s (b) at p 123
deficing/anti-icing, two-step – definition, s (b) at p 123
fluid application – guidance (EASA), pp 123–126
fluid application – interruption of, s (a) at p 123
fluid application – unsuccessful, s (a) at p 123
fluid manufacturer documentation – fluid application, s h at p 126
fluid manufacturer documentation – fluid transfer system requirements, s h at p 126
fluid manufacturer documentation – fluid storage requirements, s h at p 126
fluid manufacturer documentation – Type II/III/IV residues, s (h) at p 126
cold – on lower wing surface, s (a) at p 123
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contamination [frozen] – removal with forced air, s (b) at p 123
contamination [frozen] – removal with hot water, s (b) at p 123
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pilot-in-command – situational awareness, s (8) at p 124
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pretakeoff contamination check (EASA), s (a) at p 123
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three-minute rule, s (b) at p 123
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Type II/III/IV – aircraft operational considerations – flightcrew briefing, s (c) at p 124
Type II/III/IV – aircraft operational considerations – increased takeoff speed, s (c) at p 124
Type II/III/IV – aircraft operational considerations – mass decrease, s (c) at p 124

113 See footnote 112.
114 EASA uses “commander”. FAA and Transport Canada tend to use the expression pilot-in-command or captain. Here we use pilot, pilot-in-command or flightcrew, as appropriate. Section 5.8 of AS6285C states that pilot-in-command is a synonym of commander.
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Type II/III/IV – aircraft operational considerations – stick force, s (c) at p 124
Type II/III/IV – aircraft operational considerations. See also aerodynamic effect of fluids – performance adjustments
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Type II/III/IV – residue – elevator jamming, s (h) at p 126
Type II/III/IV – residue – flap jamming, s (h) at p 126
Type II/III/IV – residue – flight control restrictions, s (h) at p 126
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EASA GM3 CAT.OP.MPA.250 Ice and Other Contaminants – Ground Procedures: De-icing/Anti-icing Background Information

Issued 2012-10-25 by EASA.

Keywords:
AEA recommendations\textsuperscript{115}, p 128
fluid effectiveness, loss of. See fluid failure
contamination [frozen] – effect on APU, s (a) at pp 126–127
contamination [frozen] – effect on control surfaces, s (a) at pp 126–127
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contamination [frozen] – effect on lift, s (a) at pp 126–127
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hazards of ice, snow and frost, s (a) at pp 126
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\textsuperscript{115} AEA recommendations are no longer published (as of December 2016). EASA now recommends using the global aircraft deicing standards and FAA documentation. See EASA Safety Information Bulletin 2017-11.
\textsuperscript{116} The expression “loss of fluid effectiveness” and “fluid failure” appears to be used interchangeably; however, there is a distinction to be made between visual failure and aerodynamic failure.
HOT, no (EASA) – high wind velocity, s (a) at p 127
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ICAO Doc 9640-AN/940 Manual of Aircraft Ground De-icing/Anti-icing Operations, 3 ed (advance unedited)

Revised 2018 by ICAO.

Doc 9640-AN/940 provides high level information on aircraft deicing/anti-icing. It summarizes the history of deicing, develops the notion of the clean aircraft concept, informs on deicing fluids, holdover time, on the various deicing checks to be done during deicing operations, distinguishes the responsibilities of the regulators and those of operators, discusses facility design, explains the necessity of air traffic control winter operations plan, summarizes deicing and anti-icing methods, and insists on the need for training and quality assurance. It recommends maintaining information updated and provides web links and bibliography to do such.

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This document has a short section\textsuperscript{117} that describes the standard phraseology to be used by flightcrew and ground crew in deicing/anti-icing operations. Only the section (12.7.2) dealing with deicing/anti-icing operations was indexed in the \textit{Guide}.

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Haruiko Oda et al, Safe Winter Operations

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Type II/III/IV – residue inspection – control linkages, p 6
Type II/III/IV – residue inspection – control tabs, p 6
Type II/III/IV – residue inspection – stabilizer rear spar, horizontal, p 6
Type II/III/IV – residue inspection – stabilizer, vertical, p 6
Type II/III/IV – residue inspection – wing leading edge devices, p 6
Type II/III/IV – residue – dried, p 6
Type II/III/IV – residue – rehydrated, p 6
Type II/III/IV – residue inspection – wing rear spar, p 6
Type II/III/IV – residue inspection, p 6
Type II/III/IV – residue, p 6
Type II/III/IV – wing anti-ice system OFF on ground, p 12
Wing anti-ice system – not a substitute for ground deicing, p 12
Winter operations – guidance (Boeing) – for flightcrews, pp 12–13
Winter operations – guidance (Boeing) – for maintenance crews, p 11
Winter operations – guidance (Boeing), pp 5–13
PART TWO: THE RUNWAY DEICING DOCUMENTS

A chart of the runway deicing documents can be found in Figure 2 at p 234.

Documents Issued by the SAE G-12 Runway Deicing Products Committee

AMS1431E Solid Runway Deicing/Anti-icing Product

Revised 2018-10-24 by SAE G-12 RDP.

AMS1431E sets the technical requirements for runway deicing and anti-icing products in the form of a solid. Runway deicing products (RDP) are used typically at airports on aircraft maneuvering areas, such as aprons, runways, and taxiways, for the prevention and removal of frozen deposits of snow, frost, and ice.

Keywords:
aircraft maneuvering area deicing product. See RDP
airfield deicing fluid. See RDP
apron deicing product. See RDP
definition – RDP, solid – lot, s 4.3
RDP, solid – acceptance tests – chloride content, s 4.2.1
RDP, solid – acceptance tests – flash point, s 4.2.1
RDP, solid – acceptance tests – total water content, s 4.2.1
RDP, solid – AIR6130 reporting, s 3.2.9.3.1
RDP, solid – airfield use label, s 5.1.2
RDP, solid – appearance, s 3.1.5
RDP, solid – approval by purchaser, s 4.4
RDP, solid – aquatic toxicity, s 3.1.1.4
RDP, solid – asphalt concrete degradation resistance, s 3.8.2.2
RDP, solid – biodegradation, s 3.1.1.3
RDP, solid – BOD, s 3.1.1.1
RDP, solid – brining, s 1.3.1.1
RDP, solid – cadmium as contaminant, s 3.1.2
RDP, solid – cadmium corrosion, s 3.2.9.3.1
RDP, solid – carbon brake oxidation, s 3.2.11
RDP, solid – changes in ingredients, s 4.4.2
RDP, solid – changes in manufacturing, s 4.4.2
RDP, solid – chloride content, ss 3.2.3, 4.2.1
RDP, solid – chromium as contaminant, s 3.1.2
RDP, solid – commingling, s 1.3.1
RDP, solid – compatibility with other RDP, s 1.3.1
RDP, solid – composition, s 3.1
RDP, solid – containers, ss 5.1.2, 5.1.4, 8.4
RDP, solid – delivery, s 5
RDP, solid – dissolution, s 1.3.1.1
RDP, solid – ecological behavior, s 3.1.1.4
RDP, solid – effect on aircraft metals, s 3.2.9
RDP, solid – effect on asphalt concrete, ss 3.2.8.2, 4.2.2, Appendix A
RDP, solid – effect on carbon brake systems, s 3.2.11
RDP, solid – effect on painted surfaces, ss 3.2.6, 4.2.2
RDP, solid – effect on runway concrete, s 3.2.8.1, 4.2.2
RDP, solid – effect on transparent plastics, ss 3.2.5, 4.2.2
RDP, solid – effect on unpainted surfaces, ss 3.2.7, 4.2.2
RDP, solid – Federal (US) Supply Classification 6850, s 8.4
RDP, solid – flash point, ss 3.2.2, 4.2.1
RDP, solid – freezing point curve, s 3.1.4
RDP, solid – friction evaluation, s 1.3.2
RDP, solid – halogens as contaminant, s 3.1.2
RDP, solid – handling, s 5.1.4
RDP, solid – heavy metals as contaminant, s 3.1.2
RDP, solid – hydrogen embrittlement, s 3.2.9.4
RDP, solid – ice melting, s 3.2.10
RDP, solid – ice penetration, s 3.1.10
RDP, solid – ice undercutting, s 3.2.10
RDP, solid – independent laboratory testing, ss 4.1, 4.5
RDP, solid – inspection, s 4.1
RDP, solid – labels, s 5
RDP, solid – lead as contaminant, s 3.1.2
RDP, solid – licensee, s 4.4.3
RDP, solid – liquefaction 119, s 1.3.1.1
RDP, solid – lot – acceptance tests, s 4.2.1
RDP, solid – lot – definition, s 4.3
RDP, solid – lot number, s 5.1.2
RDP, solid – low embrittling cadmium plate, s 3.2.9.3
RDP, solid – mercury as contaminant, s 3.1.2
RDP, solid – multiple location tests, s 4.4.3
RDP, solid – nitrate as contaminant, s 3.1.2
RDP, solid – packaging, ss 5.1, 8.4
RDP, solid – performance, s 3.2.10
RDP, solid – periodic tests, s 4.2.2
RDP, solid – pH, ss 3.2.1, 4.2.1
RDP, solid – phosphate as contaminant, s 3.1.2
RDP, solid – physical properties, s 3.2
RDP, solid – preproduction tests, s 4.2.3
RDP, solid – production same as approved sample, s 4.4.2
RDP, solid – purchase orders, s 6
RDP, solid – quotation, s 6
RDP, solid – rejection, s 7
RDP, solid – reports, s 4.5
RDP, solid – resampling, s 4.6
RDP, solid – retesting, s 4.6
RDP, solid – right-to-know regulations, s 5.1.3
RDP, solid – runway concrete surface scaling resistance, s 3.2.8.1
RDP, solid – safety data sheet, s 4.5.1
RDP, solid – sampling plan, s 4.3
RDP, solid – sampling, s 4.3

119 Usually liquefaction is a process whereby, in a phase transition, a gas or a solid becomes a liquid. In this case, it seems dissolution would be a better term as the RDP is dissolved in water to form a solution. The dissolution process of a salt is also known as brining.
AMS1435D Liquid Runway Deicing Product

Revised 2018-11-02 by SAE G-12 RDP.

AMS1435 sets the technical requirements for runway deicing and anti-icing products in the form of a liquid. Runway deicing products are used typically at airports on aircraft maneuvering areas, such as aprons, runways, and taxiways, for the prevention and removal of frozen deposits of snow, frost, and ice. Runway deicing products (RDP) in liquid form, sometimes called runway deicing fluids, must never be used as aircraft deicing fluid.

Keywords:
aircraft maneuvering area deicing product. See RDP
airfield deicing fluid. See RDP
apron deicing product. See RDP
definition – RDP, liquid – lot, s 4.3
fluid runway and taxiway deicing/anti-icing compound. See RDP, liquid
liquid runway and taxiway deicing/anti-icing compound. See RDP, liquid
RDF. See RDP, liquid
RDP, fluid. See RDP, liquid
RDP, liquid – acceptance tests – flash point, s 4.2.1
RDP, liquid – acceptance tests – pH, s 4.2.1
RDP, liquid – acceptance tests – specific gravity, s 4.2.1
RDP, liquid – AIR6130 reporting, s 3.2.5.3.1
RDP, liquid – airfield use label, s 5.1.2
RDP, liquid – appearance, s 3.1.2
RDP, liquid – approval by purchaser, s 4.4.1
RDP, liquid – aquatic toxicity, s 3.1.1.2
RDP, liquid – asphalt concrete degradation resistance, ss 3.2.10.2, 4.2.2
RDP, liquid – biodegradation, s 3.1.1.1
RDP, liquid – BOD, s 3.1.1.1
RDP, liquid – bulk shipments, s 4.3.2
RDP, liquid – cadmium as contaminant, s 3.1.1.3
RDP, liquid – cadmium corrosion, s 3.2.5.3
RDP, liquid – carbon brake oxidation, s 3.2.13
RDP, liquid – changes in ingredients, s 4.4.2
RDP, liquid – changes in manufacturing, s 4.4.2
RDP, liquid – chromium as contaminant, s 3.3.1.3
RDP, liquid – commingling, s 1.3.1
RDP, liquid – compatibility with other RDP, s 1.3.1
RDP, liquid – composition, s 3.1
RDP, liquid – containers, ss 5.1.1, 5.1.2, 5.1.4, 8.4
RDP, liquid – delivery, s 5
RDP, liquid – dilution, s 1.3.1.1
RDP, liquid – drum shipments, s 4.3.1
RDP, liquid – ecological behavior, s 3.1.1.2
RDP, liquid – effect on aircraft materials, ss 3.2.5, 4.2.2
RDP, liquid – effect on asphalt concrete, ss 3.2.10.2, 4.2.2, Appendix A
RDP, liquid – effect on carbon brake systems, s 3.2.13
RDP, liquid – effect on painted surfaces, ss 3.2.7, 4.2.2
RDP, liquid – effect on runway pavement, s 3.2.10
RDP, liquid – effect on transparent plastics, ss 3.2.6, 4.2.2
RDP, liquid – effect on unpainted surface, ss 3.2.8, 4.2.2
RDP, liquid – Federal (US) Supply Classification 6850, s 8.5
RDP, liquid – flash point, ss 3.2.1, 4.2.1
RDP, liquid – formamide, s 1.1.3
RDP, liquid – freezing point, ss 3.2.4. 4.2.2
RDP, liquid – friction evaluation, s 1.3.2
RDP, liquid – halogens as contaminant, s 3.1.1.3
RDP, liquid – handing, s 5.1.4
RDP, liquid – heavy metals as contaminant, s 3.1.1.3
RDP, liquid – hydrogen embrittlement, s 3.2.5.4
RDP, liquid – ice melting, s 3.2.12
RDP, liquid – ice penetration, s 3.1.12
RDP, liquid – ice undercutting, s 3.2.12
RDP, liquid – independent laboratory testing, ss 4.1, 4.5
RDP, liquid – inspection, s 4.1
RDP, liquid – labels, s 5
RDP, liquid – lead as contaminant, s 3.1.1.3
RDP, liquid – licensee, s 4.4.3
RDP, liquid – lot – acceptance, s 4.2.1
RDP, liquid – lot – definition, s 4.3
RDP, liquid – lot number, ss 4.5, 5.1.2
RDP, liquid – low embrittling cadmium plate, s 3.2.5.3
RDP, liquid – mercury as contaminant, s 3.1.1.3
RDP, liquid – nitrate as contaminant, s 3.1.1.3
RDP, liquid – packaging, ss 5.1.4, 5.1.5, 8.4
RDP, liquid – performance, s 3.2.12
RDP, liquid – periodic tests, s 4.2.2
AIR6130A Cadmium Plate Cyclic Corrosion Test

Revised 2017-05-18 by SAE G-12 RDP.

AIR6130A describes a 14-day material test to determine the cyclic effects of runway deicing products on aircraft cadmium plated parts. Some runway and taxiway deicing/anti-icing products, have been found to cause severe corrosion on aircraft components with cadmium plating. There is a need for users to understand the effect of these products on aircraft components when they are exposed repeatedly in a normal winter operating environment. The existing test in the AMS1431E and AMS1435D specifications for runway deicing products is a one-time 24-hour immersion test
for cadmium corrosion, which does not accurately reflect how aircraft and airport equipment are affected by runway deicers. AIR6130 with its 14-day cyclic test is intended to provide better information to the end user/purchaser of the deicing products regarding the cyclic effects on cadmium plated aircraft parts or airport equipment. The document is intended to be referred to by the AMS1431 and AMS1435 specifications, which will then provide more useful information to the end-users in the test report.

Keywords:
cadmium plate corrosion test – AMS1431 sample, s 3c
cadmium plate corrosion test – AMS1435 sample, s 3b
cadmium plate corrosion test – cleaning of test specimens, s 5b
cadmium plate corrosion test – criterion for undesirable corrosion effects, s 6
cadmium plate corrosion test – gravimetric results, ss 5i., 5l.
cadmium plate corrosion test – procedure, s 5
cadmium plate corrosion test – runway deicing compound sample, s 3
cadmium plate corrosion test – sample preparation, s 4
cadmium plate corrosion test – steel substrate, s 3
cadmium plate corrosion test – test coupons, s 3
cadmium plate corrosion test – test results, s 6
cadmium plate corrosion test – test specimen, s 3
cadmium plated aircraft parts – RDP caused corrosion, s 1
cadmium plated aircraft parts corrosion test. See cadmium plate corrosion test
corrosion of cadmium plated aircraft parts – undesirable corrosion criterion, s 6
corrosion of cadmium plated aircraft parts, s 1
RDP – cadmium plate corrosion test, Title at p 1, s 1
RDP – undesirable corrosion criterion, s 6
RDP caused corrosion – undesirable corrosion criterion, s 6
runway deicing fluid. See RDP, liquid
runway deicing/anti-icing compound. See RDP
taxiway deicing/anti-icing compound. See RDP

**AIR6170A Ice Melting Test Method for Runways and Taxiways Deicing/Anti-icing Chemicals**

Revised 2017-01-21 by SAE G-12 RDP.

AIR6170A describes a quantitative test method for liquid and solid deicing/anti-icing products, to evaluate the amount of ice melted as a function of the time and temperature.

Keywords:
AMS1431 RDP ice melting test. See RDP ice melting test
AMS1435 RDP ice melting test. See RDP ice melting test
ice melting test for RDP. See RDP ice melting test
ice melting test. See RDP ice melting test
RDP – comparative melting capability, s 3.2
RDP – use on taxiways, s 1
RDP ice melting capability, comparative, s 3.2
RDP ice melting relative capacity, s 1
RDP ice melting test ice preparation, s 3.3.5
RDP ice melting test procedure, s 3.4
RDP ice melting test reference control solution, ss 3.5.3, 3.5.3.1, 3.5.3.2
RDP ice melting test report, s 3.8
RDP ice melting test sample preparation, ss 3.5.1, 3.5.2
RDP ice melting test significance, s 1
RDP ice melting test significance, ss 1, .2
RDP ice melting test temperatures ss 3.6, 3.7
RDP ice melting test, Title at p 1
RDP ice melting v temperature, ss 1, 3.8
RDP ice melting v time, ss 1, 3.8
RDP, liquid – ice melting test. See RDP ice melting test
RDP, solid – ice melting test. See RDP ice melting test
SHRP H-332, s 2

AIR6172A Ice Undercutting Test Method for Runways and Taxiways Deicing/Anti-icing Chemicals

Revised 2017-03-15 by SAE G-12 RDP.

AIR6172A describes a quantitative test method, for liquid and solid runway deicing/anti-icing products (RDP), to evaluate the ice undercut as a function of the time and temperature.

Keywords:
AMS1431 RDP ice undercutting test. See RDP ice undercutting test
AMS1435 RDP ice undercutting test. See RDP ice undercutting test
ice undercutting test, RDP. See RDP ice undercutting test, Title at p 1
ice undercutting test. See RDP ice undercutting test
RDP ice undercutting test description, s 3.1
RDP ice undercutting test dye, ss 3.3.1, 3.4.4
RDP ice undercutting test dye – rhodamine, s 3.3.3
RDP ice undercutting test dye – fluorescein, s 3.3.3
RDP ice undercutting test equipment, s 3.3
RDP ice undercutting test ice cavity preparation, s 3.3.6
RDP ice undercutting test ice preparation, s 3.3.5
RDP ice undercutting test procedure, s 3.4
RDP ice undercutting test reference control solution, ss 3.4.3, 3.4.3.1, 3.4.3.2
RDP ice undercutting test reference control solution – 25% w/w potassium acetate solution, s 3.4.3.2
RDP ice undercutting test report, s 3.7
RDP ice undercutting test sample preparation, ss 3.4.1, 3.4.2
RDP ice undercutting test significance, s 3.2
RDP ice undercutting test temperature, s 3.5, 3.6
RDP ice undercutting test, Title at p 1
RDP, liquid – ice undercutting test. See RDP ice undercutting test
RDP, solid – ice undercutting test. See RDP ice undercutting test
SHRP H-332, s 2.4
AIR6211A Ice Penetration Test Method for Runways and Taxiways Deicing/Anti-Icing Chemicals

Revised 2017-05-08 by SAE G-12 RDP.

AIR6211A describes a quantitative method, for liquid and solid runway deicing/anti-icing products (RDP), to evaluate the ice penetration as a function of the time and temperature.

Keywords:
AMS1431 RDP ice penetration test. See RDP ice penetration test
AMS1435 RDP ice penetration test. See RDP ice penetration test
ice penetration test. See RDP ice penetration test
RDP ice penetration test – description, s 3.1
RDP ice penetration test dye, s 3.4.4
RDP ice penetration test ice preparation, s 3.3.4
RDP ice penetration test procedure, s 3.4
RDP ice penetration test reference control solution – potassium acetate 50%, s 3.4.3.1
RDP ice penetration test reference control solution – potassium acetate 25%, s 3.4.3.2
RDP ice penetration test reference control solution,
RDP ice penetration test reference control solution, s 3.4.3
RDP ice penetration test significance – reporting, s 3.7
RDP ice penetration test significance, s 3.2
RDP ice penetration test temperature, ss 3.6, 3.7
RDP ice penetration test time, s 3.7
RDP ice penetration test, Title at p 1
RDP, liquid – ice penetration test. See RDP ice penetration test
RDP, solid – ice penetration test. See RDP ice penetration test
SHRP H-332, s 2.4

Documents Issued by the SAE A-5A Wheels, Brakes and Skid Control Committee

AIR5490A Carbon Brake Contamination and Oxidation

Revised 2016-04-12 by SAE A-5A.

This document provides information on the susceptibility of aircraft carbon brake discs to contamination and oxidation. Carbon used in the manufacture of aircraft brake discs is porous, and can absorb liquids and contaminants, such as runway deicing products (RDP), aircraft deicing fluids (ADF), sea water, aircraft hydraulic fluid, aircraft wash fluids, sea water, cleaning solvents, etc. Some of the contaminants can negatively impact the intended performance of the brakes, particularly through catalytic oxidation of the carbon.
Although aircraft carbon brakes had been operating for many years with the occasional oxidative degradation issues, the introduction of environmentally-friendly, low BOD, alkali organic salt based runway deicing products in the 1990s resulted in significant increases in the frequency of occurrences and severity of carbon brake disk degradation. The catalytic oxidative action is attributed to the alkali moiety of the organic salts.

This document intends to raise awareness of the effects of carbon brake contamination and present information on the chemicals promoting catalytic oxidation, the mechanism of oxidation, and inspection technique on and off the aircraft.\textsuperscript{120}

Keywords:
aircraft carbon brake. See carbon brake
aircraft deicing fluid. See deicing fluid
aircraft hydraulic fluid – definition, s 2.2
aircraft lubricant – definition, s 2.2
airplane. See aircraft
carbon brake – antioxidant treatment – barrier coating, s 5.2.4a
carbon brake – antioxidant treatment – barrier coating, self-healing, s 5.2.4a
carbon brake – antioxidant treatment – chemical vapor infiltration, s 5.2.5
carbon brake – antioxidant treatment – densification of the polyacrylonitrile fibers, s 5.2.5
carbon brake – antioxidant treatment – disk soaking, s 5.2.4a
carbon brake – antioxidant treatment – oxidation inhibitor, phosphate based, s 5.2.4b
carbon brake – antioxidant treatment – oxidation inhibitor, s 5.2.4b
carbon brake – antioxidant treatment – oxidation resistance of the carbon, s 5.2.5
carbon brake – antioxidant treatment – phosphate solution, s 5.2.4b
carbon brake – antioxidant treatment – porosity of the carbon, s 5.2.5
carbon brake – antioxidant treatment, s 2.2
carbon brake – catalytic oxidation. See carbon brake oxidation
carbon brake – contamination. See carbon brake contamination
carbon brake – degradation, Rationale at p 1
carbon brake – friction and wear modifier – definition, s 4.2.2
carbon brake – friction material, s 3
carbon brake – inspection, Rationale at p 1
carbon brake – operating temperature v steel brake operating temperature, s 3a
carbon brake – oxidation. See carbon brake oxidation
carbon brake – removal criteria, s 5.4.3.2
carbon brake – return-to-service criteria, s 5.4.4.2
carbon brake – smoke from, s 4.2.1 note
carbon brake contamination – decontamination method, s 8
carbon brake contamination – detection – chromatography, s 5.4

\textsuperscript{120} SAE Committee A-5A appears to use the word airplane rather than aircraft in the following expressions: airplane anti-icing/deicing fluids, airplane hydraulic fluids, airplane lubricants, and airplane wash fluids. In this \textit{Guide to Aircraft Ground Deicing}, we index the word “aircraft” rather than the word “airplane”. Specifically, Committee A-5A refers to airplane anti-icing/deicing fluids. SAE G-12 refers to them as aircraft deicing/anti-icing fluids. Here we follow SAE G-12 usage.
carbon brake contamination – detection – conductivity measurement, s 5.4
carbon brake contamination – detection – discoloration, s 5.4.1
carbon brake contamination – detection – hardness probes, with, s 5.4
carbon brake contamination – detection – odor, s 5.4
carbon brake contamination – detection – off-aircraft inspection, s 5.4.4
carbon brake contamination – detection – on-aircraft inspection, s 5.4.3
carbon brake contamination – detection – smoke, s 5.4
carbon brake contamination – detection – spectrometry, s 5.4
carbon brake contamination – detection – staining, s 5.4
carbon brake contamination – detection – visual, by, ss 5.4, 5.4.1, 5.4.2, 5.4.3.1
carbon brake contamination – effect – aircraft runway over-runs, s 6.2
carbon brake contamination – effect – brake disk lug rupture, s 5.3.1
carbon brake contamination – effect – brake disk rupture, s 6.1
carbon brake contamination – effect – brake overheating, s 6.2
carbon brake contamination – effect – brake torque, s 4.2.2
carbon brake contamination – effect – brake vibrations, ss 4.2.2, 6.1
carbon brake contamination – effect – brake wear, s 4.2.2
carbon brake contamination – effect – brake wear, ss 3b, 6.3
carbon brake contamination – effect – catalytic oxidation, s 3a
carbon brake contamination – effect – complete loss of braking capability, s 5.3.1
carbon brake contamination – effect – friction coefficient, increase and decrease, s 6.2
carbon brake contamination – effect – increased aircraft braking distance in rejected takeoff, s 5.3.1
carbon brake contamination – effect – loss in braking performance, ss 3a, 5.3.1
carbon brake contamination – effect – loss of brake disk reuse capability, s 5.3.3
carbon brake contamination – effect – loss of friction area, s 3a
carbon brake contamination – effect – loss of mechanical strength, s 3a
carbon brake contamination – effect – loss of rubbed area, s 3a
carbon brake contamination – effect – mass loss, s 5.1.2
carbon brake contamination – effect – of humidity on friction coefficient of contaminated brakes, s 6.2
carbon brake contamination – effect – overheating of other brakes, s 6.2
carbon brake contamination – effect – partial loss of braking capability, s 5.3.1
carbon brake contamination – effect – premature brake removal, s 5.3.2
carbon brake contamination – effect – runway over-runs, s 6.2
carbon brake contamination – effect – structural brake disc failure, ss 3a, 5.3
carbon brake contamination – effect – temporary or permanent change in friction level, ss 3b, 6.2
carbon brake contamination – effect – torque reduction, s 3
carbon brake contamination – effect – uneven braking, s 6.2
carbon brake contamination – effect – vibration, squeal, s 6.1
carbon brake contamination – effect – vibration, whirl, s 6.1
carbon brake contamination – prevention – phosphate solutions 121, s 5.2.4b
carbon brake contamination – prevention – use of wheel covers, s 7
carbon brake contamination – source – acetate v formate, s 4.2.1b
carbon brake contamination – source – aircraft deicing fluids, s 4.1b
carbon brake contamination – source – aircraft hydraulic fluids, s 4.1e
carbon brake contamination – source – aircraft hydraulic fluids, phosphate ester based, s 4.1e
carbon brake contamination – source – aircraft lubricants, s 4.1d
carbon brake contamination – source – aircraft wash fluids, s 4.1c
carbon brake contamination – source – alkali metal salts, s 4.2.1b
carbon brake contamination – source – alkali organic salts, s 4.2.1b
carbon brake contamination – source – automatic aircraft washing systems, s 7

121 Section 8 of AIR5490 stated that brake manufacturers had used phosphate or boron solutions to protect against oxidation. Boron solution was deleted from AIR5490A; no explanation was given.
carbon brake contamination – source – calcium salts, s 4.2.1c
carbon brake contamination – source – catalyst – alkali metal based RDP, s 4.2.1b
carbon brake contamination – source – catalyst – anti-viral agent, s 4.2.1f
carbon brake contamination – source – catalyst – calcium from cleaning agents, s 4.2.1c
carbon brake contamination – source – catalyst – disinfectants, ss 4.2.1f, 5.2.9
carbon brake contamination – source – catalyst – potassium acetate, s 4.2.1b
carbon brake contamination – source – catalyst – potassium formate, s 4.2.1b
carbon brake contamination – source – catalyst – potassium from cleaning agents, s 4.2.1c
carbon brake contamination – source – catalyst – potassium in Purple K fire extinguishers, s 4.2.1k
carbon brake contamination – source – catalyst – RDP, s 4.2.1b
carbon brake contamination – source – catalyst – sodium acetate, s 4.2.1b
carbon brake contamination – source – catalyst – sodium formate, s 4.2.1b
carbon brake contamination – source – catalyst – sodium from cleaning agents, ss 4.2.1a, 4.2.1c
carbon brake contamination – source – catalyst – sodium from sea water, s 4.2.1a
carbon brake contamination – source – catalyst – sodium hypochlorite, ss 4.2.1f, 5.2.9
carbon brake contamination – source – catalyst – temperature indicating crayon marks, s 4.2.1e
carbon brake contamination – source – catalyst, s 4.2.1
carbon brake contamination – source – cleaning solvents, ss 4.1g, 5.2.8
carbon brake contamination – source – disinfectants, bleach containing, ss 4.1h, 5.2.9
carbon brake contamination – source – disinfectants, calcium containing, s 4.1h
carbon brake contamination – source – disinfectants, chlorine\(^\text{122}\) containing, ss 4.1h, 5.2.9
carbon brake contamination – source – disinfectants, citric acid containing, s 4.1h
carbon brake contamination – source – disinfectants, hypochlorite containing, ss 4.1h, 5.2.9
carbon brake contamination – source – disinfectants, potassium containing, s 4.1h
carbon brake contamination – source – disinfectants, sodium containing, s 4.1h
carbon brake contamination – source – disinfectants, ss 4.1h, 5.2.9
carbon brake contamination – source – fire extinguishing agent, ss 4.1f, 4.2.2
carbon brake contamination – source – formate v acetate, s 4.2.1b
carbon brake contamination – source – hydraulic fluid leaks, s 4.2.2
carbon brake contamination – source – hydraulic system servicing, s 4.2.2
carbon brake contamination – source – RDP, s 4.1a
carbon brake contamination – source – sea water, s 4.1j
carbon brake contamination – source – solvents, cleaning, ss 4.1g, 5.2.8
carbon brake contamination – source – temperature indicator crayon marks, s 4.1i
carbon brake oxidation – oxidation effects v cumulative thermal load, s 5.3
carbon brake oxidation – temperature in absence of contamination [ca 400 °C], s 5.1.1
carbon brake oxidation – variables – aircraft deicing fluids, s 5.2.7
carbon brake oxidation – variables – airline route structure, s 5.2.6
carbon brake oxidation – variables – airport selection of RDP, s 5.2.6
carbon brake oxidation – variables – alcohol based RDP, s 5.2.6
carbon brake oxidation – variables – alkali metal acetate based RDP, s 5.2.6
carbon brake oxidation – variables – alkali metal formate based RDP, s 5.2.6
carbon brake oxidation – variables – ambient temperature, s 5.2.1
carbon brake oxidation – variables – antioxidant coatings, s 5.2.4
carbon brake oxidation – variables – antioxidant treatment, s 5.2.4
carbon brake oxidation – variables – brake wear, s 5.2.1
carbon brake oxidation – variables – cleaners, s 5.2.8
carbon brake oxidation – variables – cooling air, s 5.2.2
carbon brake oxidation – variables – cooling ducts in wheel bay, s 5.2.2
carbon brake oxidation – variables – cooling fans, s 5.2.2

\(^{122}\) ARP5490A, in section 4.1h, lists chlorine containing disinfectants as potential source of carbon brake contamination. Chlorine is meant to include hypochlorite and bleach (see section 5.2.9).
carbon brake oxidation – variables – energy absorbed during braking, s 5.2.1
carbon brake oxidation – variables – length of winter, s 5.2.6
carbon brake oxidation – variables – mass of carbon heat sink, s 5.2.1
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carbon brake oxidation – variables – ram air cooling, s 5.2.2
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definition – runway anti-icing/deicing solids and fluids, s 2.2
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lubricant, aircraft – definition, s 2.2
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RDP – catalytic oxidation of carbon brakes, Rationale at p 1, s 1
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RDP – market introduction history, Rationale at p 1, s 5.2.6
RDP – oxidation of carbon brakes, Rationale at p 1, s 1,
runway anti-icing/deicing solids and fluids – definition, s 2.2

AIR5490A, in section 2.2, defines hygroscopic as absorbs liquid. Hygroscopic is usually defined as the property of a substance that takes up and retains moisture.
AIR5567A Test Method for Catalytic Brake Oxidation

Issued 2015-08-17 by SAE A-5A.

This test method provides stakeholders including fluid manufacturers, brake manufacturers, aircraft constructors, aircraft operators and airworthiness authorities with a relative assessment of the effect of runway deicing products on carbon brake oxidation. This simple test is only designed to assess the relative effects of runway deicing products by measuring mass change of contaminated and bare carbon samples tested under the same conditions. It is not possible to set a general acceptance threshold oxidation limit based on this test method because carbon brake oxidation is a function of heat sink design and the operating environment.

Keywords:
aircraft carbon brake. See carbon brake
alkali metal salts – effect on carbon brakes, p 1
decarbonized soil – catalyst for carbon brake oxidation, p 1
carbon brake – antioxidant treatment – generic, s 3.2
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RDP – catalytic oxidation of carbon brakes, p 1
RDP – effect on carbon brakes p 1, s 1
Documents Issued by SAE G-15 Airport Snow and Ice Control

AMS1448B Sand, Airport Snow and Ice Control


This is a stabilized document meaning it is no longer updated by SAE G-15 and is not known to be used actively by air carriers or operators.

It is included in this Guide as, from time to time, questions are asked on the effects of sand upon aircraft components which are discussed briefly in AMS1448B.

Keywords:
sand – aircraft engine, detrimental to, s 1.3
sand – boxed dry, s 3.1
sand – chlorides as contaminant, s 3.2.1
sand – containers, s 5
sand – effect on aircraft engines, s 1.3
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sand – free from clay, s 3.1
sand – free from debris, s 3.1
sand – free from organic matter, s 3.1
sand – free from salts, s 3.1
sand – free from stones, s 3.1
sand – gradation, s 3.1.1
sand – impurities, s 3.1
sand – periodic tests, s 4.2.2
sand – preproduction tests, s 4.2.3
sand – quality assurance, s 4
sand – rejection, s 7
sand – report, s 4.5
sand – sampling, s 4.3
sand – specification, title at p 1
sand – use on ramp, s 1.2
sand – use on runway, s 1.2
sand – use on taxiway, s 1.2
sand – washed, s 3.1
sand – washed, s 3.1

Documents Issued by the FAA

FAA Special Airworthiness Information Bulletin SAIB NM-08-27R1 Landing gear: Catalytic Oxidation of Aircraft Carbon Brakes due to Runway De-icing (RDI) Fluids

Issued 2008-12-31 by the FAA.
This bulletin informs aircraft owners and operators of the deleterious effect of alkali organic salt based runway deicing products on aircraft with carbon brakes. The alkali moiety of the organic salts is known to catalyze oxidation of the carbon with accompanying possible brake failure. The FAA recommends detailed visual inspection of carbon brake stators and rotors, looking for obvious damage. Depending on wheels removal frequency and findings, more frequent inspections may be appropriate to prevent reduction of brake effectiveness or brake failure.

Keywords:
carbon brake – inspection frequency, pp 2–3
carbon brake – inspection of rotor, pp 2–3
carbon brake – inspection of stator, pp 2–3
carbon brake contamination – detection – visual – carbon chips, p 2
carbon brake contamination – detection – visual – crushed carbon, p 2
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carbon brake contamination – effect – dragged brake, p 2
carbon brake contamination – effect – overheated brakes, p 2
carbon brake contamination – effect – vibrations, p 2
carbon brake contamination – process, pp 1-2
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carbon brake contamination – source – catalyst – potassium acetate, p 1
carbon brake contamination – source – catalyst – potassium formate, p 1
carbon brake contamination – source – catalyst – RDP, p 1
RDP – catalytic oxidation of carbon brakes, p 1
RDP – oxidation of carbon brakes, p 1

Documents Issued by Transport Canada

Transport Canada, Catalytic Oxidation of Aircraft Carbon Brakes due to Runway De-icing (RDI) Fluids, Service Difficulty Advisory AV-2009-03

Issued 2009-06-26 by Transport Canada.

This advisory informs aircraft owners and operators of the deleterious effect of alkali organic salt based runway deicing products on aircraft with carbon brakes. The alkali moiety of the organic salts is known to catalyze oxidation of the carbon with accompanying possible brake failure or
dragged bake and subsequent overheat. Transport Canada recommends detailed visual inspection of carbon brake stators and rotors at each landing gear wheel removal, looking for obvious damage.

Keywords:
carbon brake – inspection frequency, p 2
carbon brake – inspection of rotor, p 2
carbon brake – inspection of stator, p 2
carbon brake contamination – detection – visual – carbon chips, p 2
carbon brake contamination – detection – visual – crushed carbon, p 2
carbon brake contamination – detection – visual – damaged carbon, p 2
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carbon brake contamination – source – catalyst – RDP, p 1
RDP – catalytic oxidation of carbon brakes, p 1
RDP – oxidation of carbon brakes, p 1

Documents Issued by EASA

EASA Safety Information Bulletin SIB No.: 2018-01 Information on Materials Used for Runway and Taxiway De/Anti-icing

Issued 2018-01-09 by EASA.

Alkali organic salt based runway deicing products have deleterious effects on aircraft carbon brakes. The alkali organic salts penetrate carbon brakes lowering the oxidation temperature of the carbon resulting in structural deterioration of carbon discs, reducing efficiency and long-term efficiency of the brakes. EASA believes aircraft operators should be aware of the nature of the runway deicing products used at airports to assess exposure of the brakes to the alkali organic salts and adjust maintenance programs. This information should be noted in SNOWTAM or in the Aeronautical Information Publication (AIP).

Keywords
AIP reporting – RDP, p 1
EASA Safety Information Bulletin SIB No.: 2008-19R2 Catalytic Oxidation of Aircraft Carbon Brakes due to Runway De-icers

Revised 2013-04-23 by EASA.

This bulletin informs aviation stakeholders of the deleterious effect of alkali organic salt based runway deicing products on aircraft with carbon brakes. The alkali moiety of the organic salts is known to catalyze oxidation of the carbon with accompanying possible brake failure or dragged bake and subsequent overheat. EASA recommends detailed visual inspection of carbon brake stators and rotors at each landing gear wheel removal, looking for obvious damage. EASA further raises issues of cadmium and aluminum corrosion of landing gear joints and of electrical wire bundles, particularly those using Kapton® insulation, caused by alkali organic salts.

Keywords:
alkali organic salts – effect on aluminum, p 1
alkali organic salts – effect on cadmium, p 1
alkali organic salts – effect on carbon brakes, p 1
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alkali organic salts – effect on landing gear, p 2
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124 Trademark of E. I. du Pont de Nemours and Company.
Runway Deicing Documents – Issued by the FAA, Transport Canada and EASA

carbon brake contamination – detection – visual – damaged carbon, p3
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sodium acetate. See also alkali organic salts
sodium formate. See also alkali organic salts

EASA AMC1 ADR.OPS.C010 Pavements, Other Ground Surfaces, and Drainage

Issued 2017 by EASA.

This short document recommends to airport operators to maintain the good friction of paved runway. Specifically, it recommends removing dust, sand, oil, rubber deposits as rapidly and as completely as possible.

Keywords:
aprons, s (a)
dust, s (a)
friction, runway, ss (a), (d)
mud, s (a)
pavement, Title
rubber deposits, s (a)
ramp, s (a)
rampway friction, ss (a), (d)
sand, s (a)
taxiways, s (a)
Alkali organic salts used in runway deicing products (RDP), catalytically reduce the temperature at which aircraft brakes undergo oxidation. Catalytic oxidation of the carbon brakes discs results in the mechanical and structural degradation of the brakes. This leads to a reduced service life of the brakes and in some instances could result in brake fires or failures. The author recommends that airlines, airports, regulators and legislators engage in discussions to change the current practice of using alkali organic salts to maintain and improve aviation safety.

Keywords:
alkali organic salts – effect on carbon brakes, pp 19–24
carbon brake – advantages – better wear, p 20
carbon brake – advantages – high temperature stability, p 20
carbon brake – advantages – reuse of worn carbon discs, p 20
carbon brake contamination – effect – brake degradation, p 20
carbon brake contamination – effect – brake fire, p 23
carbon brake contamination – effect – brake softening, p 20
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carbon brake contamination – effect – flight cancellation, p 24
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125 (2014) 53 Q01 Boeing Aero Magazine 19, online:<
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carbon brake oxidation – mitigation – proper touchdown speeds, p 24
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potassium formate. See also alkali organic salts
RDP – oxidation of carbon brakes, pp 19–24
sodium acetate. See also alkali organic salts
sodium formate. See also alkali organic salts
Frequently Asked Questions

1. What are the differences between the FAA and Transport Canada (TC) Holdover Time Guidelines?\textsuperscript{126}

The FAA and Transport Canada Holdover Time (HOT) Guidelines are derived from the same data set. There are some differences:

- **Snowfall intensities.** The snowfall intensities as a function of prevailing visibility tables are significantly different.

- **Very light snow cells.** The TC tables provide one holdover time in each very light snow cell which is based on a rate of 4 g/dm²/h; the FAA tables provide two values in each cell based on rates of 3 and 4 g/dm²/h. Holdover time tables impacted: all.

- **Snow cells.** TC caps snow holdover times at 2 hours; FAA caps snow holdover times at 3 hours. This results in different holdover times in some cases. Holdover time tables impacted: select Type II and Type IV fluid specific and Type IV generic.

- **Light freezing rain “-3°C and above” and “below -3 to -6°C” cells.** The TC Type I holdover time tables give holdover times for these cells based on testing conducted at -6°C; the FAA Type I holdover time tables give holdover times for these cells based on testing conducted at -10°C. Holdover time tables impacted: Type I.

The HOT Guidelines must be read with their respective accompanying documents. For the FAA it is the *FAA Notice N 8900.525 Revised FAA–Approved Deicing Program Updates, Winter 2019–2020* and for TC, *Transport Canada Guidelines for Aircraft Ground Icing Operations TP 14052E, 4th ed, August 2019*. These two documents are significantly different.

\textsuperscript{126} Information provided by Stephanie Bendickson of APS Aviation with authorization by Antoine Lacroix of Transport Canada. Thank you.
2. **When does any SAE standard (AMS, AS, ARP, AIR) become effective?**

It becomes effective on the day of publication unless the standard states an effective date. There is no grace period.

Examples:
AMS14315D and AMS1431E only have publication dates and no separate effective date. Therefore they became effective on their respective publication dates.

AMS1435D became effective on 2018-11-02
AMS1431E became effective on 2018-10-24

3. **Does a manufacturer need to retest to all the technical requirements according the latest version of the Aerospace Material Specification (AMS)?**

My understanding is no; my answer is based on custom and purpose of the SAE standards in general, and of Aerospace Material Standards in particular.

Only the tests for which the technical requirements have changed need to be performed. Otherwise every time a specification is issued, all tests would have to be redone entirely. That would be expensive and inefficient. The purpose of issuing a revised version of a specification is to update whatever has been changed and not to force an entire requalification. For example, sometimes, a caution note will be added and none of the technical requirements change; in those instances, there is no need to retest the product.

4. **Is it necessary to wait for the result of the long term stability test before offering for sale a product according to a given AMS specification?**

The purchaser can waive this requirement until the results are known. It is generally understood and usual that purchasers will waive long term stability requirement until the results become available. The testing laboratory will generally state on the qualification report that the long term stability test is under way.

5. **Can a purchaser waive a requirement?**

There are provisions usually in AMS standards for a purchaser to waive a requirement. For instance see section 7 of AMS1431E and of AMS1435C:
7. REJECTIONS
Product not conforming to this specification, or to modifications authorized by purchaser, will be subject to rejection.

The words “modifications authorized by the purchaser” would include waiving of a requirement. If the purchaser waives a requirement, it should be understood that the purchaser has the required competence and or authority, particularly if regulated, to waive the requirement.

6. Are residual fluid and fluid residue the same?
No. Residual fluid refers to Type I, II, III or IV fluid that is left on the surface of the aircraft during flight or after flight.

Fluid residue is usually Type II, III or IV that has dried up in aerodynamically quiet areas of the aircraft. The dried up residue can rehydrate when exposed to rain and humidity to form a gel that can freeze and impede the movement of control surfaces.
# List of Preferred Words and Expressions

<table>
<thead>
<tr>
<th>Preferred</th>
<th>Avoid</th>
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<tr>
<td>1,3-propanediol</td>
<td>1,3-Propanediol</td>
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<td>deicing/anti-icing code</td>
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<td>gate</td>
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<td>hoarfrost</td>
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<td>MOWV</td>
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<td>in-flight (adjective)</td>
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<td>impact ice</td>
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\(^{127}\) Aerodrome is used in the expression “Terminal Aerodrome Forecast” (TAF).

\(^{128}\) See footnote 5.
message board
pilot-in-command
pilot-in-command
pilot-in-command
post deicing/anti-icing check
post deicing/anti-icing check
post deicing/anti-icing check
pre-deicing process
pre-deicing process
pre-deicing process
pre-takeoff contamination check
pre-takeoff contamination check
pre-takeoff contamination check
pre-takeoff
pre-takeoff
program
propylene glycol
rehydrated
rotorcraft
safety data sheet
SDS
service provider
takeoff
takeoff
tote
walk-around

signboard
commander
pilot in command
Pilot-in-Command
post application check
post deicing check
post-deicing check
pre-deicing step
pre-step
pre-takeoff contamination check
pre-takeoff contamination check
pretakeoff contamination inspection
pre takeoff
pre-takeoff
programme
Propylene Glycol
re-hydrated
helicopter
material safety data sheet
MSDS
FBO
take off
take-off
1 m³ container
walk around
Figure 2 Runway Deicing Documents

Testing Procedures
- AIR6130A Cadmium Plate Corrosion Test
- AIR6170A Ice Melting Method
- AIR6172A Ice Undercutting Method
- AIR6211A Ice Penetration Method

Material Specification
- AMS1431E Solid RDP
- AMS1435D Liquid RDP

Related Specification
- AIR5490A Carbon Brake Contamination

Guidance
- EASA, FAA, Transport Canada, Boeing
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