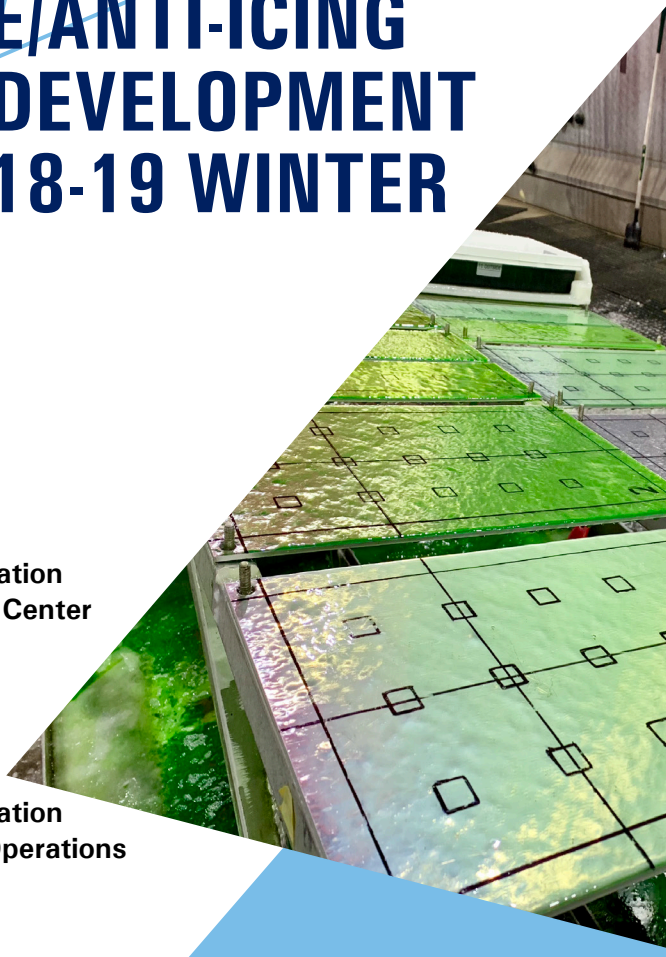
TP 15425E

AIRCRAFT GROUND DE/ANTI-ICING FLUID HOLDOVER TIME DEVELOPMENT PROGRAM FOR THE 2018-19 WINTER



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Transport Canada
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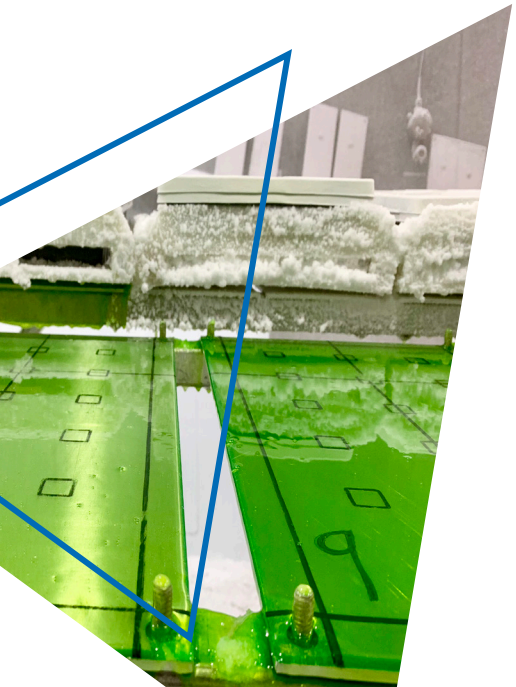
In cooperation with:

Federal Aviation Administration
William J. Hughes Technical Center

Transport Canada
Civil Aviation

Federal Aviation Administration
Flight Standards – Air Carrier Operations

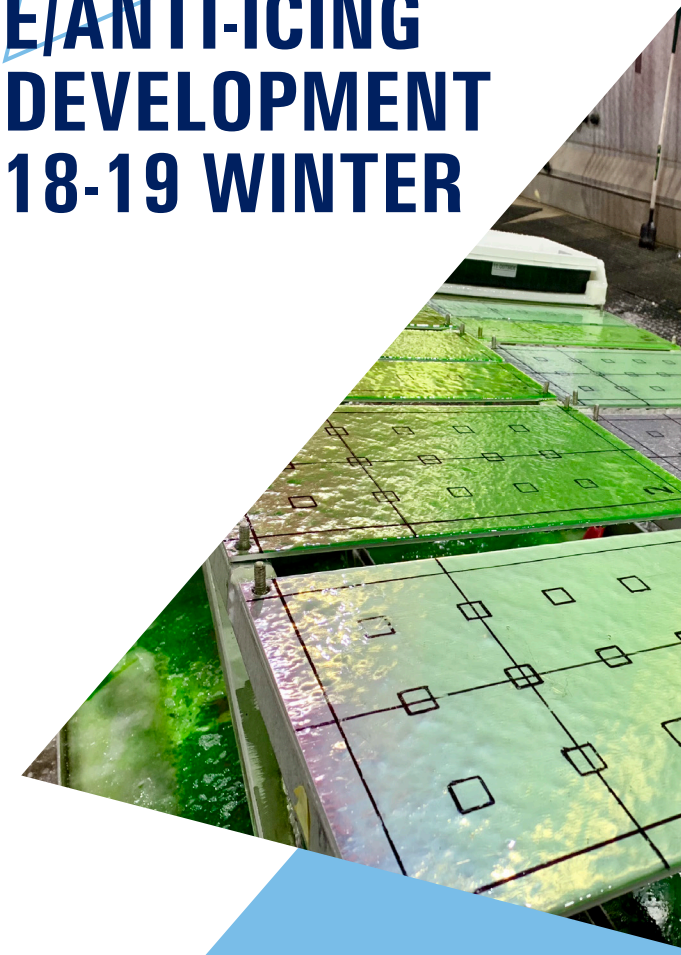


APS Aviation Inc.

FINAL VERSION 1.0
JANUARY 2020

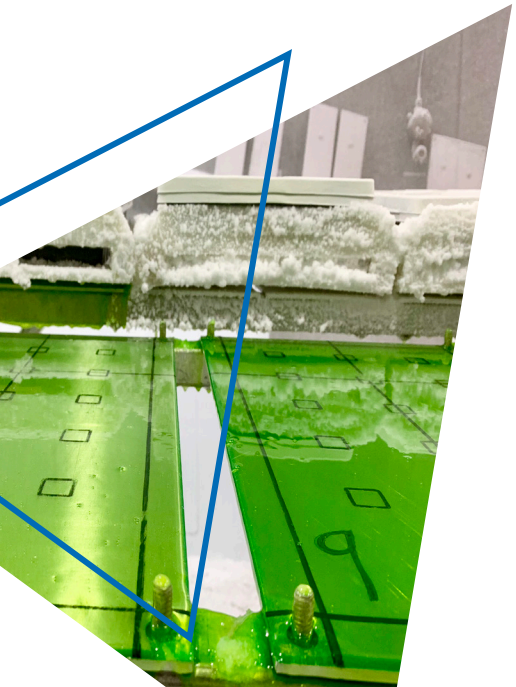
TP 15425E

AIRCRAFT GROUND DE/ANTI-ICING FLUID HOLDOVER TIME DEVELOPMENT PROGRAM FOR THE 2018-19 WINTER



by:

Benjamin Bernier



APS Aviation Inc.

FINAL VERSION 1.0

JANUARY 2020

The contents of this report reflect the views of APS Aviation Inc. and not necessarily the official view or opinions of the Transport Canada Innovation Centre or the co-sponsoring organizations.

Neither the Transport Canada Innovation Centre nor the co-sponsoring organizations endorse the products or manufacturers. Trade or manufacturers' names appear in this report only because they are essential to its objectives.

DOCUMENT ORIGIN AND APPROVAL RECORD

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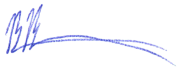

Jun 12, 2020

Benjamin Bernier, B.Sc. — Date
Junior Project Leader

Reviewed and Approved by:



Jun 12, 2020

John D'Avirro, B.Eng., PBDM — Date
Director, Aviation Services

Un sommaire français se trouve avant la table des matières.

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PREFACE

Under contract to the Transport Canada Innovation Centre, APS Aviation Inc. has undertaken a research program to advance aircraft ground de/anti-icing technology. The primary objectives of the research program are the following:

- To develop holdover time data for all new de/anti-icing fluids;
- To evaluate fluid holdover times for snow at temperatures below -14°C;
- To evaluate and develop the use of artificial snow for holdover time development;
- To conduct wind tunnel testing to support the development of guidance material for operating in ice pellet conditions;
- To conduct additional testing and analysis for very cold snow to determine appropriate generic holdover times;
- To conduct preliminary research for the development of temperature-specific snow holdover time data;
- To conduct general and exploratory de/anti-icing research;
- To finalize the publication of historical reports;
- To update the regression information report to reflect changes made to the holdover time guidelines; and
- To update the holdover time guidance materials for annual publication by Transport Canada and the Federal Aviation Administration.

The research activities of the program conducted on behalf of Transport Canada during the winter of 2018-19 are documented in four reports. The titles of the reports are as follows:

- TP 15425E Aircraft Ground De/Anti-Icing Fluid Holdover Time Development Program for the 2018-19 Winter;
- TP 15426E Regression Coefficients and Equations Used to Develop the Winter 2019-20 Aircraft Ground Deicing Holdover Time Tables;
- TP 15427E Aircraft Ground Icing General Research Activities During the 2018-19 Winter; and
- TP 15428E Wind Tunnel Trials to Support Further Development of Ice Pellet Allowance Times: Winters 2017-18 and 2018-19.

In addition, the following interim report is being prepared:

- *Artificial Snow Research Activities for the 2018-19 Winter.*

This report, TP 15425E, has the following objective:

- To develop holdover time data for new de/anti-icing fluids and to document changes made to the holdover time guidelines.

This objective was met by conducting endurance time tests with fluids in simulated freezing precipitation at the National Research Council Canada Climatic Engineering Facility in Ottawa, in artificial snow at PMG Technologies in Blainville, and in natural snow at the APS Aviation Inc. test site at Montreal-Trudeau Airport in Montreal.

PROGRAM ACKNOWLEDGEMENTS

This multi-year research program has been funded by the Transport Canada Innovation Centre, with support from the Federal Aviation Administration William J. Hughes Technical Center, Transport Canada Civil Aviation, and Federal Aviation Administration Flight Standards – Air Carrier Operations. This program could not have been accomplished without the participation of many organizations. APS Aviation Inc. would therefore like to thank Transport Canada, the Federal Aviation Administration, National Research Council Canada, and supporting members of the SAE International G-12 Aircraft Ground Deicing Committees.

APS Aviation Inc. would also like to acknowledge the dedication of the research team, whose performance was crucial to the acquisition of hard data, completion of data analysis, and preparation of reports. This includes the following people: Brandon Auclair, David Beals, Steven Baker, Stephanie Bendickson, Benjamin Bernier, Chloë Bernier, Chris D'Avirro, John D'Avirro, Jaycee Ewald, Shaney Herrmann, Peter Kitchener, Shahdad Movaffagh, Annaelle Reuveni, Marco Ruggi, Javad Safari, Saba Tariq, Jodi Wilson, David Youssef, and Nondas Zoitakis.

Special thanks are extended to Antoine Lacroix, Yvan Chabot, Deborah deGrasse, Warren Underwood, and Charles J. Enders, who on behalf of Transport Canada and the Federal Aviation Administration, have participated, contributed, and provided guidance in the preparation of these documents.

PROJECT ACKNOWLEDGEMENTS

APS Aviation Inc. would like to acknowledge the contributions of the following organizations to this project: Meteorological Services Canada and Aéroports de Montréal for providing an outdoor testing location, and the fluid manufacturers for providing support and funding.

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4. Title and Subtitle	5. Publication Date
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	6. Performing Organization Document No.: 300293
7. Author(s): Benjamin Bernier	8. Transport Canada File No.: 2450-BP-14
9. Performing Organization Name and Address: APS Aviation Inc. 6700 Côte-de-Liesse Rd., Suite 102 Montreal, Quebec, H4T 2B5	10. PWGSC File No.: TOR-7-40103
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	14. Project Officer: Antoine Lacroix

15. Supplementary Notes (Funding programs, titles of related publications, etc.)

Several research reports for testing of de/anti-icing technologies were produced for previous winters on behalf of Transport Canada (TC). These are available from the TC Innovation Centre. Several reports were produced as part of this winter's research program. Their subject matter is outlined in the preface. This project was co-sponsored by the Federal Aviation Administration.

16. Abstract

The primary objective of the 2018-19 holdover time (HOT) test program was to evaluate the performance of new deicing and anti-icing fluids over the entire range of conditions encompassed by the HOT Guidelines. The objective was met by conducting endurance time tests. The procedure for these tests consisted of pouring fluids onto clean aluminum test surfaces inclined at 10º. The onset of failure was recorded as a function of time in natural frost, natural snow, artificial snow, simulated freezing fog, simulated freezing drizzle, simulated light freezing rain, and simulated rain on a cold-soaked wing. A total of 614 tests were conducted with six fluids. In the winter of 2019-20, supplemental research was conducted investigating HOTs in very cold snow conditions. As a result of this research, the changes provided below were made to the HOT Guidelines for the winter of 2019-20.

(a) Fluid-specific HOT Guidelines were created for three new fluids: ROMCHIM ADD-PROTECT Type II (Type II), AllClear ClearWing EG (Type IV), and Cryotech Polar Guard® Xtend (Type IV).

(b) Supplemental testing was completed with LNT E450, an existing Type IV fluid, in order to support a proposed change to the fluid's lowest operational use temperature (LOUT). An updated fluid specific HOT table (with the reduced LOUT) was published in 2019-20 HOT Guidelines. At the time of writing this report, the guidelines reflect that the freezing point and aerodynamic acceptance test results for LNT E450 are pending.

(c) The generic HOTs provided to Type II/IV fluids that have not undergone fluid-specific testing in very cold snow conditions (temperatures below -14°C) were updated after additional analysis was completed in 2018-19.

(d) The analytical protocol used to determine fluid-specific HOTs in snow below -29°C was finalized in 2018-19. This resulted in changes to the snow HOTs in the coldest temperature band for Cryotech Polar Guard® II and Cryotech Polar Guard® Advance.

(e) Decreases were made to the Type II and Type IV generic HOTs as a result of the new Type II fluid and the changes to the generic very cold snow HOTs.

(f) A note was modified in the Type IV allowance time table to clarify that if the glycol type of the fluid being used is unknown, no allowance times exist for aircraft with rotation speeds of less than 115 knots.

(g) A note was modified in the Type II/III/IV fluid application table to clarify that HOTs do not exist below the lowest temperatures stated in the HOT table bands. Additionally, the table for the application of Heated Type III fluid has been removed as there are currently no Type III fluids with HOTs for heated applications.

It is recommended that any new de/anti-icing fluids be evaluated over the entire range of conditions in the HOT Guidelines.

17. Key Words	18. Distribution Statement
Anti-icing, deicing, deicing fluid, holdover times, precipitation, endurance times, Type I, Type II, Type III, Type IV, aircraft, ground, test, winter	Available from the Transport Canada Innovation Centre

19. Security Classification (of this publication)	20. Security Classification (of this page)	21. Declassification (date)	22. No. of Pages	23. Price
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Benjamin Bernier	2450-BP-14

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	14. Agent de projet: Antoine Lacroix

15. Remarques additionnelles (programmes de financement, titres de publications connexes, etc.)

Plusieurs rapports de recherche sur des essais de technologies de dégivrage et d'antigivrage ont été produits au cours des hivers précédents pour le compte de Transports Canada (TC). Ils sont disponibles auprès du Centre d'innovation de TC. De nombreux rapports ont été rédigés dans le cadre du programme de recherche de cet hiver. Leur objet apparaît à l'avant-propos. Ce projet était coparrainé par la Federal Aviation Administration.

16. Résumé

Le principal objectif du programme d'essai sur les durées d'efficacité de l'hiver 2018-2019 était d'évaluer la performance de nouveaux liquides de dégivrage et d'antigivrage pour toute la gamme des conditions météorologiques couvertes par les lignes directrices relatives aux durées d'efficacité. Pour atteindre cet objectif, des essais d'endurance ont été menés. La procédure suivie pour ces essais consistait à verser les liquides sur des surfaces d'aluminium propres, inclinées à 10°. On notait ensuite l'amorce de la perte d'efficacité en fonction du temps, sous le givre naturel, la neige naturelle et artificielle, et dans des conditions artificielles simulant du brouillard verglaçant, de la bruine verglaçante, de la pluie verglaçante faible et de la pluie sur une aile imprégnée de froid. Un total de 614 essais ont été menés, avec six liquides. Au cours de l'hiver 2019-2020, des essais supplémentaires ont été menés dans des conditions de givre, et d'autres recherches visant à étudier les durées d'efficacité dans des conditions de neige très froide ont été effectuées. À la suite de ces recherches, les changements ci-dessous ont été apportés aux lignes directrices relatives aux durées d'efficacité pour l'hiver 2019-2020.

(a) Des lignes directrices relatives aux durées d'efficacité spécifiques à trois nouveaux liquides, soit ROMCHIM ADD-PROTECT Type II (type II), AllClear ClearWing EG (type IV) et Cryotech Polar Guard® Xtend (type IV) ont été créées.

(b) Des essais supplémentaires ont été effectués sur un liquide existant de type IV, LNT E450, pour évaluer un changement proposé à la température minimale d'utilisation opérationnelle (LOUT) du produit. Un tableau ajusté des durées d'efficacité spécifiques à ce liquide (incluant la réduction de la température minimale d'utilisation opérationnelle) a été publié dans les lignes directrices sur les durées d'efficacité pour 2019-2020. Au moment de la rédaction de ce rapport, les lignes directrices indiquent que les résultats des tests de point de congélation et d'acceptation aérodynamique pour LNT E450 sont toujours attendus.

(c) À la suite d'analyses supplémentaires achevées en 2018-2019, les durées d'efficacité génériques ont été mises à jour pour les liquides de type II/IV pour lesquels des essais spécifiques dans des conditions de neige très froide (températures inférieures à -14 °C) n'ont pas été effectués.

(d) Le protocole analytique établi pour déterminer les durées d'efficacité spécifiques aux liquides dans des conditions de neige au-dessous de -29 °C a été complété en 2018-2019, ce qui a entraîné des changements aux durées d'efficacité des liquides Cryotech Polar Guard[MD] II et Cryotech Polar Guard[MD] Advance dans des conditions de neige, pour la plage des températures les plus basses.

(e) À la suite de l'ajout d'un nouveau liquide de type II et de changements apportés aux durées d'efficacité génériques dans des conditions de neige très froide, des réductions ont été appliquées aux durées d'efficacité génériques des liquides de type II et de type IV.

(f) Une note du tableau des marges de tolérance des liquides de type IV a été modifiée afin de préciser qu'il n'existe aucune marge de tolérance pour des liquides utilisés sur des aéronefs dont les vitesses de rotation sont inférieures à 115 nœuds si le type de glycol utilisé est inconnu.

(g) Une note du tableau d'application des liquides de types II, III et IV a été modifiée dans le but de préciser qu'aucune durée d'efficacité n'existe au-dessous des températures les plus basses indiquées dans les plages de températures des tableaux des durées d'efficacité. De plus, le tableau d'application du liquide de type III chauffé a été retiré, puisqu'il n'existe actuellement aucun liquide de type III pour lequel des durées d'efficacité sont disponibles lorsqu'il est appliqué chauffé.

Il est recommandé que tout nouveau liquide de dégivrage ou d'antigivrage soit évalué pour toute la gamme des conditions couvertes par les lignes directrices relatives aux durées d'efficacité.

17. Mots clés	18. Diffusion
Antigivrage, dégivrage, liquide de dégivrage, durées d'efficacité, précipitation, temps d'endurance, type I, type II, type III, type IV, aéronef, sol, essai, hiver	Disponible auprès du Centre d'innovation de Transports Canada

19. Classification de sécurité (de cette publication)	20. Classification de sécurité (de cette page)	21. Déclassification (date)	22. Nombre de pages	23. Prix
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EXECUTIVE SUMMARY

Under contract to the Transport Canada (TC) Innovation Centre, with support from the Federal Aviation Administration (FAA), and several fluid manufacturers, APS Aviation Inc. (APS) has undertaken a testing and research program to further advance aircraft ground de/anti-icing technology. The program has a number of objectives, and work completed to address these objectives is documented in a series of related reports. The primary objective, the development of holdover time (HOT) guidelines for new de/anti-icing fluids, is addressed in this report. The objective was met by conducting endurance time tests with several de/anti-icing fluids. This report also documents changes made to the HOT Guidelines for the winter of 2019-20.

Test Procedures

Test conditions, test parameters, and test bed specifications were determined based on the requirements of Aerospace Recommended Practice (ARP) 5485B and ARP5945A, which were developed by the SAE International (SAE) G-12 HOT Subcommittee for Type II/III/IV and Type I fluids, respectively. The tests consisted of pouring freezing point depressant fluids onto clean, inclined (10°), standard flat aluminum plates. The plates were mounted on test stands and systematically exposed to a variety of natural or simulated icing conditions. For each plate, the elapsed time required to reach a predefined end condition was recorded.

The variables recorded during testing included: failure time, type of precipitation, rate of precipitation, visibility, wind speed, wind direction, ambient temperature, test surface temperature, relative humidity, fluid brand, fluid type, and fluid concentration.

Data Collection and Testing

During the 2018-19 test season, data was collected during natural snow and natural frost events at the APS test site at Montreal-Trudeau Airport in Montreal and several mobile test sites and in simulated precipitation conditions (freezing drizzle, light freezing rain, freezing fog, and rain on cold-soaked surface) at the National Research Council Canada (NRC) Climatic Engineering Facility (CEF) in Ottawa.

APS conducted 614 endurance time tests in the winter of 2018-19. APS also conducted supplemental research on endurance times for operations in very cold snow. The results of testing were incorporated into the winter 2019-20 HOT Guidelines.

Changes to the Holdover Time Guidelines

The research resulted in several changes to the HOT Guidelines for winter 2019-20.

- Fluid-specific HOT Guidelines were created for three new fluids: ROMCHIM ADD-PROTECT Type II (Type II), AllClear ClearWing EG (Type IV), and Cryotech Polar Guard® Xtend (Type IV).
- Supplemental testing was completed with LNT E450, an existing Type IV fluid, in order to support a proposed change to the fluid's lowest operational use temperature (LOUT). An updated fluid-specific HOT table (with the reduced LOUT) was published in the 2019-20 HOT Guidelines. At the time of writing this report, the guidelines reflect that the freezing point and aerodynamic acceptance test results for LNT E450 are pending.
- The generic HOTs provided to Type II/IV fluids that have not undergone fluid-specific testing in very cold snow conditions (temperatures below -14°C) were updated after additional analysis was completed in 2018-19.
- The analytical protocol used to determine fluid-specific HOTs in snow below -29°C was finalized in 2018-19. This resulted in changes to the snow HOTs in the coldest temperature band for Cryotech Polar Guard® II and Cryotech Polar Guard® Advance.
- Minor decreases were made to the Type II generic HOTs as a result of the new Type II fluid and the changes to the generic very cold snow HOTs. Minor decreases were made to the Type IV generic HOTs as a result of the changes to the generic very cold snow HOTs (the addition of the new Type IV fluids did not result in any changes to the Type IV generic HOTs).
- A note was modified in the Type IV allowance time table to clarify that if the glycol type of the fluid being used is unknown, no allowance times exist for aircraft with rotation speeds of less than 115 knots.
- A note was modified in the Type II/III/IV fluid application table to clarify that HOTs do not exist below the lowest temperatures stated in the HOT table bands. Additionally, the table for the application of heated Type III fluid has been removed as there are currently no Type III fluids with HOTs for heated applications.

Recommendations

It is recommended that any new Type I, Type II, Type III, or Type IV fluid be evaluated over the entire range of conditions encompassed by the HOT tables.

SOMMAIRE

En vertu d'un contrat avec le Centre d'innovation de Transports Canada (TC), avec l'appui de la Federal Aviation Administration (FAA) et de plusieurs fabricants de liquides, APS Aviation Inc. (APS) a entrepris des essais et un programme de recherches visant à approfondir la technologie de dégivrage et d'antigivrage d'aéronefs au sol. Le programme poursuivait plusieurs objectifs et les travaux effectués pour atteindre ces objectifs sont documentés dans une suite de rapports connexes. Le principal objectif, le développement de lignes directrices sur les durées d'efficacité (HOT) de nouveaux liquides de dégivrage et d'antigivrage, fait l'objet du présent rapport. Pour atteindre cet objectif, des essais sur les durées d'efficacité ont été menés avec plusieurs liquides de dégivrage et d'antigivrage. Le présent rapport documente également l'ensemble des changements apportés aux lignes directrices sur les durées d'efficacité pour l'hiver 2019-2020.

Procédures d'essai

Les conditions d'essai, les paramètres d'essai et les spécifications relatives au banc d'essai ont été déterminés en vertu des exigences des pratiques recommandées en aérospatiale ARP5485B et ARP5495A, élaborées par le sous-comité G-12 de la SAE International (SAE) sur les durées d'efficacité pour les liquides de types II, III et IV ainsi que de type I, respectivement. Ces tests consistaient à verser des liquides abaisseurs du point de congélation sur des plaques en aluminium et en matériaux composites standards, plates, propres et inclinées (à 10°). Les plaques étaient montées sur un support d'essai et systématiquement exposées à une gamme de conditions de givrage, naturelles ou simulées. Pour chaque plaque, on notait le temps écoulé avant l'atteinte d'un état final prédéfini.

Parmi les variables mesurées dans le cadre de ces essais, on notait : temps de défaillance, type de précipitation, taux de précipitation, visibilité, vitesse du vent, direction du vent, température ambiante, température de la surface d'essai, humidité relative, marque de commerce du liquide, type de liquide et concentration du liquide.

Collecte de données et essais

Les données recueillies au cours de la saison d'essai 2018-2019 concernaient des tests sous neige naturelle et givre naturel menés à l'installation d'essai d'APS, à l'aéroport Montréal-Trudeau, à Montréal, de même que des essais effectués dans des conditions de précipitations simulées (bruine verglaçante, pluie verglaçante faible, brouillard verglaçant et pluie sur des surfaces imprégnées de froid) à l'installation de génie climatique du Conseil national de recherches du Canada (CNRC), à Ottawa.

Au cours de l'hiver 2018-2019, un total de 614 essais d'endurance ont été menés par APS, qui a également effectué des tests d'endurance supplémentaires pour une utilisation dans des conditions de neige très froide. Les résultats des essais effectués ont été inclus dans les lignes directrices relatives aux durées d'efficacité pour l'hiver 2019-2020.

Changements aux lignes directrices sur les durées d'efficacité

Les recherches effectuées ont entraîné de nombreux changements dans les lignes directrices relatives aux durées d'efficacité pour l'hiver 2019-2020.

- Des lignes directrices relatives aux durées d'efficacité spécifiques à trois nouveaux liquides, soit ROMCHIM ADD-PROTECT Type II (type II), AllClear ClearWing EG (type IV) et Cryotech Polar Guard® Xtend (type IV) ont été créées.
- Des essais supplémentaires ont été effectués sur un liquide existant de type IV, LNT E450, pour évaluer un changement proposé à la température minimale d'utilisation opérationnelle (LOUT) du produit. Un tableau ajusté des durées d'efficacité spécifiques à ce liquide (incluant la réduction de la température minimale d'utilisation opérationnelle) a été publié dans les lignes directrices sur les durées d'efficacité pour 2019-2020. Au moment de la rédaction de ce rapport, les lignes directrices indiquent que les résultats des tests de point de congélation et d'acceptation aérodynamique pour LNT E450 sont toujours attendus.
- À la suite d'analyses supplémentaires achevées en 2018-2019, les durées d'efficacité génériques ont été mises à jour pour les liquides de type II/IV pour lesquels des essais spécifiques dans des conditions de neige très froide (températures inférieures à -14 °C) n'ont pas été effectués.
- Le protocole analytique établi pour déterminer les durées d'efficacité spécifiques aux liquides dans des conditions de neige au-dessous de -29 °C a été complété en 2018-2019, ce qui a entraîné des changements aux durées d'efficacité des liquides Cryotech Polar Guard^{MD} II et Cryotech Polar Guard^{MD} Advance dans des conditions de neige, pour la plage des températures les plus basses.
- À la suite de l'ajout d'un nouveau liquide de type II et de changements apportés aux durées d'efficacité génériques dans des conditions de neige très froide, des réductions mineures ont été appliquées aux durées d'efficacité génériques des liquides de type II. À la suite de changements apportés aux durées d'efficacité génériques dans des conditions de neige très froide, des réductions mineures ont été appliquées aux durées d'efficacité génériques des

liquides de type IV (l'ajout des nouveaux liquides de type IV n'a pas entraîné de changement aux durées d'efficacité génériques pour ces produits).

- Une note du tableau des marges de tolérance des liquides de type IV a été modifiée afin de préciser qu'il n'existe aucune marge de tolérance pour des liquides utilisés sur des aéronefs dont les vitesses de rotation sont inférieures à 115 nœuds si le type de glycol utilisé est inconnu.
- Une note du tableau d'application des liquides de types II, III et IV a été modifiée dans le but de préciser qu'aucune durée d'efficacité n'existe au-dessous des températures les plus basses indiquées dans les plages de températures des tableaux des durées d'efficacité. De plus, le tableau d'application du liquide de type III chauffé a été retiré, puisqu'il n'existe actuellement aucun liquide de type III pour lequel des durées d'efficacité sont disponibles lorsqu'il est appliqué chauffé.

Recommandations

Il est recommandé que tout nouveau liquide de type I, de type II, de type III ou de type IV soit évalué pour toute la gamme des conditions couvertes par les tableaux des durées d'efficacité.

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CONTENTS

Page

1. INTRODUCTION 1

1.1 Background 1
1.2 Objectives 5
1.3 Report Content 6
1.4 Report Format 6
1.5 Publication of Holdover Time Guidelines 6
1.5.1 Publication by Transport Canada 7
1.5.2 Publication by Federal Aviation Administration 7

2. TESTING IN 2018-19 9

2.1 Procedures 9
2.2 Software 10
2.3 Test Sites 10
2.4 Fluids Tested 11
2.5 Description of Tests 13
2.6 Reporting 13
2.7 Wind Tunnel Trials to Support Further Development of Ice Pellet Allowance Times 13
2.8 Supplemental Research – Holdover Times in Very Cold Snow 14

3. CHANGES TO THE TYPE I HOLDOVER TIME GUIDELINES 15

3.1 New Fluids/Data 15
3.2 Changes to Holdover Time Guidelines Format 15
3.3 Type I Generic Holdover Time Values 15

4. CHANGES TO THE TYPE II HOLDOVER TIME GUIDELINES 17

4.1 New Fluids/Data 17
4.1.1 New Fluids 17
4.1.2 Very Cold Snow Generics Analysis 17
4.1.3 Modified Fluid-Specific Snow Holdover Times Below -29°C 17
4.2 Removed Fluids/Data 17
4.3 Type II Generic Holdover Time Values 18
4.3.1 Protocol for the Determination of Type II Generic Holdover Times 18
4.3.2 Use of Generic Holdover Times in Very Cold Snow 18
4.3.3 Impact of New and Removed Fluids/Data 18
4.3.4 Type II Generic Holdover Time Values and the Fluids Responsible 19

5. CHANGES TO THE TYPE III HOLDOVER TIME GUIDELINES 23

5.1 New Fluids/Data 23
5.2 Removed Fluids/Data 23
5.3 Changes to Holdover Time Guidelines Format 23
5.4 Type III Generic Holdover Time Values 23

6. CHANGES TO THE TYPE IV HOLDOVER TIME GUIDELINES 25

6.1 New Fluids/Data 25
6.1.1 New Fluids 25
6.1.2 Supplemental Testing with LNT E450 25
6.1.3 Very Cold Snow Generics Analysis 25
6.1.4 Modified Fluid-Specific Snow Holdover Times Below -29°C 26
6.2 Removed Fluids/Data 26
6.3 Type IV Generic Holdover Time Values 26
6.3.1 Protocol for the Determination of Type IV Generic Holdover Times 26
6.3.2 Use of Generic Holdover Times in Very Cold Snow 26

6.3.3 Impact of New and Removed Fluids/Data 27
6.3.4 Type IV Generic Holdover Time Values and the Fluids Responsible 27
7. OTHER CHANGES TO HOLDOVER TIME GUIDELINES CONTENT 31
7.1 Allowance Time Tables 31
7.2 Fluid Application Tables 31
7.3 Active Frost Holdover Time Guidelines 31
8. SUPPLEMENTAL RESEARCH: HOLDOVER TIMES FOR SNOW AT VERY COLD TEMPERATURES 33
8.1 Background 33
8.2 Previous Work 33
8.3 Objectives 34
8.4 Reassessment of Generic Holdover Times for Very Cold Snow for Type II and Type IV Fluids 34
8.4.1 Analysis Background 34
8.4.2 Analysis 36
8.5 Snow HOTs at LOUT for Fluids with LOUT <-29°C 46
8.5.1 Protocol Background and Methodology 46
8.5.2 Artificial Snow LOUT Data for Cryotech Polar Guard® II/Advance 47
8.5.3 HOTs at LOUT Analysis for Cryotech Polar Guard® II/Advance 48
8.6 Conclusions 49
8.7 Recommendations 50
9. CONCLUSIONS 51
9.1 Annual Testing 51
9.2 Supplemental Research: Holdover Times for Snow at Very Cold Temperatures 52
10. RECOMMENDATIONS 53
REFERENCES 55

LIST OF APPENDICES

A Transport Canada Statement of Work Excerpt – Aircraft & Anti-Icing Fluid Winter Testing 2018-19

B Procedures for Holdover Time Testing

C Methodology for Endurance Time Testing of Type II, III, and IV Fluids Winter 2018-19

D Aircraft Ground Anti-Icing Fluid Endurance Time Test Results – Romchim Add-Protect Type II (Type II)

E Aircraft Ground Anti-Icing Fluid Endurance Time Test Results – AllClear ClearWing EG (Type IV)

F Aircraft Ground Anti-Icing Fluid Endurance Time Test Results – Cryotech Polar Guard Xtend (Type IV)

G Aircraft Ground Anti-Icing Fluid Endurance Time Test Results – LNT E450 (Type IV) Supplemental Testing to Support LOUT Change

H Transport Canada and Federal Aviation Administration Holdover Time Guidelines, Winter 2019-2020

I Transport Canada and Federal Aviation Administration Regression Information, Winter 2019-2020

LIST OF TABLES

Page

Table 1.1: Summary of APS Holdover Time Testing Activities 2
Table 2.1: Fluid Receipt Data (Commercialized Fluids) 12
Table 2.2: Fluid Characteristic Data (Commercialized Fluids) 12
Table 2.3: Summary of Tests Conducted 13
Table 4.1: Type II Generic HOT Values and Responsible Fluids – Winter 2018-19 20
Table 4.2: Type II Generic HOT Values and Responsible Fluids – Winter 2019-20 21
Table 6.1: Type IV Generic HOT Values and Responsible Fluids – Winter 2018-19 29
Table 6.2: Type IV Generic HOT Values and Responsible Fluids – Winter 2019-20 30
Table 8.1: Very Cold Snow Generics Analysis – Fluid Data Groupings 36
Table 8.2: Participating vs. Non-Participating Fluid Performance Analysis – Type II PG 38
Table 8.3: Participating vs. Non-Participating Fluid Performance Analysis – Type IV PG 39
Table 8.4: Participating vs. Non-Participating Fluid Performance Analysis – Type IV EG 40
Table 8.5: Summary of Very Cold Snow Worst-Performing Fluid Analysis Results 41
Table 8.6: Generic Very Cold Snow HOT Adjustment Factors 41
Table 8.7: Very Cold Snow Worst-Performing Fluid Analysis – Type II PG 43
Table 8.8: Very Cold Snow Worst-Performing Fluid Analysis – Type IV PG 43
Table 8.9: Very Cold Snow Worst-Performing Fluid Analysis – Type IV EG 44
Table 8.10: 2019-20 Generic Very Cold Snow HOTs – Type II PG Fluids 44
Table 8.11: 2019-20 Generic Very Cold Snow HOTs – Type IV PG Fluids 45
Table 8.12: 2019-20 Generic Very Cold Snow HOTs – Type IV EG Fluids 45
Table 8.13: Log of Cryotech Polar Guard® Advance Artificial Snow LOUT Tests 47
Table 8.14: Cryotech Polar Guard® II/Advance Artificial Snow Performance at -25°C vs. -31°C 48
Table 8.15: Cryotech Polar Guard® II/Advance Snow HOTs at LOUT Calculation 48
Table 8.16: Cryotech Polar Guard® II/Advance Snow HOTs at LOUT 2018-19 vs. 2019-20 49

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GLOSSARY

APS	APS Aviation Inc.
ARP	Aerospace Recommended Practice
CEF	Climatic Engineering Facility
FAA	Federal Aviation Administration
HOT	Holdover Time
IREQ	Institut de Recherche d'Hydro-Québec
LOUT	Lowest Operational Use Temperature
LOWV	Lowest On-Wing Viscosity
NRC	National Research Council Canada
PMG	PMG Technologies Inc.
SAE	SAE International
TC	Transport Canada
WSET	Water Spray Endurance Test

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1. INTRODUCTION

Under winter precipitation conditions, aircraft are cleaned prior to takeoff. This is typically done with aircraft ground deicing fluids, which are freezing point depressant fluids developed specifically for aircraft use. If required, aircraft are then protected against further accumulation of precipitation by the application of aircraft ground anti-icing fluids, which are also freezing point depressant fluids. Most anti-icing fluids contain thickeners to extend protection time.

Prior to the 1990s, aircraft ground de/anti-icing had not been extensively researched. However, following several ground icing related incidents in the late 1980s, an aircraft ground icing research program was initiated by Transport Canada (TC). The objective of the program is to improve knowledge, improve safety, and enhance operational capabilities of aircraft operating in winter precipitation conditions.

Since its inception in the early 1990s, the aircraft ground icing research program has been managed by TC, with the co-operation of the United States Federal Aviation Administration (FAA), the National Research Council Canada (NRC), several major airlines, and de/anti-icing fluid manufacturers.

There is still an incomplete understanding of some of the hazards related to aircraft ground icing. As a result, the aircraft ground icing research program continues, with the objective of further reducing the risks posed by the operation of aircraft in winter precipitation conditions.

Under contract to the TC Innovation Centre, with support from the FAA William J. Hughes Technical Center, TC Civil Aviation, and FAA Flight Standards – Air Carrier Operations, APS Aviation Inc. (APS) carried out research in the winter of 2018-19 in support of the aircraft ground icing research program. Each major project completed as part of the 2018-19 research is documented in a separate individual report. This report documents the aircraft ground de/anti-icing holdover time (HOT) development project.

1.1 Background

APS has completed considerable testing related to de/anti-icing fluids on behalf of TC since 1990. Specifically, research has been conducted to determine fluid HOTs, to substantiate HOT tables, and to further the knowledge and development of deicing technology. A summary of the HOT-related research activities completed by APS is provided in Table 1.1.

Table 1.1: Summary of APS Holdover Time Testing Activities

Year	TDC Publication #	Conditions Tested	Fluids Tested	Test Locations
1990-91	TP 11206E	• Natural Precipitation (mostly snow)	• Type II (100%)	Mostly Montreal Worldwide
1991-92	TP 11454E	• Natural Precipitation (mostly snow)	• Type III (first gen)	Mostly Montreal St. John's
1992-93	TP 11836E	• Natural Snow • Simulated Freezing Drizzle (prelim) • Simulated Freezing Fog (outdoor) • Artificial Snow (prelim)	• Type I • Type II (100%) • Type III (first gen)	Montreal Ottawa (NRC) Rigaud
1993-94	TP 12915E	• Natural Snow • Simulated Freezing Drizzle • Simulated Light Freezing Rain • Simulated Freezing Fog (outdoor)	• Type I • Type II (dilutions primarily, neat	Montreal Ottawa (NRC)
1994-95	TP 12654E	• Natural Snow • Simulated Freezing Drizzle • Simulated Light Freezing Rain • Simulated Freezing Fog (indoor) • Rain on a Cold-Soaked Surface (prelim)	• Type I • Type II • Type IV (prelim)	Montreal Ottawa (NRC)
1995-96	TP 12896E	• Natural Snow • Simulated Freezing Drizzle • Simulated Light Freezing Rain • Simulated Freezing Fog (indoor) • Rain on a Cold-Soaked Surface	• Type I • Type II • Type IV	Montreal Ottawa (NRC)
1996-97	TP 13131E	• Natural Snow • Simulated Freezing Drizzle • Simulated Light Freezing Rain • Simulated Freezing Fog (indoor) • Rain on a Cold-Soaked Surface	• Type I • Type II (100%) • Type III (first gen) • Type IV	Montreal Ottawa (NRC)
1997-98	TP 13318E	• Natural Snow • Simulated Freezing Drizzle • Simulated Light Freezing Rain • Simulated Freezing Fog (indoor) • Rain on a Cold-Soaked Surface	• Type IV	Montreal Ottawa (NRC)
1998-99	TP 13477E	• Natural Snow • Simulated Freezing Drizzle • Simulated Light Freezing Rain • Simulated Freezing Fog (indoor) • Rain on a Cold-Soaked Surface • Artificial Snow	• Type I • Type II • Type IV (Low Viscosity)	Montreal Ottawa (NRC)
1999-2000	TP 13659E	• Natural Snow • Simulated Freezing Drizzle • Simulated Light Freezing Rain • Simulated Freezing Fog (indoor) • Rain on a Cold-Soaked Surface • Artificial Snow • Preliminary Frost	• Type I • Type II • Type IV	Montreal Ottawa (NRC) Varennes (IREQ)

Table 1.1: Summary of APS Holdover Time Testing Activities (cont'd)

Year	TDC Publication #	Conditions Tested	Fluids Tested	Test Locations
2000-01	TP 13826E	• Natural Snow • Simulated Freezing Drizzle • Simulated Light Freezing Rain • Simulated Freezing Fog (indoor) • Rain on a Cold-Soaked Surface • Artificial Snow • Preliminary Frost	• Type I • Type II • Type IV	Montreal Ottawa (NRC) Varennes (IREQ)
2001-02	TP 13991E	• Natural Snow • Simulated Freezing Drizzle • Simulated Light Freezing Rain • Simulated Freezing Fog (indoor) • Rain on a Cold-Soaked Surface • Artificial Snow • Preliminary Frost	• Type I • Type II • Type IV	Montreal North Bay Ottawa (NRC) Thompson Val-d'Or
2002-03	TP 14144E	• Natural Snow • Simulated Freezing Drizzle • Simulated Light Freezing Rain • Simulated Freezing Fog (indoor) • Rain on a Cold-Soaked Surface • Artificial Snow • Preliminary Frost	• Type I • Type II • Type IV	Montreal Ottawa (NRC) St-Alexis Varennes (IREQ)
2003-04	TP 14374E	• Natural Snow • Simulated Freezing Drizzle • Simulated Light Freezing Rain • Simulated Freezing Fog (indoor) • Rain on a Cold-Soaked Surface • Natural Frost • Artificial Snow	• Type II • Type III	Montreal Ottawa (NRC) St-Adele Val-d'Or
2004-05	TP 14443E	• Natural Snow • Simulated Freezing Drizzle • Simulated Light Freezing Rain • Simulated Freezing Fog (indoor) • Rain on a Cold-Soaked Surface • Natural Frost	• Type II • Type III • Type IV	Montreal Ottawa (NRC)
2005-06	TP 14712E	• Natural Snow • Simulated Freezing Drizzle • Simulated Light Freezing Rain • Simulated Freezing Fog (indoor) • Rain on a Cold-Soaked Surface • Natural Frost • Ice Pellets / Mixed Conditions	• Type I • Type II • Type IV	Montreal Ottawa (NRC)
2006-07	TP 14776E	• Natural Snow • Simulated Freezing Drizzle • Simulated Light Freezing Rain • Simulated Freezing Fog (indoor) • Rain on a Cold-Soaked Surface • Natural Frost • Artificial Snow • Ice Pellets / Mixed Conditions	• Type I • Type II • Type IV	Montreal Ottawa (NRC)

Table 1.1: Summary of APS Holdover Time Testing Activities (cont'd)

Year	TDC Publication #	Conditions Tested	Fluids Tested	Test Locations
2007-08	TP 14869E	• Natural Snow • Simulated Freezing Drizzle • Simulated Light Freezing Rain • Simulated Freezing Fog (indoor) • Rain on a Cold-Soaked Surface • Natural Frost • Artificial Snow • Ice Pellets / Mixed Conditions • Snow Pellets	• Type II • Type III • Type IV	Montreal Ottawa (NRC)
2008-09	TP 14933E	• Natural Snow • Simulated Freezing Drizzle • Simulated Light Freezing Rain • Simulated Freezing Fog (indoor) • Rain on a Cold-Soaked Surface • Natural Frost • Ice Pellets / Mixed Conditions	• Type II • Type III • Type IV	Montreal Ottawa (NRC)
2009-10	TP 15050E	• Natural Snow • Simulated Freezing Drizzle • Simulated Light Freezing Rain • Simulated Freezing Fog (indoor) • Rain on a Cold-Soaked Surface • Ice Pellets / Mixed Conditions • Snow Pellets	• Type I • Type II • Type IV	Dolbeau-Mistassini Montreal Ottawa (NRC) St-Sauveur Thetford Mines Val-d'Or
2010-11	TP 15156E	• Natural Snow • Simulated Freezing Drizzle • Simulated Light Freezing Rain • Simulated Freezing Fog (indoor) • Rain on a Cold-Soaked Surface • Artificial Snow • Ice Pellets / Mixed Conditions	• Type I • Type II • Type IV	Montreal Ottawa (NRC)
2011-12	TP 15156E	• Natural Snow • Simulated Freezing Drizzle • Simulated Light Freezing Rain • Simulated Freezing Fog (indoor) • Rain on a Cold-Soaked Surface • Artificial Snow	• Type I • Type II • Type III	Montreal Gaspésie Rimouski St-Jovite Edmundston Ottawa (NRC)
2012-13	TP 15228E	• Natural Snow • Simulated Freezing Drizzle • Simulated Light Freezing Rain • Simulated Freezing Fog (indoor) • Rain on a Cold-Soaked Surface • Artificial Snow	• Type I • Type II • Type III	Montreal Ottawa (NRC)
2013-14	TP 15271E	• Natural Snow/Frost • Simulated Freezing Drizzle • Simulated Light Freezing Rain • Simulated Freezing Fog (indoor) • Rain on a Cold-Soaked Surface • Artificial Snow	• Type I • Type II • Type III • Type IV	Montreal Val-d'Or Timmins Kuujjuaq Ottawa (NRC)

Table 1.1: Summary of APS Holdover Time Testing Activities (cont'd)

Year	TDC Publication #	Conditions Tested	Fluids Tested	Test Locations
2014-15	TP 15321E	• Natural Snow/Frost • Simulated Freezing Drizzle • Simulated Light Freezing Rain • Simulated Freezing Fog (indoor) • Rain on a Cold-Soaked Surface • Artificial Snow	• Type I • Type II • Type III • Type IV	Beaconsfield Grand Prairie Mirabel Montreal Morin Heights Ottawa (NRC)
2015-16	TP 15338E	• Natural Snow/Frost • Simulated Freezing Drizzle • Simulated Light Freezing Rain • Simulated Freezing Fog (indoor) • Rain on a Cold-Soaked Surface • Artificial Snow	• Type II • Type III • Type IV	Beaconsfield Blainville (PMG) Iqaluit Montreal Ottawa (NRC) Schefferville St-Adèle
2016-17	TP 15372E	• Natural Snow/Frost • Simulated Freezing Drizzle • Simulated Light Freezing Rain • Simulated Freezing Fog (indoor) • Rain on a Cold-Soaked Surface • Artificial Snow	• Type II • Type III • Type IV	Beaconsfield Blainville (PMG) Calgary Iqaluit Montreal Ottawa (NRC) Red Deer Wabush
2017-18	TP 15396E	• Natural Snow/Frost • Simulated Freezing Drizzle • Simulated Light Freezing Rain • Simulated Freezing Fog (indoor) • Rain on a Cold-Soaked Surface • Artificial Snow	• Type II • Type IV	Beaconsfield Blainville (PMG) Coaticook Forestville Fort Saint-John Montreal Ottawa (NRC) Pink Mountain
2018-19	TP 15425E	• Natural Snow/Frost • Simulated Freezing Drizzle • Simulated Light Freezing Rain • Simulated Freezing Fog (indoor) • Rain on a Cold-Soaked Surface • Artificial Snow	• Type II • Type IV	Alma Beaconsfield Blainville (PMG) Edmundston Montreal Ottawa (NRC) St-Jérôme

1.2 Objectives

The primary objectives of the 2018-19 HOT test program were to conduct flat plate tests under conditions of natural and simulated precipitation to determine de/anti-icing fluid endurance times for new fluids, to develop HOT Guidelines based on samples of newly and previously qualified deicing and anti-icing fluids, and to document changes made to the HOT Guidelines for the winter of 2019-20. The detailed objectives of the 2018-19 test program are provided in the statement of work excerpt provided in Appendix A.

1.3 Report Content

APS has written a report on the HOT test program for each year it has been carried out. In 2003-04, the report was condensed to increase readability and to present the reader with, for the most part, only new and current information from the previous year's report.

Notably, the reader is now directed to the TC report, TP 14144E, *Aircraft Ground De/Anti-Icing Fluid Holdover Time Development Program for the 2002-03 Winter* (1), for the detailed test methodology and individual fluid test information. These are provided in appendices to the report rather than within the report itself.

In the winter of 2009-10, a decision was made to include detailed test information only for fluids that are expected to be qualified and commercialized. Test information for other fluids is not included.

1.4 Report Format

The subsequent sections of this report contain the following:

a) Section 2 summarizes 2018-19 testing;
b) Section 3 documents changes to the Type I HOT Guidelines;
c) Section 4 documents changes to the Type II HOT Guidelines;
d) Section 5 documents changes to the Type III HOT Guidelines;
e) Section 6 documents changes to the Type IV HOT Guidelines;
f) Section 7 documents other changes to HOT Guidelines content;
g) Section 8 documents supplemental research related to very cold snow HOTs;
h) Section 9 presents conclusions derived from the test program; and
i) Section 10 lists recommendations for future testing.

1.5 Publication of Holdover Time Guidelines

HOT Guidelines are published annually by both TC and the FAA.

1.5.1 Publication by Transport Canada

The TC HOT Guidelines are published on the following website:

- http://www.tc.gc.ca/en/services/aviation/general-operating-flight-rules/de-icing-aircraft/hold-over-guidelines.html

The TC HOT Guidelines are intended to be used in conjunction with the document, TP 14052E, *Guidelines for Aircraft Ground Icing Operations (Fourth Edition)* (2), which includes reference material related to ground icing operations. TP 14052E (2) is also available on the TC website.

1.5.2 Publication by Federal Aviation Administration

The FAA HOT Guidelines are published on the following website:

- https://www.faa.gov/other_visit/aviation_industry/airline_operators/airline_safety/deicing/

The FAA HOT Guidelines are intended to be used in conjunction with the N 8900 series notice, *Revised FAA-Approved Deicing Program Updates, Winter 20xx-20xx* (3), which is published annually and provides additional guidance and reference material applicable to the current winter. The latest N 8900 series is also available on the FAA website.

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2. TESTING IN 2018-19

An overview of the testing completed in the winter of 2018-19 is provided in this chapter.

2.1 Procedures

Test procedures for HOT testing of Type II, III, and IV fluids were developed in accordance with SAE International (SAE) Aerospace Recommended Practice (ARP) 5485B, *Endurance Time Test Procedures for SAE Type II/III/IV Aircraft Deicing/Anti-Icing Fluids* (4). Test procedures for HOT testing of Type I fluids were developed in accordance with ARP5945A, *Endurance Time Test Procedures for SAE Type I Aircraft Deicing/Anti-Icing Fluids* (5).

Because this report serves as the publishing mechanism for the APS endurance time test program, all current endurance time test procedures are included in the report, even if they are not updated or used in a given year (for example, the Type I procedure is included even if no Type I fluids are tested). This is to ensure the most current procedure is available for reference.

The procedures valid for Winter 2018-19 are included in Appendix B. They include:

1. Procedure: Endurance Time Testing in Simulated Freezing Precipitation with SAE Type I, II, III, and IV De/Anti-Icing Fluids;
2. Procedure: Endurance Time Testing in Natural Snow with SAE Type I, II, III, and IV De/Anti-Icing Fluids;
3. Procedure: Endurance Time Testing in Simulated Snow with SAE Type I, II, III, and IV Fluids;
4. Procedure: Endurance Time Testing in Active Frost with SAE Type I, II, III, and IV De/Anti-Icing Fluids;
5. Overall Program of Tests at NRC, April 2019; and
6. Overall Program of Tests at PMG, April 2019.

The first procedure provides the detailed test methodology for indoor simulated light freezing rain, freezing fog, freezing drizzle, and rain on cold-soaked surface testing. The second procedure provides the detailed test methodology for natural snow testing. The third procedure provides the detailed test methodology for artificial snow testing. The fourth procedure provides the detailed test methodology for natural active frost testing.

The fifth procedure was developed to coordinate HOT testing and other aircraft ground icing research projects at the annual APS indoor simulated freezing precipitation test session. The sixth procedure was developed to coordinate HOT testing and other aircraft ground icing research projects at the annual APS indoor artificial snow test session. HOT testing and testing for other program elements were conducted at the same sessions to maximize use of the facilities and resources.

The endurance time test methodology is described in detail in TP 14144E (1).

The primary details of the test procedures used each winter, including details specific to the given winter (i.e., test sites), are summarized annually in a test methodology report. A copy of this report is included as Appendix C. The report is also included as an annex to each fluid manufacturer report (see Subsection 2.6).

2.2 Software

Over the winters of 2012-13 and 2013-14, two software projects were completed to improve the HOT testing process.

1. A new interface was created for the freezing precipitation (indoor) rate management program. The new interface streamlines the process for measuring and managing precipitation rates in freezing precipitation.
2. An application was created to replace the paper-based end condition data form. It improves efficiency and accuracy in recording endurance times and adds new features to better manage the testing process.

Further details on these upgrades are provided in the TC report, TP 15269E, *Aircraft Ground Icing General Research Activities During the 2013-14 Winter* (6).

2.3 Test Sites

Simulated precipitation testing (freezing drizzle, light freezing rain, freezing fog, and rain on cold-soaked surface) was conducted at the NRC Climatic Engineering Facility (CEF) in Ottawa.

Natural snow and natural frost testing was conducted primarily at the APS test site at the Pierre Elliott Trudeau Airport in Montreal. Several tests were also conducted at remote locations using a mobile test site. The remote locations included Alma (Quebec), Beaconsfield (Quebec), Edmundston (New Brunswick), and Saint-Jérôme (Quebec).

Artificial snow testing was conducted at the PMG Technologies Inc. (PMG) cold chamber in Blainville (Quebec).

2.4 Fluids Tested

Six fluids underwent endurance time testing in the winter of 2018-19. As described in Subsection 1.3, only the endurance time test results of fluids that are expected to be commercialized are published in this report; the results of any other fluids that undergo testing are provided only to the fluid manufacturers.

One Type II fluid was tested.

1. **ROMCHIM ADD-PROTECT Type II:** This new Type II fluid underwent endurance time testing in Winter 2018-19 and is expected to be commercialized in the future. The detailed test results are provided in Appendix D.

Five Type IV fluids were tested.

1. **AllClear ClearWing EG:** This new Type IV fluid (100/0 only, no dilutions) underwent endurance time testing in Winter 2018-19 and is expected to be commercialized in the future. The detailed test results are provided in Appendix E.
2. **Cryotech Polar Guard® Xtend:** This new Type IV fluid underwent endurance time testing in Winter 2018-19 and the 100/0 fluid (only) is expected to be commercialized in the future. The detailed test results are provided in Appendix F.
3. **LNT Solutions E450:** Supplemental testing was conducted with this existing Type IV fluid in Winter 2018-19 to support a proposed change to the fluid's lowest operational use temperature (LOUT). The detailed test results are provided in Appendix G.
4. **Type IV Experimental Fluid #1:** A Type IV experimental fluid was submitted for testing in Winter 2018-19. This fluid will not be commercialized and therefore the detailed test results are not provided in this report.
5. **Type IV Experimental Fluid #2:** A second Type IV experimental fluid was submitted for testing in Winter 2018-19. This fluid will not be commercialized and therefore the detailed test results are not provided in this report.

Table 2.1 and Table 2.2 provide additional relevant fluid receipt and fluid characteristic data, respectively, for the fluids documented in this report.

Table 2.1: Fluid Receipt Data (Commercialized Fluids)

Fluid Manufacturer	Fluid Name	Fluid Type	Fluid Formulation	Date Received	Batch #	Dilutions Received (%)
ROMCHIM	ADD-PROTECT Type II	II	Propylene Glycol	13-Dec-18	1440	100, 75, 50
AllClear	ClearWing EG	IV	Ethylene Glycol	7-Jan-19	120718	100
Cryotech	Polar Guard® Xtend	IV	Propylene Glycol	12-Dec-18	PGA181205PA	100
LNT Solutions	E450	IV	Ethylene Glycol	21-Jan-19	45SN051218L	100

Table 2.2: Fluid Characteristic Data (Commercialized Fluids)

Fluid	Fluid Dil.	Brix (Measured)	WSET (mins)	Freeze Point (Stated, °C)	Aerodynamic LOUT (Stated, °C)	Viscosity (Measured, mPa.s)	
						Mfr. Method	AS9968 Method
ROMCHIM ADD-PROTECT Type II	100/0	36.0	41	-35.0	-31.5	4,000[1]	4,000[1]
	75/25	28.5	26	-21.0	-15.0	7,700[1]	7,700[1]
	50/50	20.25	9	-10.0	-9.5	14,500[1]	14,500[1]
AllClear ClearWing EG	100/0	32.25°	120	-38.0	-29.0	35,500[2]	13,360[1]
Cryotech Polar Guard® Xtend	100/0	36.0	83	-38.8	-31.0	6,000[3]	6,350[1]
LNT Solutions E450	100/0	31.50°	n/a	n/a	n/a	41,000[4]	n/a

1 Spindle LV1, 600 mL low form (Griffin) beaker, 575 mL of fluid, 20°C, 0.3 rpm, for 10.0 minutes.
2 Spindle SC4-31/13R, small sample adapter, 9 mL, 0°C, 0.3 rpm, for 30.0 minutes.
3 Spindle SC4-34/13R, small sample adapter, 10 mL, 20°C, 0.3 rpm, for 10.0 minutes.
4 Spindle SC4-34/13R, small sample adapter, 9 mL, 0°C, 0.3 rpm, for 10.0 minutes.

2.5 Description of Tests

In total, 614 endurance time tests were conducted during the winter of 2018-19. Table 2.3 shows a summary of the tests conducted. Details for each test are included in the reports provided to the manufacturers (see Subsection 2.6).

Table 2.3: Summary of Tests Conducted

Precipitation Type	Tests Conducted
Natural Snow	257
Artificial Snow	65
Freezing Fog	90
Freezing Drizzle	64
Light Freezing Rain	67
Rain on Cold-Soaked Surface	28
Natural Frost	43
Total	**614**

2.6 Reporting

A comprehensive report was created for each fluid tested to document its performance in detail. These reports were provided to the fluid manufacturers. As per Subsection 1.3, copies of the reports for fluids expected to be qualified and commercialized have been included as appendices to this report. The relevant reports can be found in Appendices D, E, F, and G. In addition, the Winter 2018-19 test methodology report is also provided as an annex to each report. This report can be found in Appendix C.

2.7 Wind Tunnel Trials to Support Further Development of Ice Pellet Allowance Times

Wind tunnel testing was conducted in the winter of 2018-19. The objectives of the testing were to validate new fluids for use with published allowance times. This research is documented in the TC report, TP 15428E, *Wind Tunnel Trials to Support Further Development of Ice Pellet Allowance Times: Winters 2017-18 and 2018-19* (7), which was provided to TC and the FAA. This research did not have an impact on the HOT Guidelines for the winter of 2019-20.

2.8 Supplemental Research – Holdover Times in Very Cold Snow

Supplemental research on HOTs for very cold snow was completed in the winter of 2018-19. This research is documented in Section 8. The impact of this research on the HOT Guidelines for the winter of 2017-18 is documented in Subsections 4.1.2, 4.1.3, 6.1.2, and 6.1.3.

3. CHANGES TO THE TYPE I HOLDOVER TIME GUIDELINES

Changes made to the Type I HOT Guidelines for the winter of 2019-20 are documented in this section. The TC and FAA 2019-20 Type I HOT Guidelines are included in Appendix H.

3.1 New Fluids/Data

A significant body of previous research and testing has indicated that all Type I fluids formulated with glycol perform in a similar manner from an endurance time perspective. As a result, regulators no longer require Type I deicing fluids formulated with propylene glycol, ethylene glycol, or diethylene glycol to undergo endurance time testing. However, regulators do require testing of fluids formulated with other glycol bases or with non-glycol bases. This is to ensure the endurance time performance of these fluids is similar to that of the Type I fluids used to generate the current Type I HOTs.

Endurance times of Type I fluids are still tested in some years, either (a) at the request of the fluid manufacturer or (b) because the fluid is not based on propylene glycol, ethylene glycol, or diethylene glycol.

No Type I fluids were tested in the winter of 2018-19.

3.2 Changes to Holdover Time Guidelines Format

No changes were made to the format of the Type I HOT Guidelines for Winter 2019-20.

3.3 Type I Generic Holdover Time Values

No changes were made to the Type I generic HOTs for the winter of 2019-20.

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4. CHANGES TO THE TYPE II HOLDOVER TIME GUIDELINES

Changes made to the Type II HOT Guidelines for the winter of 2019-20 are documented in this chapter. The TC and FAA 2019-20 Type II HOT Guidelines are included in Appendix H.

4.1 New Fluids/Data

This section documents changes to the Type II HOT Guidelines that were made because of the introduction of new fluids or new data and analysis.

4.1.1 New Fluids

One new Type II fluid was added to the HOT Guidelines for the winter of 2019-20: **ROMCHIM ADD-PROTECT Type II**. This new fluid underwent endurance time testing in the winter of 2018-19. Details of this testing are included in Appendix D. The introduction of this fluid led to five reductions in the Type II generic HOTs (see Subsection 4.3.3).

4.1.2 Very Cold Snow Generics Analysis

Additional analysis related to the generic HOTs for Type II/IV fluids in very cold snow conditions (temperatures below -14°C) was completed during the winter of 2018-19. As a result, these generic values have been updated for the winter of 2019-20.

This research is described in further detail in Section 8.

4.1.3 Modified Fluid-Specific Snow Holdover Times Below -29°C

The analytical protocol used to determine fluid-specific HOTs in snow below -29°C was finalized in 2018-19. This resulted in changes to the snow HOTs in the coldest temperature band for Cryotech Polar Guard® II.

This research is described in further detail in Section 8.

4.2 Removed Fluids/Data

No Type II data was removed from the HOT Guidelines for the winter of 2019-20.

4.3 Type II Generic Holdover Time Values

Type II generic HOTs are published annually. These HOTs represent the worst case performance of all Type II fluids and can be used with any Type II fluid. The protocol used to determine the Type II generic HOT values each winter is described in Subsection 4.3.1. Subsection 4.3.3 describes the impact of new and removed data on the generic HOTs. Subsection 4.3.4 presents the changes to the generic HOTs for Winter 2019-20 and details the fluids responsible for each generic HOT value.

4.3.1 Protocol for the Determination of Type II Generic Holdover Times

The values in the Type II generic HOT table are generated each year by taking the shortest HOTs of all Type II fluids listed in the TC and FAA HOT Guidelines. It should be noted that the HOT Guidelines include fluids whose qualifications have recently expired (i.e., within four years). Fluids are only removed from the generics analysis when they are removed from the HOT Guidelines.

4.3.2 Use of Generic Holdover Times in Very Cold Snow

Fluid-specific HOTs are provided for very cold snow (temperatures below -14°C) only for those Type II fluids that have undergone the necessary supplemental testing. All other fluids are provided with newly established generic HOTs for very cold snow. In very cold snow, generic HOTs specific to Type II PG fluids have been determined based on both recently collected and historical fluid-specific data. Development of these generic values is discussed in Subsection 8.4.

4.3.3 Impact of New and Removed Fluids/Data

The impact of the new fluid and the generics analysis on the Type II generic HOTs were as follows:

- The addition of **ROMCHIM ADD-PROTECT Type II** resulted in two 20-minute decreases and three 10-minute decreases; and
- The very cold snow generics update resulted in decreases to all Type II generic snow HOTs at temperatures below -14°C.

4.3.4 Type II Generic Holdover Time Values and the Fluids Responsible

The Type II generic HOTs and the fluids that are responsible for them are shown in Table 4.1 and Table 4.2 for Winters 2018-19 and 2019-20, respectively. All decreases made to the HOTs for Winter 2019-20 are shown in Table 4.2 in red. The Winter 2018-19 table is included for reference.

Due to space limitations, the following abbreviations are used in the tables:

- ABAX ECOWING 26 (A-E26);
- ABAX ECOWING AD-2 (A-AD2);
- Aviation Shaanxi Cleanwing II (AS-CII);
- Beijing Yadilite YD-102 Type II (B-YD);
- Clariant Safewing MP II FLIGHT (C-Flight);
- Clariant Safewing MP II FLIGHT PLUS (C-Flight+);
- Kilfrost Ice Clear II (K-IC-2);
- Kilfrost ABC-K Plus (K-AK+);
- Newave Aerochemical FCY-2 (N-FCY-2);
- Newave Aerochemical FCY-2 Bio+ (N-FCY-2B);
- Oksayd Defrost PG 2 (O-PG2); and
- ROMCHIM ADD-PROTECT Type II (R-AP).

In both tables, the following abbreviations are used:

- A “U” indicates the fluid is responsible for the upper value in the cell;
- An “L” indicates the fluid is responsible for the lower value in the cell; and
- A “B” indicates the fluid is responsible for both the upper and lower values in the cell.

Table 4.1: Type II Generic HOT Values and Responsible Fluids – Winter 2018-19

Outside Air Temperature (°C)	Fluid Concentration Neat Fluid/Water	Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets	Freezing Drizzle	Light Freezing Rain	Rain on Cold Soaked Wing
-3 and above	100/0	**0:55 – 1:50**	**0:25 – 0:50**	**0:30 – 1:00**	**0:20 – 0:35**	**0:08 – 0:45**
		AS-CII **(B)** O-PG2 **(B)**	B-YD **(B)**	O-PG2 **(B)** K-IC-2 **(U)**	O-PG2 **(B)** AS-CII **(U)** N-FCY-2 **(U)**	N-FCY-2 **(B)** N-FCY-2B **(L)**
	75/25	**0:25 – 0:55**	**0:15 – 0:25**	**0:15 – 0:40**	**0:10 – 0:20**	**0:04 – 0:25**
		B-YD **(B)**	B-YD **(B)**	B-YD **(B)**	B-YD **(B)**	B-YD **(B)** A-AD2 **(L)** N-FCY-2 **(U)**
	50/50	**0:15 – 0:25**	**0:05 – 0:10**	**0:08 – 0:15**	**0:06 – 0:09**	CAUTION: No holdover time guidelines exist
		B-YD **(B)** A-AD2 **(L)** N-FCY-2B **(L)**	B-YD **(B)**	B-YD **(B)** A-AD2 **(U)**	A-AD2 **(B)** B-YD **(U)**	
below -3 to -8	100/0	**0:30 – 1:05**	**0:20 – 0:35**	**0:20 – 0:45**	**0:15 – 0:20**	
		K-AK + **(B)**	B-YD **(B)** N-FCY-2 **(L)** N-FCY-2B **(L)**	N-FCY-2 **(B)**	N-FCY-2 **(B)** A-E26 **(L)** K-AK + **(L)** N-FCY-2B **(L)**	
	75/25	**0:25 – 0:50**	**0:10 – 0:20**	**0:15 – 0:25**	**0:08 – 0:15**	
		B-YD **(U)** K-AK + **(L)** C-Flight **(L)**	B-YD **(B)** N-FCY-2B **(L)**	B-YD **(B)** A-AD2 **(L)** N-FCY-2 **(L)**	N-FCY-2 **(B)** B-YD **(U)**	
below -8 to -14	100/0	**0:30 – 1:05**	**0:15 – 0:30**	**0:20 – 0:45**	**0:15 – 0:20**	
		K-AK + **(B)**	B-YD **(B)** N-FCY-2 **(B)** N-FCY-2B **(B)**	N-FCY-2 **(B)**	N-FCY-2 **(B)** A-E26 **(L)** K-AK + **(L)** N-FCY-2B **(L)**	
	75/25	**0:25 – 0:50**	**0:08 – 0:20**	**0:15 – 0:25**	**0:08 – 0:15**	
		B-YD **(U)** K-AK + **(L)** C-Flight **(L)**	B-YD **(B)** N-FCY-2B **(B)** N-FCY-2 **(U)**	B-YD **(B)** A-AD2 **(L)** N-FCY-2 **(L)**	N-FCY-2 **(B)** B-YD **(U)**	
below -14 to -18	100/0	**0:15 – 0:35**	**0:06 – 0:20**			
		A-AD2 **(L)** N-FCY-2 **(U)**	Generic **(B)**			
below -18 to -25	100/0	**0:15 – 0:35**	**0:02 – 0:09**			
		A-AD2 **(L)** N-FCY-2 **(U)**	Generic **(B)**			
below -25 to LOUT	100/0	**0:15 – 0:35**	**0:01 – 0:06**			
		A-AD2 **(L)** N-FCY-2 **(U)**	Generic **(B)**			

L = DRIVES LOWER LIMIT U = DRIVES UPPER LIMIT B = DRIVES BOTH

Table 4.2: Type II Generic HOT Values and Responsible Fluids – Winter 2019-20

Outside Air Temperature (°C)	Fluid Concentration Neat Fluid/Water	Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets	Freezing Drizzle	Light Freezing Rain	Rain on Cold Soaked Wing
-3 and above	100/0	**0:55 – 1:50**	**0:25 – 0:50**	**0:30 – 1:00**	**0:20 – 0:35**	**0:08 – 0:45**
		AS-CII **(B)** O-PG2 **(B)**	B-YD **(B)**	O-PG2 **(B)** K-IC-2 **(U)**	O-PG2 **(B)** AS-CII **(U)** N-FCY-2 **(U)**	N-FCY-2 **(B)** N-FCY-2B **(L)**
	75/25	**0:25 – 0:55**	**0:15 – 0:25**	**0:15 – 0:40**	**0:10 – 0:20**	**0:04 – 0:25**
		B-YD **(B)**	B-YD **(B)**	B-YD **(B)**	B-YD **(B)**	B-YD **(B)** A-AD2 **(L)** N-FCY-2 **(U)**
	50/50	**0:15 – 0:25**	**0:05 – 0:10**	**0:08 – 0:15**	**0:06 – 0:09**	CAUTION: No holdover time guidelines exist
		B-YD **(B)** A-AD2 **(L)** N-FCY-2B **(L)**	B-YD **(B)**	B-YD **(B)** A-AD2 **(U)**	A-AD2 **(B)** B-YD **(U)**	
below -3 to -8	100/0	**0:30 – 0:45**	**0:20 – 0:35**	**0:20 – 0:45**	**0:15 – 0:20**	
		K-AK + **(L)** R-AP **(U)**	B-YD **(B)** N-FCY-2 **(L)** N-FCY-2B **(L)**	N-FCY-2 **(B)**	N-FCY-2 **(B)** A-E26 **(L)** K-AK + **(L)** N-FCY-2B **(L)**	
	75/25	**0:25 – 0:50**	**0:10 – 0:20**	**0:15 – 0:25**	**0:08 – 0:15**	
		K-AK + **(L)** C-Flight **(L)** B-YD **(U)**	B-YD **(B)** N-FCY-2B **(L)**	B-YD **(B)** A-AD2 **(L)** N-FCY-2 **(L)**	N-FCY-2 **(B)** B-YD **(U)**	
below -8 to -14	100/0	**0:30 – 0:45**	**0:15 – 0:30**	**0:20 – 0:45**	**0:15 – 0:20**	
		K-AK + **(L)** R-AP **(U)**	B-YD **(B)** N-FCY-2 **(B)** N-FCY-2B **(B)**	N-FCY-2 **(B)**	N-FCY-2 **(B)** A-E26 **(L)** K-AK + **(L)** N-FCY-2B **(L)**	
	75/25	**0:25 – 0:50**	**0:08 – 0:20**	**0:15 – 0:25**	**0:08 – 0:15**	
		B-YD **(U)** K-AK + **(L)** C-Flight **(L)**	B-YD **(B)** N-FCY-2B **(B)** N-FCY-2 **(U)**	B-YD **(B)** A-AD2 **(L)** N-FCY-2 **(L)**	N-FCY-2 **(B)** B-YD **(U)**	
below -14 to -18	100/0	**0:15 – 0:25**	**0:02 – 0:07**			
		A-AD2 **(L)** R-AP **(U)**	Generic **(B)**			
below -18 to -25	100/0	**0:15 – 0:25**	**0:01 – 0:03**			
		A-AD2 **(L)** R-AP **(U)**	Generic **(B)**			
below -25 to LOUT	100/0	**0:15 – 0:25**	**0:00 – 0:01**			
		A-AD2 **(L)** R-AP **(U)**	Generic **(B)**			

L = DRIVES LOWER LIMIT U = DRIVES UPPER LIMIT B = DRIVES BOTH

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5. CHANGES TO THE TYPE III HOLDOVER TIME GUIDELINES

Changes made to the Type III HOT Guidelines for the winter of 2019-20 are documented in this section. The TC and FAA 2019-20 Type III HOT Guidelines are included in Appendix H.

5.1 New Fluids/Data

No Type III fluids were tested in the winter of 2018-19.

5.2 Removed Fluids/Data

No Type III data was removed from the HOT Guidelines for the winter of 2019-20.

5.3 Changes to Holdover Time Guidelines Format

No changes were made to the Type III HOT Guidelines format for the winter of 2019-20.

5.4 Type III Generic Holdover Time Values

As there is only one Type III fluid currently in the HOT Guidelines, there is no need at this time to provide generic HOTs for Type III fluids. Therefore, a Type III generic HOT table is not included in the 2019-20 HOT Guidelines. This could change in the future if new fluids or data become available.

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6. CHANGES TO THE TYPE IV HOLDOVER TIME GUIDELINES

Changes made to the Type IV HOT Guidelines for the winter of 2019-20 are documented in this section. The TC and FAA 2019-20 Type IV HOT Guidelines are included in Appendix H.

6.1 New Fluids/Data

This section documents changes to the Type IV HOT Guidelines that were made because of the introduction of new fluids or new data and analysis.

6.1.1 New Fluids

Two new Type IV fluids were added to the HOT Guidelines for the winter of 2019-20: **AllClear ClearWing EG** (100/0 only, no dilutions) and **Cryotech Polar Guard® Xtend** (100/0 only, no dilutions). These new fluids underwent endurance time testing in the winter of 2018-19. Details of this testing are included in Appendices E and F. The introduction of these fluids had no impact on the Type IV generic HOTs (see Subsection 6.3.3).

6.1.2 Supplemental Testing with LNT E450

In the winter of 2018-19, supplemental artificial snow and freezing fog testing was conducted with the existing fluid LNT E450 (100/0 dilution only). This testing was conducted in order to support a proposed reduction to the fluid's LOUT. An updated fluid-specific HOT table (with the reduced LOUT) was published in the 2019-20 HOT Guidelines. At the time of writing this report, the Guidelines indicate that the freezing point and aerodynamic acceptance test results for LNT E450 are pending. Details of this testing are included in Appendix G.

6.1.3 Very Cold Snow Generics Analysis

Additional analysis related to the generic HOTs for Type II/IV fluids in very cold snow conditions (temperatures below -14°C) was completed during the winter of 2018-19. As a result, the generic values have been updated for the winter of 2019-20.

This research is described in further detail in Section 8.

6.1.4 Modified Fluid-Specific Snow Holdover Times Below -29°C

The analytical protocol used to determine fluid-specific HOTs in snow below -29°C was finalized in 2018-19. This resulted in changes to the snow HOTs in the coldest temperature band for Cryotech Polar Guard® Advance.

This research is described in further detail in Section 8.

6.2 Removed Fluids/Data

No Type IV data was removed from the HOT Guidelines for the winter of 2019-20.

6.3 Type IV Generic Holdover Time Values

Type IV generic HOTs are published annually. These HOTs represent the worst case performance of all Type IV fluids and can be used with any Type IV fluid. The protocol used to determine the generic HOT values each winter is described in Subsection 6.3.1. Subsection 6.3.3 describes the impact of new and removed data on the generic HOTs. Subsection 6.3.4 presents the changes to the generic HOTs for Winter 2019-20 and details the fluids that are responsible for the values.

6.3.1 Protocol for the Determination of Type IV Generic Holdover Times

The values in the Type IV generic HOT table are generated each year by taking the shortest HOTs of all Type IV fluids listed in the TC and FAA HOT Guidelines. It should be noted that the HOT Guidelines include fluids whose qualifications have recently expired (i.e., within four years). Fluids are only removed from the generics analysis when they are removed from the HOT Guidelines.

6.3.2 Use of Generic Holdover Times in Very Cold Snow

Fluid-specific HOTs are provided for very cold snow (temperatures below -14°C) only for those Type IV fluids that have undergone the necessary supplemental testing. All other fluids are provided with newly established generic HOTs for very cold snow. In very cold snow, generic HOTs specific to Type IV PG and Type IV EG fluids have been determined based on recent and historical fluid-specific data. Development of these generic values is discussed in Subsection 8.4.

6.3.3 Impact of New and Removed Fluids/Data

The impact of the new fluids and generics analysis on the Type IV HOTs were as follows:

- The addition of **AllClear ClearWing EG** and **Cryotech Polar Guard® Xtend** did not result in any changes to the Type IV generic HOTs; and
- The very cold snow generics update resulted in decreases to all Type IV generic snow HOTs at temperatures below -14°C.

6.3.4 Type IV Generic Holdover Time Values and the Fluids Responsible

The Type IV generic HOTs and the fluids that are responsible for them are shown in Table 6.1 and Table 6.2 for winters 2018-19 and 2019-20, respectively. All decreases made to the HOTs for Winter 2019-20 are shown in Table 6.2 in red. The winter 2018-19 table is included for reference.

Due to space limitations, the following abbreviations are used in the tables:

- ABAX ECOWING AD-49 / Dow UCAR FlightGuard AD-49 (A/D-49);
- CHEMCO ChemR EG IV (CC-CEIV);
- Clariant Max Flight 04 (C-MF-04);
- Clariant Max Flight SNEG (C-MF-S);
- Clariant Safewing MP IV LAUNCH (C-L);
- Clariant Safewing MP IV LAUNCH PLUS (C-L+);
- Clariant Safewing EG IV NORTH (C-NORTH);
- Cryotech Polar Guard® (CR-PG);
- Cryotech Polar Guard® Advance (CR-PGA);
- Cryotech Polar Guard® Xtend (CR-PGX);
- Dow UCAR FlightGuard AD-480 (D-480);
- Inland Technologies ECO-SHIELD (IT-ES);
- Kilfrost ABC-S PLUS (K-AS+);
- LNT Solutions E450 (L-E450);
- Newave Aerochemical FCY 9311 (N-9311);
- Oksayd Defrost ECO 4 (O-DE4); and
- Shaanxi Cleanway Aviation Cleansurface IV (SC-CIV).

In both tables, the following abbreviations are used:

- A "U" indicates the fluid is responsible for the upper value in the cell;
- An "L" indicates the fluid is responsible for the lower value in the cell; and
- A "B" indicates the fluid is responsible for both the upper and lower values in the cell.

In Table 6.1 and Table 6.2, HOTs are provided for given precipitation rates in snow. These correspond to the snow HOTs as follows:

- Very light snow (TC): 4 g/dm²/h;
- Very light snow (FAA): lower limit = 3 g/dm²/h; upper limit = 4 g/dm²/h;
- Light snow: lower limit = 4 g/dm²/h; upper limit = 10 g/dm²/h; and
- Moderate snow: lower limit = 10 g/dm²/h; upper limit = 25 g/dm²/h.

Finally, it should be noted that TC caps snow HOTs at two hours while the FAA caps them at three hours. The values in the tables are capped at three hours.

Table 6.1: Type IV Generic HOT Values and Responsible Fluids – Winter 2018-19

Outside Air Temp. (°C)	Fluid Concentration Neat Fluid/Water	Freezing Fog or Ice Crystals	Snow, Snow Grains, or Snow Pellets				Freezing Drizzle	Light Freezing Rain	Rain on Cold Soaked Wing
			25 g/dm²/h	10 g/dm²/h	4 g/dm²/h	3 g/dm²/h			
-3 and above	100/0	**1:15 – 2:40**	**0:35**	**1:10**	**2:20**	**2:45**	**0:40 – 1:30**	**0:25 – 0:40**	**0:08 – 1:10**
		IT-ES **(B)** O-DE4 **(U)**	CC-CEIV N-9311 O-DE4	N-9311	N-9311	L-E450	IT-ES **(B)** O-DE4 **(U)**	CC-CEIV **(B)** IT-ES **(U)**	C-NORTH **(L)** O-DE4 **(U)**
	75/25	**1:25 – 2:40**	**0:40**	**1:15**	**2:05**	**2:25**	**0:50 – 1:20**	**0:30 – 0:45**	**0:09 – 1:15**
		K-AS + **(B)**	CR-PGA	K-AS +	K-AS +	K-AS +	SC-CIV **(L)** K-AS + **(U)**	K-AS + **(L)** SC-CIV **(U)**	SC-CIV **(B)** CR-PGA **(L)**
	50/50	**0:30 – 0:55**	**0:10**	**0:25**	**1:00**	**1:10**	**0:15 – 0:40**	**0:09 – 0:20**	CAUTION: No holdover time guidelines exist
		K-AS + **(B)**	CR-PGA	CR-PGA	K-AS +	K-AS +	K-AS + **(B)**	CR-PGA **(B)** C-L + **(L)** SC-CIV **(L)** K-AS + **(L)**	
below -3 to -8	100/0	**0:20 – 1:35**	**0:30**	**0:55**	**1:50**	**2:20**	**0:25 – 1:20**	**0:20 – 0:25**	
		A/D-49 **(B)**	N-9311	N-9311	N-9311	L-E450 N-9311	A/D-49 **(L)** C-L + **(L)** C-MF-04 **(L)** K-AS + **(L)** N-9311 **(U)** O-DE4 **(U)**	A/D-49 **(B)** C-MF-04 **(L)** K-AS + **(L)** N-9311 **(L)** SC-CIV **(L)**	
	75/25	**0:30 – 1:20**	**0:30**	**1:00**	**1:50**	**2:10**	**0:20 – 1:05**	**0:15 – 0:25**	
		C-MF-S **(L)** C-L **(U)**	CR-PGA SC-CIV	SC-CIV	SC-CIV	K-AS +	C-L + **(B)** C-MF-S **(B)** K-AS + **(L)** CR-PGA **(U)**	K-AS + **(B)**	
below -8 to -14	100/0	**0:20 – 1:35**	**0:25**	**0:45**	**1:20**	**1:40**	**0:25 – 1:20**	**0:20 – 0:25**	
		A/D-49 **(B)**	N-9311 SC-CIV	SC-CIV	SC-CIV	SC-CIV	See "below -3 to -8" row	See "below -3 to -8" row	
	75/25	**0:30 – 1:20**	**0:20**	**0:45**	**1:40**	**2:00**	**0:20 – 1:05**	**0:15 – 0:25**	
		C-MF-S **(L)** C-L **(U)**	SC-CIV	SC-CIV	C-MF-S SC-CIV	C-MF-S K-AS +	See "below -3 to -8" row	See "below -3 to -8" row	
below -14 to -18	100/0	**0:20 – 0:40**	**0:06**	**0:20**	**0:40**	**0:50**			
		C-MF-S **(L)** C-MF-04 **(L)** A/D-49 **(U)**	Generic	Generic	Generic	Generic			
below -18 to -25	100/0	**0:20 – 0:40**	**0:02**	**0:09**	**0:20**	**0:25**			
		C-MF-S **(L)** C-MF-04 **(L)** A/D-49 **(U)**	Generic	Generic	Generic	Generic			
below -25 to LOUT	100/0	**0:20 – 0:40**	**0:01**	**0:06**	**0:20**	**0:25**			
		C-MF-S **(L)** A/D-49 **(U)**	Generic	Generic	Generic	Generic			
L = DRIVES LOWER LIMIT U = DRIVES UPPER LIMIT B = DRIVES BOTH									

Table 6.2: Type IV Generic HOT Values and Responsible Fluids – Winter 2019-20

Outside Air Temp. (°C)	Fluid Concentration Neat Fluid/Water	Freezing Fog or Ice Crystals	Snow, Snow Grains, or Snow Pellets				Freezing Drizzle	Light Freezing Rain	Rain on Cold Soaked Wing
			25 g/dm²/h	10 g/dm²/h	4 g/dm²/h	3 g/dm²/h			
-3 and above	100/0	**1:15 – 2:40**	**0:35**	**1:10**	**2:20**	**2:45**	**0:40 – 1:30**	**0:25 – 0:40**	**0:08 – 1:10**
		IT-ES **(B)** O-DE4 **(U)**	CC-CEIV N-9311 O-DE4	N-9311	N-9311	L-E450	IT-ES **(B)** O-DE4 **(U)**	CC-CEIV **(B)** IT-ES **(U)**	C-NORTH **(L)** O-DE4 **(U)**
	75/25	**1:25 – 2:40**	**0:40**	**1:15**	**2:05**	**2:25**	**0:50 – 1:20**	**0:30 – 0:45**	**0:09 – 1:15**
		K-AS + **(B)**	CR-PGA	K-AS +	K-AS +	K-AS +	SC-CIV **(L)** K-AS + **(U)**	K-AS + **(L)** SC-CIV **(U)**	SC-CIV **(B)** CR-PGA **(L)**
	50/50	**0:30 – 0:55**	**0:10**	**0:25**	**1:00**	**1:10**	**0:15 – 0:40**	**0:09 – 0:20**	CAUTION: No holdover time guidelines exist
		K-AS + **(B)**	CR-PGA	CR-PGA	K-AS +	K-AS +	K-AS + **(B)**	CR-PGA **(B)** C-L + **(L)** SC-CIV **(L)** K-AS + **(L)**	
below -3 to -8	100/0	**0:20 – 1:35**	**0:30**	**0:55**	**1:50**	**2:20**	**0:25 – 1:20**	**0:20 – 0:25**	
		A/D-49 **(B)**	N-9311	N-9311	N-9311	L-E450 N-9311	A/D-49 **(L)** C-L + **(L)** C-MF-04 **(L)** K-AS + **(L)** N-9311 **(U)** O-DE4 **(U)**	A/D-49 **(B)** C-MF-04 **(L)** K-AS + **(L)** N-9311 **(L)** SC-CIV **(L)**	
	75/25	**0:30 – 1:20**	**0:30**	**1:00**	**1:50**	**2:10**	**0:20 – 1:05**	**0:15 – 0:25**	
		C-MF-S **(L)** C-L **(U)**	CR-PGA SC-CIV	SC-CIV	SC-CIV	K-AS +	C-L + **(B)** C-MF-S **(B)** K-AS + **(L)** CR-PGA **(U)**	K-AS + **(B)**	
below -8 to -14	100/0	**0:20 – 1:35**	**0:25**	**0:45**	**1:20**	**1:40**	**0:25 – 1:20**	**0:20 – 0:25**	
		A/D-49 **(B)**	N-9311 SC-CIV	SC-CIV	SC-CIV	SC-CIV	See "below -3 to -8" row	See "below -3 to -8" row	
	75/25	**0:30 – 1:20**	**0:20**	**0:45**	**1:40**	**2:00**	**0:20 – 1:05**	**0:15 – 0:25**	
		C-MF-S **(L)** C-L **(U)**	SC-CIV	SC-CIV	C-MF-S SC-CIV	C-MF-S K-AS +	See "below -3 to -8" row	See "below -3 to -8" row	
below -14 to -18	100/0	**0:20 – 0:40**	**0:02**	**0:09**	**0:30**	**0:45**			
		C-MF-S **(L)** C-MF-04 **(L)** A/D-49 **(U)** CR-PGX **(U)**	Generic	Generic	Generic	Generic			
below -18 to -25	100/0	**0:20 – 0:40**	**0:01**	**0:03**	**0:10**	**0:20**			
		C-MF-S **(L)** C-MF-04 **(L)** A/D-49 **(U)** CR-PGX **(U)**	Generic	Generic	Generic	Generic			
below -25 to LOUT	100/0	**0:20 – 0:40**	**0:00**	**0:02**	**0:07**	**0:10**			
		C-MF-S **(L)** A/D-49 **(U)** CR-PGX **(U)**	Generic	Generic	Generic	Generic			

L = DRIVES LOWER LIMIT U = DRIVES UPPER LIMIT B = DRIVES BOTH

7. OTHER CHANGES TO HOLDOVER TIME GUIDELINES CONTENT

In addition to the changes made to the Type I, II, III, and IV HOT Guidelines, a number of other changes were made to the HOT Guidelines for Winter 2019-20. These changes are documented in this section.

7.1 Allowance Time Tables

A note was modified in the Type IV allowance time table to clarify that if the glycol type of the fluid being used is unknown, no allowance times exist for aircraft with rotation speeds of less than 115 knots.

7.2 Fluid Application Tables

A note was modified in the Type II, III, and IV fluid application table to clarify that HOTs do not exist below the lowest temperatures stated in the HOT table bands. Additionally, the table for the application of heated Type III fluids has been removed as there are currently no Type III fluids with HOTs for heated applications.

7.3 Active Frost Holdover Time Guidelines

Endurance time testing in active frost was conducted with all fluids submitted for endurance time testing in the winters of 2017-18 and 2018-19. The active frost data sets are now complete for all fluids that were submitted for testing in 2017-18. The test durations were compared to their respective generic HOTs: all completed ("failed") tests surpassed the generic HOTs, as did all tests that were not completed (due to active frost ending before fluid failure could occur).

Additional active frost data will be collected in Winter 2019-20 with retained samples of the fluids that were submitted for testing in Winter 2018-19. Their respective data sets will be analysed once the additional data collection is completed.

The generic frost HOTs can be considered substantiated for all fluids added to the HOT Guidelines for Winter 2018-19. As a result, no changes were made to the active frost HOTs for Winter 2019-20.

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8. SUPPLEMENTAL RESEARCH: HOLDOVER TIMES FOR SNOW AT VERY COLD TEMPERATURES

In the winter of 2018-19, additional analysis was completed to further advance HOTs for snow at very cold temperatures. This work was a continuation of research conducted in previous years.

8.1 Background

In the winter of 2003-04, generic HOTs for Type II and Type IV fluids in very cold snow (defined as temperatures below -14°C) were implemented as a result of industry identifying that existing natural snow data was not sufficient to support fluid-specific HOTs at these temperatures. The generic HOTs put in place were based on artificial snow data collected with limited fluids.

Natural snow testing conducted in the winters of 2014-15 and 2015-16 determined that these generic HOTs were not sufficiently conservative. As a result, reductions were put in place for the Winter 2016-17 operating season.

Industry subsequently requested that TC and the FAA support research to determine fluid-specific HOTs for Type II, III, and IV fluids in very cold snow. APS completed this research on their behalf in the winter of 2016-17. The result was the publication of fluid-specific HOTs for very cold snow for "Participating" Type II, III, and IV fluids. In addition, some reductions were made to the generic very cold snow HOTs that remained in place for "Non-Participating" fluids.

Additional very cold snow research conducted in 2017-18 resulted in the establishment of formal protocols for determining fluid-specific HOTs for Type II and Type IV fluids and for validating the use of generic HOTs with Type II and Type IV fluids. Analysis conducted in 2017-18 indicated that modifications to the generic very cold snow HOTs were likely necessary. However, further analysis and discussion with the regulatory authorities were deemed necessary to determine the specific changes.

8.2 Previous Work

The very cold snow research conducted in recent years is documented in the four reports listed below:

- The 2014-15 testing is documented in the TC report, TP 15321E, *Aircraft Ground De/Anti-Icing Fluid Holdover Time Development Program for the 2014-15 Winter* (8);

- The 2015-16 testing is documented in the TC report, TP 15338E, *Aircraft Ground De/Anti-Icing Fluid Holdover Time Development Program for the 2015-16 Winter* (9);
- The 2016-17 testing is document in the TC report, TP 15372E, *Aircraft Ground De/Anti-Icing Fluid Holdover Time Development Program for the 2016-17 Winter* (10); and
- The 2017-18 testing is document in the TC report, TP 15396E, *Aircraft Ground De/Anti-Icing Fluid Holdover Time Development Program for the 2017-18 Winter* (11).

8.3 Objectives

The objective of this project for the winter of 2018-19 was to continue the analysis started in 2017-18 relating to the determination of appropriate HOTs for very cold snow for Type II and Type IV fluids for which fluid-specific data does not exist.

These HOTs are referred to as the "generic" very cold snow HOTs from this point forward; however, it should be noted that in this case "generic" describes HOTs for which fluid-specific data does not exist, as opposed to other Type II/IV generic HOTs, which are the shortest HOTs of all fluid-specific data for a fluid type.

8.4 Reassessment of Generic Holdover Times for Very Cold Snow for Type II and Type IV Fluids

Note: No generic HOTs currently exist for Type III fluids as only one Type III fluid is currently listed in the HOT Guidelines. The work described in this section pertains to Type II and Type IV fluids only. If the need arises for Type III generic HOTs, further work will be required to determine appropriate values for very cold snow.

8.4.1 Analysis Background

Fluid-specific natural snow data collected at very cold temperatures in 2016-17 led to the development of fluid-specific very cold snow HOTs for all fluids that participated in the optional testing program. Several of these fluid-specific HOTs were found to be shorter than the corresponding generic HOTs at the time. The generic HOTs were reduced accordingly. However, because fluid-specific data was only collected with a few fluids, further analysis was required to examine the possibility that some fluids (those for which fluid-specific data does not exist) could have shorter HOTs than the HOTs published as the generic values.

Type II and Type IV generic HOTs are typically determined by taking the shortest fluid-specific HOT of all fluids of a specific fluid type for each condition incorporated into the Type II/IV HOT tables. In the case of very cold snow, this approach cannot be used, as fluid-specific data does not exist for every fluid. Additionally, collecting the missing data was not considered feasible due to the high costs of collecting natural snow data at very cold temperatures and the difficulty in obtaining appropriate lowest on-wing viscosity (LOWV) samples for testing.

In 2017-18, an analytical approach was taken to examine the generic HOTs for very cold snow at temperatures below -14°C. The analysis followed these general steps:

1. Determine if the Type II/IV natural snow data collected in 2016-17 likely represents the worst case very cold snow HOT performance of all Type II/IV fluids;
2. Determine a methodology for estimating very cold snow HOTs for all Type II/IV fluids using existing data (this was attempted using several approaches);
3. Use this methodology to estimate HOTs for all those fluids missing natural snow data for very cold snow; and
4. Compare the estimated very cold snow HOTs to the current generic HOTs, and identify if there are any conditions in which the estimated HOTs are lower and if so, determine what the lowest estimated value is.

The analysis indicated that some of the generic HOTs currently in place are likely not sufficiently conservative to account for the performance of all Type II/IV fluids. This result was more pronounced for propylene glycol–based fluids as compared to ethylene glycol–based fluids.

However, due to a lack of confidence in the precision of the results generated by the analyses, it was not clear which changes should be made to the generic HOTs for very cold snow. It was determined that further discussion between APS, TC, and the FAA – as well as additional analysis – was required.

It was decided that this discussion would take place in the winter of 2018-19 and changes to the generic HOTs for very cold snow, if appropriate, would be put in place for the winter of 2019-20.

As a result, the analysis commenced in 2017-18 was further developed in 2018-19 with the goal of determining generic HOTs for very cold snow that would be appropriately conservative regardless of which fluid was being used.

8.4.2 Analysis

This section describes the analysis performed and the resulting changes to the generic very cold snow HOTs.

8.4.2.1 Data Grouping and Fluid Classification

For this analysis, all Type II and IV fluids that are listed in the 2019-20 HOT Guidelines were grouped based on fluid type and fluid base (ethylene vs. propylene). The fluids in each grouping were then further subdivided into two categories: those that had participated in the optional natural very cold snow testing (known as "Participating" fluids) and those that had not (known as "Non-Participating" fluids).

The "Participating" Type II and Type IV fluids are as follows:

1. Clariant Safewing MP II FLIGHT (PG-based Type II);
2. Clariant Safewing MP IV LAUNCH (PG-based Type IV);
3. Clariant Safewing MP IV LAUNCH PLUS (PG-based Type IV);
4. Cryotech Polar Guard Advance (PG-based Type IV);
5. Cryotech Polar Guard II (PG-based Type II);
6. Dow UCAR™ Endurance EG106 (EG-based Type IV); and
7. LNT Solutions E450 (EG-based Type IV).

The fluid groupings are summarized below in Table 8.1.

Table 8.1: Very Cold Snow Generics Analysis – Fluid Data Groupings

Fluid Type and Base	Number of Participating Fluids	Number of Non-Participating Fluids
Type II – PG	2	11
Type IV – PG	3	10
Type IV – EG	2	5

It should be noted that no Type II EG category exists as there are no EG-based Type II fluids currently listed in the HOT Guidelines.

The intent of separating the data in this fashion was to isolate groups of fluids with variable sensitivity to temperature. Each of the three groupings was then analysed separately, resulting in three discrete sets of recommendations for changes to the generics.

8.4.2.2 Determining the Worst-Performing Fluid Adjustment Factor

In order to address the concern that the natural snow data set used to determine the very cold snow generic times may not have included the worst-performing fluids, the general endurance time performance of the "Participating" fluids was evaluated against that of the "Non-Participating" fluids for each of the three data groupings (Type II PG, Type IV PG, and Type IV EG).

This was done by calculating the regression-derived endurance times in the majority of the HOT boundary conditions for the neat dilution of every Type II and Type IV fluid that was listed in the 2019-20 HOT Guidelines. The regression coefficients used in the calculations are those listed in the 2019-20 Regression Information documents. The 2019-20 HOT Guidelines are included in Appendix H. The 2019-20 Regression Information documents are included in Appendix I.

For each condition evaluated, the calculated endurance time of the worst-performing (lowest endurance time) "Non-Participating" fluid was expressed as a ratio of the calculated endurance time of the worst-performing "Participating" fluid. For reference purposes, this calculated ratio is subsequently described as the "Worst-Performing Fluid Ratio."

This analysis was performed separately for each of the data groupings (Type II PG, Type IV PG, and Type IV EG). The results for each data grouping are shown below in Table 8.2, Table 8.3, and Table 8.4, respectively.

Table 8.2: Participating vs. Non-Participating Fluid Performance Analysis – Type II PG

Condition				Minimum ET Non-Participating Fluids (min)	Minimum ET Participating Fluids (min)	Worst-Performing Fluid Ratio (Min Non-Participating ET / Min Participating ET)
Precip. Type	Temp. (°C)	Dil.	Rate (g/dm²/h)			
FREEZING FOG	-3	Neat	5	52.8	169.1	31%
			2	108.2	244.2	44%
	-14	Neat	5	27.5	53.8	51%
			2	46.5	104.2	45%
	-25	Neat	5	15.2	27.4	55%
			2	25.6	51.1	50%
FREEZING DRIZZLE	-3	Neat	13	32.2	80.9	40%
			5	60.3	123.5	49%
	-10	Neat	13	18.4	35.5	52%
			5	43.3	89.9	48%
FREEZING RAIN	-3	Neat	25	21.2	46.7	45%
			13	34.6	83.4	41%
	-10	Neat	25	13.1	27.4	48%
			13	18.9	44.4	43%
COLD-SOAKED WING	1	Neat	75	8.3	11.5	72%
			5	44.9	89.3	50%
SNOW	-3	Neat	25	25.3	58.2	43%
			10	49.9	95.7	52%
			4	96.5	157.5	61%
			3	111.7	184.1	61%
	-8	Neat	25	18.3	46.9	39%
			10	37.0	77.1	48%
			4	70.9	126.8	56%
			3	85.8	148.3	58%
	-14	Neat	25	13.1	39.4	33%
			10	28.2	66.6	42%
			4	55.1	109.5	50%
			3	66.8	128.1	52%

Table 8.3: Participating vs. Non-Participating Fluid Performance Analysis – Type IV PG

Condition				Minimum ET Non-Participating Fluids (min)	Minimum ET Participating Fluids (min)	Worst-Performing Fluid Ratio (Min Non-Participating ET / Min Participating ET)
Precip. Type	Temp. (°C)	Dil.	Rate (g/dm²/h)			
FREEZING FOG	-3	Neat	5	74.8	169.1	44%
			2	161.9	241.8	67%
	-14	Neat	5	19.0	53.8	35%
			2	96.5	115.2	84%
	-25	Neat	5	21.4	23.1	93%
			2	39.1	48.8	80%
FREEZING DRIZZLE	-3	Neat	13	39.2	89.5	44%
			5	87.5	122.1	72%
	-10	Neat	13	23.1	26.7	87%
			5	80.6	93.0	87%
FREEZING RAIN	-3	Neat	25	37.4	57.9	65%
			13	42.2	88.3	48%
	-10	Neat	25	17.6	25.2	70%
			13	26.5	38.5	69%
COLD-SOAKED WING	1	Neat	75	11.2	14.1	79%
			5	71.9	101.7	71%
SNOW	-3	Neat	25	35.8	55.2	65%
			10	71.0	104.8	68%
			4	140.8	170.8	82%
			3	170.4	199.2	86%
	-8	Neat	25	28.3	44.0	64%
			10	56.2	83.8	67%
			4	111.6	144.6	77%
			3	138.4	168.5	82%
	-14	Neat	25	22.7	37.7	60%
			10	43.0	68.2	63%
			4	81.5	118.1	69%
			3	99.6	140.3	71%

Table 8.4: Participating vs. Non-Participating Fluid Performance Analysis – Type IV EG

Condition				Minimum ET Non-Participating Fluids (min)	Minimum ET Participating Fluids (min)	Worst-Performing Fluid Ratio (Min Non-Participating ET / Min Participating ET)
Precip. Type	Temp. (°C)	Dil.	Rate (g/dm²/h)			
FREEZING FOG	-3	Neat	5	110.9	111.9	99%
			2	196.4	177.2	111%
	-14	Neat	5	85.4	88.6	96%
			2	220.9	197.6	112%
	-25	Neat	5	36.9	31.9	116%
			2	82.0	66.0	124%
FREEZING DRIZZLE	-3	Neat	13	44.9	71.8	63%
			5	97.4	119.1	82%
	-10	Neat	13	58.3	56.4	103%
			5	89.9	107.8	83%
FREEZING RAIN	-3	Neat	25	25.6	51.1	50%
			13	39.9	74.0	54%
	-10	Neat	25	30.7	45.0	68%
			13	49.3	71.9	69%
COLD-SOAKED WING	1	Neat	75	8.7	18.1	48%
			5	89.0	124.1	72%
SNOW	-3	Neat	25	33.2	38.4	86%
			10	76.9	79.6	97%
			4	161.0	145.1	111%
			3	201.3	166.5	121%
	-8	Neat	25	33.2	33.5	99%
			10	70.5	69.4	102%
			4	143.6	122.8	117%
			3	178.1	141.0	126%
	-14	Neat	25	32.0	30.5	105%
			10	65.2	63.1	103%
			4	130.7	109.6	119%
			3	156.2	125.9	124%

The average and the standard deviation of the worst-performing fluid ratios for each condition were then determined for each data grouping and are shown below in Table 8.5.

Table 8.5: Summary of Very Cold Snow Worst-Performing Fluid Analysis Results

Fluid Type and Base	Average of Worst-Performing Fluid Ratios	Standard Deviation of Worst-Performing Fluid Ratios
Type II – PG	49%	9%
Type IV – PG	70%	14%
Type IV – EG	95%	24%

These calculated averages are considered approximations of the relative performance of the worst-performing "Non-Participating" fluids vs. the worst-performing "Participating" fluids.

These values were subsequently used to determine an appropriate adjustment factor to apply to the generic very cold snow HOTs derived from the "Participating" fluid data in order to account for the worst-performing "Non-Participating" fluids. This adjustment factor was calculated separately for each data grouping by taking their respective Average of Worst-Performing Fluid Ratios and decreasing it by two sigma in order to ensure that the resulting HOTs are sufficiently conservative. The determined adjustment factors are listed below in Table 8.6.

Table 8.6: Generic Very Cold Snow HOT Adjustment Factors

Fluid Type and Base	Generic Very Cold Snow HOT Adjustment Factor
Type II – PG	31%
Type IV – PG	41%
Type IV – EG	47%

8.4.2.3 Calculation of Modified Generic Very Cold Snow HOTs

The endurance time performance of the "Participating" fluids in very cold snow was used as the basis for the modified generic very cold snow HOTs.

The regression-derived endurance time in each of the very cold snow HOT boundary conditions was calculated for each of the "Participating" fluids. The values in each boundary condition were then compared within each of the data groupings; the endurance time of the worst-performing fluid in each condition served as the new base value for the generic time in that HOT cell.

These base values were subsequently multiplied by their respective generic very cold snow HOT adjustment factors listed in Table 8.6. The resulting values were then subjected to the standard HOT rounding rules to establish the new generic very cold snow HOTs.

This analysis was performed separately for each of the data groupings (Type II PG, Type IV PG, and Type IV EG), resulting in three new sets of generic very cold snow HOTs. In each case, the temperature used for the LOUT cells was the coldest LOUT of any fluid within that particular data grouping. The results (unrounded) for each data grouping are shown below in Table 8.7, Table 8.8, and Table 8.9, respectively.

The newly modified generic very cold snow HOTs (for use in 2019-20 and beyond) are shown below in HOT table format in Table 8.10, Table 8.11, and Table 8.12.

Table 8.7: Very Cold Snow Worst-Performing Fluid Analysis – Type II PG

Condition				Endurance Times - Participating Fluids (min)		Min. ET Participating Fluids (min)	Adjusted Min. ET Participating Fluids (min)
Precip. Type	Temp. (°C)	Dil.	Rate (g/dm²/h)	Cryotech Polar Guard II	Clariant Safewing MP II FLIGHT		
VERY COLD SNOW	-18	Neat	25	11.5	8.5	8.5	2.7
			10	33.2	24.4	24.4	7.7
			4	96.1	70.4	70.4	22.1
			3	134.2	98.2	98.2	30.8
	-25	Neat	25	4.8	3.6	3.6	1.1
			10	13.8	10.4	10.4	3.3
			4	40.1	30.0	30.0	9.4
			3	56.0	41.8	41.8	13.1
	LOUT (-30.5)	Neat	25	2.8	2.1	2.1	0.7
			10	8.1	6.1	6.1	1.9
			4	23.4	17.7	17.7	5.6
			3	32.6	24.7	24.7	7.7

Table 8.8: Very Cold Snow Worst-Performing Fluid Analysis – Type IV PG

Condition				Endurance Times - Participating Fluids (min)			Min. ET Participating Fluids (min)	Adjusted Min. ET Participating Fluids (min)
Precip. Type	Temp. (°C)	Dil.	Rate (g/dm²/h)	Clariant Safewing MP IV LAUNCH	Clariant Safewing MP IV LAUNCH PLUS	Cryotech Polar Guard Advance		
VERY COLD SNOW	-18	Neat	25	6.7	7.4	11.5	6.7	2.8
			10	22.1	23.7	33.2	22.1	9.2
			4	73.5	75.7	96.1	73.5	30.4
			3	107.1	109.1	134.2	107.1	44.4
	-25	Neat	25	2.7	3.0	4.8	2.7	1.1
			10	9.0	9.6	13.8	9.0	3.7
			4	29.9	30.6	40.1	29.9	12.4
			3	43.5	44.1	56.0	43.5	18.0
	LOUT (-30.5)	Neat	25	1.6	1.7	2.8	1.6	0.6
			10	5.2	5.5	8.1	5.2	2.1
			4	17.1	17.5	23.4	17.1	7.1
			3	25.0	25.2	32.6	25.0	10.3

Table 8.9: Very Cold Snow Worst-Performing Fluid Analysis – Type IV EG

Condition				Endurance Times - Participating Fluids (min)		Min. ET Participating Fluids (min)	Adjusted Min. ET Participating Fluids (min)
Precip. Type	Temp. (°C)	Dil.	Rate (g/dm²/h)	Dow UCAR™ Endurance EG106	LNT Solutions E450		
VERY COLD SNOW	-18	Neat	25	22.9	21.2	21.2	10.1
			10	49.3	63.8	49.3	23.4
			4	106.4	191.8	106.4	50.5
			3	135.4	271.1	135.4	64.3
	-25	Neat	25	19.1	10.6	10.6	5.0
			10	41.1	31.9	31.9	15.1
			4	88.7	96.0	88.7	42.1
			3	112.9	135.6	112.9	53.6
	LOUT (-33)	Neat	25	16.3	5.8	5.8	2.8
			10	35.2	17.5	17.5	8.3
			4	75.8	52.7	52.7	25.0
			3	96.5	74.5	74.5	35.4

Table 8.10: 2019-20 Generic Very Cold Snow HOTs – Type II PG Fluids

Outside Air Temperature	Fluid Conc.	Snow, Snow Grains, or Snow Pellets (hr:min)		
		Very Light	Light	Moderate
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:20 - 0:30*	0:07 - 0:20	0:02 - 0:07
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:09 - 0:15*	0:03 - 0:09	0:01 - 0:03
below -25 to LOUT °C (below 0 to LOUT °F)	100/0	0:05 - 0:07*	0:01 - 0:05	0:00 - 0:01

*Upper HOT in very light snow included in FAA tables only (not TC tables).

Table 8.11: 2019-20 Generic Very Cold Snow HOTs – Type IV PG Fluids

Outside Air Temperature	Fluid Conc.	Snow, Snow Grains, or Snow Pellets (hr:min)		
		Very Light	Light	Moderate
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:30 - 0:45*	0:09 - 0:30	0:02 – 0:09
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:10 - 0:20*	0:03 - 0:10	0:01 - 0:03
below -25 to LOUT °C (below 0 to LOUT °F)	100/0	0:07 - 0:10*	0:02 - 0:07	0:00 - 0:02

*Upper HOT in very light snow included in FAA tables only (not TC tables).

Table 8.12: 2019-20 Generic Very Cold Snow HOTs – Type IV EG Fluids

Outside Air Temperature	Fluid Conc.	Snow, Snow Grains, or Snow Pellets (hr:min)		
		Very Light	Light	Moderate
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:50 - 1:05*	0:25 - 0:50	0:10 - 0:25
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:40 - 0:55*	0:15 - 0:40	0:05 - 0:15
below -25 to LOUT °C (below 0 to LOUT °F)	100/0	0:25 - 0:35*	0:08 - 0:25	0:02 - 0:08

*Upper HOT in very light snow included in FAA tables only (not TC tables).

8.5 Snow HOTs at LOUT for Fluids with LOUT <-29°C

The protocol used to determine fluid-specific HOTs for snow below -29°C was finalized in 2018-19. This section describes the protocol and the resulting changes to the fluid-specific HOT tables.

8.5.1 Protocol Background and Methodology

This protocol was first employed in 2016-17 to determine appropriate snow HOTs in the coldest temperature band for AllClear AeroClear MAX, a Type III fluid with an LOUT of -35°C, and was initially described in TP 15372E (10). The protocol has now been adopted for all Type II, III, and IV fluids with LOUTs that are below -29°C.

The protocol is as follows:

1. Artificial snow tests are run at -25°C and at the LOUT at the boundary rates for very light, light, and moderate snow as outlined in the HOT Guidelines (3, 4, 10, and 25 g/dm²/h, with two tests at each rate/temperature pairing);
2. The relative performance of the fluid at -25°C vs. the LOUT is determined by dividing the endurance times of the tests run at the LOUT by the endurance times of the tests run at -25°C for each of the boundary rates;
3. The resulting relative performance outputs are averaged;
4. The final average endurance ratio is reduced by a factor of two sigma in order to ensure the final output remains conservative; and
5. The reduced endurance time ratio is applied to the HOTs derived for -25°C from the natural snow data to obtain HOTs for the LOUT.

Application of this protocol resulted in changes to the existing snow HOTs in the "below -25°C to LOUT" temperature band for two fluids: Cryotech Polar Guard® II (Type II, LOUT -30.5°C) and Cryotech Polar Guard® Advance (Type IV, LOUT -30.5°C).

The protocol was also used to determine the snow HOTs in the "below -25°C to LOUT" temperature band for LNT Solutions E450 in order to support a proposed reduction to that fluid's LOUT. Additional details pertaining to this testing can be found in Subsection 6.1.2 and the associated report included as Appendix G.

8.5.2 Artificial Snow LOUT Data for Cryotech Polar Guard® II/Advance

Cryotech Polar Guard® II and Cryotech Polar Guard® Advance are the same fluid; the fluid is marketed under two different names (each with a differing fluid type). As such, only one set of artificial snow data was required to apply the protocol to both fluid-specific HOT tables. The artificial snow data collected is summarized below in Table 8.13.

Table 8.13: Log of Cryotech Polar Guard® Advance Artificial Snow LOUT Tests

Test No.	Date	Snow Type	Fluid Name	Fluid Dilution	Test Temp. (°C)	Target Icing Intensity (g/dm²/h)	Endurance Time (min)
CAL2	20-Feb-17	Artificial	Polar Guard Advance	100%	-25	25	8.3
CAL1/CS169	20-Feb-17	Artificial	Polar Guard Advance	100%	-25	25	11.0
CS169S	29-Mar-17	Artificial	Polar Guard Advance	100%	-25	25	14.5
CS169T	29-Mar-17	Artificial	Polar Guard Advance	100%	-25	25	12.5
CS167	22-Feb-17	Artificial	Polar Guard Advance	100%	-25	10	24.0
CS167R	20-Mar-17	Artificial	Polar Guard Advance	100%	-25	10	25.5
CS167S	30-Mar-17	Artificial	Polar Guard Advance	100%	-25	10	28.0
CS166	22-Feb-17	Artificial	Polar Guard Advance	100%	-25	4	55.4
CS165	21-Feb-17	Artificial	Polar Guard Advance	100%	-25	3	53.0
CS165R	30-Mar-17	Artificial	Polar Guard Advance	100%	-25	3	84.4
CS180	3-Mar-17	Artificial	Polar Guard Advance	100%	-31	25	15.7
CS178	3-Mar-17	Artificial	Polar Guard Advance	100%	-31	10	25.1
CS177	7-Mar-17	Artificial	Polar Guard Advance	100%	-31	4	47.9
CS176	3-Mar-17	Artificial	Polar Guard Advance	100%	-31	3	61.2

The data set in Table 8.1 was collected previously as part of the very cold snow research conducted in 2016-17; see TP 15372E (10) for additional details. As such, it does not strictly adhere to the data targets that were determined in 2018-19 (two tests per rate/temperature pairing). In some cases, more than two tests were run (and the average endurance time of all tests was used); in others, only a single test was run.

Although the data was collected at -31°C, it should be noted that the fluid LOUT for Cryotech Polar Guard® II/Advance is -30.5°C.

8.5.3 HOTs at LOUT Analysis for Cryotech Polar Guard® II/Advance

Table 8.14 shows the relative endurance time performance of the fluid in artificial snow at -25°C vs. -31°C.

Table 8.14: Cryotech Polar Guard® II/Advance Artificial Snow Performance at -25°C vs. -31°C

Rate (g/dm²/h)	Avg. Fail Time at -25°C (min)	Avg. Fail Time at -31°C (min)	-31°C HOT as % of -25°C HOT
3	68.7	61.2	89.1%
4	55.4	47.9	86.4%
10	25.8	25.1	97.1%
25	11.6	15.7	135.2%
Average			**101.9%**
Standard Deviation			**22.6%**
-35°C Performance Factor (2 sigma)			**56.7%**

The -35°C performance factor of 56.7 percent was subsequently applied to the HOTs derived for -25°C from the fluid's natural snow data set in order to determine the new snow HOTs in the "below -25°C to LOUT" temperature band. The newly determined snow HOTs at LOUT are shown below in Table 8.15.

Table 8.15: Cryotech Polar Guard® II/Advance Snow HOTs at LOUT Calculation

Precipitation Rate (g/dm²/h)	Unrounded Snow HOT at -25°C (Regression-Derived)	Unrounded Snow HOT at LOUT (-25°C HOT * -35°C Performance Factor)
3	56.0	31.8
4	40.1	22.7
10	13.8	7.8
25	4.8	2.7

The new snow HOTs for the "below -25°C to LOUT" temperature band for Cryotech Polar Guard® II and Cryotech Polar Guard® Advance are shown in HOT table format in Table 8.16. The 2018-19 values are also shown, for reference. The 2019-20 values that represent decreases from the previous values are shown in red. No HOTs were increased as a result of these changes.

Table 8.16: Cryotech Polar Guard® II/Advance Snow HOTs at LOUT 2018-19 vs. 2019-20

Outside Air Temperature	Fluid Conc.	Snow, Snow Grains, or Snow Pellets* (hr:min)		
		Very Light	Light	Moderate
below -25 to -30.5 °C (below 0 to -13 °F) **Previous (2018-19)**	100/0	0:25 – 0:35	0:08 – 0:25	0:02 – 0:08
below -25 to -30.5 °C (below 0 to -13 °F) **New (2019-20)**	100/0	0:25 – **0:30**	**0:07** – 0:25	0:02 – **0:07**

**FAA values shown; TC publishes only the lower value for very light snow.*

8.6 Conclusions

The generic very cold snow HOTs were revised as a result of analysis conducted in 2018-19. The previous generic HOTs were replaced by three new sets of generic HOTs. Discrete sets of generic very cold snow HOTs now exist for:

1. PG-Based Type II Fluids;
2. PG-Based Type IV Fluids; and
3. EG-Based Type IV Fluids.

In most situations, the newly applicable generic HOTs represent reductions from the previous generic HOTs.

The protocol used to determine fluid-specific HOTs for snow below -29°C was finalized in the year of this report's publication. This resulted in changes to the existing snow HOTs in the "below -25°C to LOUT" temperature band for two fluids: Cryotech Polar Guard® II and Cryotech Polar Guard® Advance.

8.7 Recommendations

It is recommended that the very cold snow generics analysis be re-visited in the future after additional natural very cold snow data collection has been completed and more fluid-specific data (with a larger set of fluids) is available for review.

It is also recommended that further research be done to investigate the validity of the existing generic very cold snow HOTs for Type I fluids.

9. CONCLUSIONS

The conclusions derived from the testing conducted as part of the Winter 2018-19 HOT development program are provided below.

9.1 Annual Testing

Endurance time testing was carried out with six de/anti-icing fluids in the winter of 2018-19. The results of this testing led to several changes being made to the HOT Guidelines. The changes, described below, were included in the Winter 2019-20 HOT Guidelines.

1. Fluid-specific HOT Guidelines were created for three new fluids: ROMCHIM ADD-PROTECT Type II (Type II), AllClear ClearWing EG (Type IV), and Cryotech Polar Guard® Xtend (Type IV).
2. Supplemental testing was completed with LNT E450, an existing Type IV fluid, in order to support a proposed change to the fluid's LOUT. An updated fluid-specific HOT table (with the reduced LOUT) was published in the 2019-20 HOT Guidelines. At the time of writing this report, the Guidelines indicate that the freezing point and aerodynamic acceptance test results for LNT E450 are pending.
3. The generic HOTs provided to Type II/IV fluids that have not undergone fluid-specific testing in very cold snow conditions (temperatures below -14°C) were updated after additional analysis was completed in 2018-19.
4. The analytical protocol used to determine fluid-specific HOTs in snow below -29°C was finalized in 2018-19. This resulted in changes to the snow HOTs in the coldest temperature band for Cryotech Polar Guard® II and Cryotech Polar Guard® Advance.
5. Minor decreases were made to the Type II generic HOTs as a result of the new Type II fluid and the changes to the generic very cold snow HOTs. Minor decreases were made to the Type IV generic HOTs as a result of the changes to the generic very cold snow HOTs (the addition of the new Type IV fluids did not result in any changes to the Type IV generic HOTs).
6. A note was modified in the Type IV allowance time table to clarify that if the glycol type of the fluid being used is unknown, no allowance times exist for aircraft with rotation speeds of less than 115 knots.
7. A note was modified in the Type II/III/IV fluid application table to clarify that HOTs do not exist below the lowest temperatures stated in the HOT table bands. Additionally, the table for the application of heated Type III fluid has been removed as there are currently no Type III fluids with HOTs for heated applications.

9.2 Supplemental Research: Holdover Times for Snow at Very Cold Temperatures

The generic very cold snow HOTs were revised as a result of analysis conducted in 2018-19. The previous generic HOTs were replaced by three new sets of generic HOTs. Discrete sets of generic very cold snow HOTs now exist for:

1. PG-Based Type II Fluids;
2. PG-Based Type IV Fluids; and
3. EG-Based Type IV Fluids.

In most situations, the newly applicable generic HOTs represent reductions from the previous generic HOTs.

The protocol used to determine fluid-specific HOTs for snow below -29°C was finalized this year. This resulted in changes to the existing snow HOTs in the "below -25°C to LOUT" temperature band for two fluids: Cryotech Polar Guard® II and Cryotech Polar Guard® Advance.

10. RECOMMENDATIONS

It is recommended that:

1. Any new Type I, II, III, or IV fluids be evaluated over the entire range of conditions encompassed by the HOT tables;

2. The very cold snow generics analysis be re-visited in the future after additional natural very cold snow data collection has been completed and more fluid-specific data (with a larger set of fluids) is available for review; and

3. Further research be done to investigate the validity of the existing generic very cold snow HOTs for Type I fluids.

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APPENDIX A

TRANSPORT CANADA
STATEMENT OF WORK EXCERPT –
AIRCRAFT & ANTI-ICING FLUID WINTER TESTING 2018-19

TRANSPORT CANADA
STATEMENT OF WORK EXCERPT –
AIRCRAFT & ANTI-ICING FLUID WINTER TESTING 2018-19

1. Endurance Time Testing for Maintenance and Publication of HOT Guidance Material (Including Frost Testing)

This program element is funded by the fluid manufacturers. The extent of effort for this program element will be determined by the number of new fluids submitted for testing.

(For the 2018-19 testing season, testing of three thickened HOT fluids is anticipated.)

a) Conduct endurance time tests with samples of Type I, Type II, Type III and Type IV fluids supplied by fluid manufacturers. Testing will be conducted using the methodology provided in Aerospace Recommended Practice (ARP) 5485 and/or ARP5945 under the following activities:

   i. Setup and planning for natural snow, natural frost, artificial snow, and simulated freezing precipitation testing;

   ii. Fluid management, training, and updates to project specific software systems (covered under a related program element);

   iii. Natural snow testing at the P.E.T. test site under a wide range of temperature, precipitation rate, and wind conditions (in some cases, travel to other locations may be necessary to collect a more complete set of data);

   iv. A minimum of two frost events (ideally up to six events) at the P.E.T. test site under a wide range of temperature and precipitation rates;

   v. Simulated freezing precipitation at the NRC CEF (in freezing drizzle, light freezing rain, freezing fog, and rain on a cold-soaked surface);

   vi. Conduct artificial snow testing (as required) at the P.E.T. test site and/or an alternate temperature controlled facility; and

   vii. For all testing conducted, record individual fluid endurance times, log, and file data.

b) Analyse the data collected and disseminate to fluid manufacturers as required.

c) Prepare reports on the findings and disseminate to TC/FAA and fluid manufacturers as required.

d) Prepare presentation material for the SAE G-12 meetings.

3. Endurance Time Testing in Very Cold Snow Conditions (Temperatures Below -14°C)

This program element is funded by the fluid manufacturers. This testing is scheduled every two years and can include either new fluids or current fluids that do not have fluid-specific HOTs for very cold snow.

A minimum of two fluids is required to move ahead with testing. For the 2018-19 Winter, no manufacturers submitted fluids for participation.

For the 2018-19 Winter, no manufacturers submitted fluids for participation. As a result, the budget for this program element was reduced and only planning and set-up activities will be performed.

a) Conduct flat plate tests with samples of Type II, Type III, and Type IV using the methodology provided in ARP5485 in very cold snow conditions (temperatures below -14°C) to develop fluid specific holdover times.

   i. Setup and plan for natural snow and artificial snow (if LOUT falls below -29°C) testing.

   ii. Conduct natural snow testing under a wide range of temperature, precipitation rate, and wind conditions. Data needs to be collected in each of the following temperature ranges: below -14°C to -18°C, below -18°C to -22°C, below -22°C to -25°C, and below -25°C. Travel is expected to collect a complete set of data (6 trips expected).

   iii. Conduct artificial snow testing (if LOUT falls below -29°C, additional required tests completed as part of program element #1) at the PMG chamber in Blainville, QC.

   iv. For all testing conducted, record individual fluid endurance times, and log and file data.

b) Conduct flat plate tests with samples of Type I fluids using the methodology provided in ARP5945. This data is being collected in support of program element #5.

c) Analyse the data collected and disseminate to TC/FAA and fluid manufacturers as required.

d) Prepare reports on the findings and disseminate to TC/FAA and fluid manufacturers as required.

e) Prepare presentation material for the SAE G-12 meetings.

5. Very Cold Snow – Additional Testing and Analysis to Determine Appropriate Generic HOTs

a) Prepare project plan and have kickoff meeting with TC/FAA.

b) Collect Type I data (fixed costs of data collection covered as part of Task #3, variable costs for Type I data collection assigned to this task).

c) Analyse the Type I data.

d) Conduct further analysis on the Type II/IV data.

e) Participate in up to three meetings with TC/FAA to discuss the data, analysis, and recommended changes to guidance materials.

f) Conduct additional analysis following the meetings as required.

g) Implement changes to HOT guidance materials if/as required.

h) Prepare a presentation for SAE G-12.

i) Prepare a report.

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APPENDIX B

PROCEDURES FOR HOLDOVER TIME TESTING

- Procedure: Endurance Time Testing in Simulated Freezing Precipitation with SAE Type I, II, III, and IV De/Anti-Icing Fluids
- Procedure: Endurance Time Testing in Natural Snow with SAE Type I, II, III, and IV De/Anti-Icing Fluids
- Procedure: Endurance Time Testing in Simulated Snow with SAE Type I, II, III, and IV Fluids De/Anti-Icing Fluids
- Procedure: Endurance Time Testing in Active Frost with SAE Type I, II, III, and IV De/Anti-Icing Fluids
- Overall Program of Tests at NRC, April 2019
- Overall Program of Tests at PMG, April 2019

PROCEDURE:
ENDURANCE TIME TESTING IN SIMULATED FREEZING PRECIPITATION WITH SAE TYPE I, II, III, AND IV DE/ANTI-ICING FLUIDS

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PROCEDURE:

ENDURANCE TIME TESTING IN SIMULATED FREEZING PRECIPITATION WITH SAE TYPE I, II, III, AND IV DE/ANTI-ICING FLUIDS

Prepared for

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Transport Canada

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Final Version 1.0

PROCEDURE: ENDURANCE TIME TESTING IN SIMULATED FREEZING PRECIPITATION WITH SAE TYPE I, II, III, AND IV DE/ANTI-ICING FLUIDS

1. BACKGROUND

The Society of Automotive Engineers (SAE) has published standards detailing acceptable practices for endurance time testing in simulated freezing precipitation conditions. The Aerospace Recommended Practice (ARP) documents ARP5945 and ARP5485 outline these practices for Type I and Type II/III/IV anti-icing fluids, respectively. These documents set the requirements for fluid samples, testing materials, test conditions, and test practices for anti-icing fluid endurance time testing. These standards are continually reviewed and updated at the discretion of the SAE Holdover Time committee.

APS has been conducting outdoor simulated freezing precipitation endurance time testing with the goal of measuring the effectiveness of new holdover time fluids since the early 1990's. All testing is conducted in accordance with the established SAE standards, ARP5945 and ARP5485.

This procedure serves as an update to the previous APS procedure, *Test Requirements for Simulated Freezing Precipitation Flat Plate Testing*, which was issued in January 2004. This new document serves to incorporate refinements to the procedure that have been made in the intervening years, as well as to provide additional information relating to event planning and APS specific processes.

2. OBJECTIVE

This procedure describes the testing procedures used to evaluate the endurance time performance of Type I, II, III and IV fluids in simulated freezing precipitation conditions.

This procedure also describes the testing procedure used to measure fluid thickness profiles of Type I, II, III and IV fluids.

A related procedure is produced annually containing year-specific test plans, equipment needs, as well as details on other projects being undertaken during the annual simulated freezing precipitation holdover time test session.

3. PRE-TESTING ACTIVITIES

This section describes activities that need to be performed prior to commencing a simulated freezing precipitation testing session.

3.1. Event Coordination and Scheduling

Simulated freezing precipitation testing is a highly coordinated activity requiring the use of advanced testing facilities, numerous personnel (from both APS and the NRC), and significant resources. To that end, a significant effort must be put into planning these activities in order to keep testing running as smoothly, with as few costly disruptions as possible.

A typical test session will require that all fluids being qualified are tested in every simulated freezing precipitation condition found within a typical fluid holdover time table. This results in testing being done in discrete blocks (referred to as “conditions”) which are defined by the following:

- Precipitation Type;
- Test Temperature; and
- Target Precipitation Rate.

These parameters of each condition are designed to replicate the boundary conditions governing each freezing precipitation holdover time table cell.

Given that each fluid being tested must be tested in all boundary conditions, each simulated freezing precipitation test session will consist of a known amount of conditions, each of whose length can be estimated with the following information:

- Number of tests to be run (determined by the number of fluids to be tested); and
- Expected endurance time of each test (estimated based on fluid performance in natural snow).

Additionally, each fluid being qualified must also undergo fluid film thickness testing. This is generally performed concurrently with the standard endurance time testing, but must also be accounted for when scheduling a test session. As fluid film thickness testing is conducted at a chamber temperature of -3°C, the testing should be scheduled to be done during the -3°C condition blocks.

It is the responsibility of the event coordinator to arrange the schedule of conditions in such a way as to ensure that each testing day will conclude at an appropriate time, and that time between conditions is minimized. To this end, like precipitation types/temperatures should be grouped as much as possible to avoid unnecessary temperature and spray equipment changes.

3.2. Data Requirements and test Planning

Unlike natural snow testing, where data is gathered at a range of rates and temperatures, simulated freezing precipitation testing is conducted at a specific set of rates and temperatures representing the boundary conditions for each precipitation type. Table 3.1 lists all of the test conditions that comprise a standard simulated freezing precipitation holdover time test session.

Table 3.1: Standard Holdover Time Freezing Precipitation Test Conditions

Condition Abbreviation	Precipitation Type	OAT (°C)	Test Rate (g/dm²/h)	Notes
ZF, -3, 2	Freezing Fog	-3	2	
ZF, -3, 5	Freezing Fog	-3	5	
ZF, -10, 2	Freezing Fog	-10	2	Type III only
ZF, -10, 5	Freezing Fog	-10	5	Type III only
ZF, -14, 2	Freezing Fog	-14	2	
ZF, -14, 5	Freezing Fog	-14	5	
ZF, -25, 2	Freezing Fog	-25	2	
ZF, -25, 5	Freezing Fog	-25	5	
ZF, -35, 2	Freezing Fog	-35	2	LOUT ≤ -29.5°C
ZF, -35, 5	Freezing Fog	-35	5	LOUT ≤ -29.5°C
ZD, -3, 5	Freezing Drizzle	-3	5	
ZD, -3, 13	Freezing Drizzle	-3	13	
ZD, -6, 5	Freezing Drizzle	-6	5	Type I only
ZD, -6, 13	Freezing Drizzle	-6	13	Type I only
ZD, -10, 5	Freezing Drizzle	-10	5	
ZD, -10, 13	Freezing Drizzle	-10	13	
ZR, -3, 13	Freezing Rain	-3	13	
ZR, -3, 25	Freezing Rain	-3	25	
ZR, -6, 13	Freezing Rain	-6	13	Type I only
ZR, -6, 25	Freezing Rain	-6	25	Type I only
ZR, -10, 13	Freezing Rain	-10	13	
ZR, -10, 25	Freezing Rain	-10	25	
CS, 1, 5	Rain on Cold Soaked Wing	-1	5	
CS, 1, 75	Rain on Cold Soaked Wing	-1	75	

As the test conditions are standardized and finite in number, the amount of tests required for a given fluid in a typical HOT test session is always known. For thickened fluids, this number is determined by how many dilutions are to be tested, as well as the fluid LOUT. For Type I fluids, data must be obtained using both aluminum and composite test surfaces for all conditions. Table 3.2 lists the data requirements in simulated freezing precipitation for all fluid types.

Table 3.2: Freezing Precipitation Data Requirements

Fluid Type, Dilution(s)	Fluid LOUT	Number of Tests Required
Type I	Any	56
Type II/IV, Neat Only	Above -29.5°C	32
	-29.5°C or Below	36
Type II/IV, All Dilutions	Above -29.5°C	72
	-29.5°C or Below	76
Type III, Neat Only	Above -29.5°C	32
	-29.5°C or Below	36
Type III, All Dilutions	Above -29.5°C	72
	-29.5°C or Below	76

Note that the totals in the above table do not include any tests which must be repeated (see Subsection 5.4.3 for details relating to repeated tests).

Refer to the above tables when planning an upcoming freezing precipitation test event; tests must be planned for each appropriate condition, and the number of tests for a given fluid should be equivalent to the appropriate number from the table above.

As a reminder, test plans for a given simulated freezing precipitation testing session are included in a related procedure that is prepared annually prior to that year's testing session.

3.3. Equipment Preparation

As all simulated freezing precipitation testing takes place at the NRC-CEF in Ottawa, there are several equipment preparation activities that must be completed prior to arrival at the NRC facility. These activities are as follows:

1) Mark all test surfaces with gridlines and with plate numbers on the back and front (note that markings should be at the bottom of the test surfaces);
2) Ensure all test plates are equipped with operational thermistors or smart button, and ensure that all temperature loggers have been properly configured. Loggers must be able to log a full week's worth of data as data will only be exported at the end of each testing week;
3) Locate the rate pans: check the quantity, confirm that all pans properly labelled and fully intact (no holes/cracks), and verify that spare pans are available;
4) Prepare labels for pour containers, as needed;
5) Confirm that the primary and backup rate station laptops are working normally, confirm that the rate station software runs on both laptops;
6) Confirm that the primary and backup rate station weigh scales are working normally, confirm that both weigh scales are communicating properly with both the primary and backup rate station laptops; and
7) Ensure that sufficient copies of all data forms, procedures and condition sheets have been printed in advance.

3.4. Fluid Preparation Management

This section describes the steps necessary to ensure that the fluids to be tested are properly prepared for testing.

3.4.1. Type I Fluid Preparation

Type I fluids will generally be sent to APS by the manufacturer in concentrate form. Prior to commencing a test session, appropriately buffered mixtures of the fluid must be prepared for each test temperature that is planned for the session. As per ARP5945A, Type I fluids must be tested at dilutions where the freezing point of the solution is 10°C colder than the OAT at which testing is taking place.

To prepare the buffered solution, you must first identify the temperatures at which the testing will take place. Separate solutions must be prepared for each discrete testing temperature, and each prepared solution must be stored at the correct temperature. For example, if the daily schedule calls for tests at both -3°C and -10°C, two separate batches of Type I fluid must be prepared (with freezing points of -13°C and -20°C respectively). Each batch must be stored at ambient room temperature (20°C).

The Type I concentrate must be diluted with hard water, which is prepared by dissolving 400mg of calcium acetate dehydrate and 280 mg of magnesium sulfate heptahydrate into 1L of water (the quantities can be scaled up proportionally if preparing a larger batch). Consult the dilution chart associated with the Type I fluid being tested in order to determine the appropriate glycol/hard water ratio necessary to achieve the desired freeze point. Dilution charts are generally available on the fluid manufacturer's website or directly from the manufacturer.

Confirm that the glycol concentration in your prepared solution is appropriate by measuring the Brix (generally Type I dilution charts will indicate the target Brix for the desired fluid freeze point). Ensure that the container in which the solution is mixed is clearly marked with the freeze point and Brix of the fluid. Pour container labels listing the fluid name, Brix and freeze point should also be created and affixed to all pour containers to be used during the test session.

Note that although ARP5945A stipulates that Type I fluid samples be sheared in a laboratory blender prior to testing, previous work has indicated that the effects of this shearing process on resulting Type I fluid endurance times are negligible. The Type I fluid shearing process is generally not performed with fluid samples as part of the typical simulated freezing precipitation testing process.

3.4.2. Type II/III/IV Fluid Management

In order to ensure that a testing session runs smoothly with minimal disruptions, it is critical that a sufficient number of filled 1L pour containers for each fluid to be tested are prepared and tempered prior to the start of a given test condition. The required amount of each fluid for each condition will be known in advance; it is good practice to have additional fluid ready for testing in the event of unexpected circumstances.

Used pour containers should be periodically refilled when time permits to prevent delays in the fluid application process. At a minimum, empty pour containers should be refilled at the conclusion of each testing day. All pour containers must be affixed with labels listing the fluid name, batch number and dilution and special care must be taken when refilling to ensure that the proper fluid, batch and dilution are used. At the testing manager's discretion, the fluid names on the pour container labels may need to be coded to preserve fluid anonymity in the presence of visitors.

All fluids to be used in simulated freezing precipitation endurance time testing must be properly stored in order to ensure that they are at the correct temperature when a test session begins. Given that simulated freezing precipitation testing takes place at several discrete testing temperatures, a series of programmable chest freezers set

to the various testing temperatures should be available at the NRC such that a sufficient quantity of fluid can be kept at each temperature being tested.

Fluid can also be stored within the test chamber itself, provided that the temperature of the chamber is the desired storage temperature for the fluid in question.

As stated in ARP5485B, the temperature of Type II, III (unheated) or IV fluid being applied to a test surface in a simulated freezing precipitation endurance time test must be within 3°C (ideally 1°C) of the OAT. Valuable testing time can be lost waiting for fluids to temper if the proper storage procedures have not been followed.

4. TEST SITE

All testing in simulated freezing precipitation is conducted indoors at the National Research Council Canada (NRC) Climatic Engineering Facility (CEF) located in Ottawa Canada, where precipitation is artificially produced using a specialized spray assembly capable of producing droplets of precisely calibrated size. This spray assembly (and the nozzles it contains) were developed by the NRC in conjunction with APS over the course of several years of research.

Photo 4.1 provides an outdoor view of the facility (U-88) giving a general indication of its size (30 m by 5.4 m, height 8 m). The facility was originally designed for the testing of locomotives; Photo 4.2 provides an interior view of the CEF set up for endurance time testing. The lowest temperature achievable in the CEF is -46°C.

Photo 4.1: Outdoor View of NRC Climatic Engineering Facility



Photo 4.2: Inside View of NRC Climatic Engineering Facility



5. TESTING PROCEDURES

This section describes the procedures to be followed during a simulated freezing precipitation test event.

The procedures conform to the requirements for simulated freezing precipitation testing outlined in Section 11 of ARP5485B – *Endurance Time Tests for Aircraft Deicing/Anti-icing Fluids, SAE Type II, III, and IV*.

The procedures also conform to the requirements for simulated freezing precipitation testing outlined in Section 11 of ARP5945A – *Endurance Time Tests for Aircraft Deicing/Anti-icing Fluids, SAE Type I*.

5.1. Set-Up

The set-up steps to be performed once upon initial arrival at the CEF for a freezing precipitation endurance time testing session are listed below:

1) Unload all equipment from the truck upon arriving at the CEF. General equipment boxes should be stored in the women's washroom off of the client area. Office equipment is to be kept in the client area.
2) Set up the fluid storage freezers within the hallway off of the client area. Ensure that there is a freezer set to each of the target test temperatures at which testing will take place during the test session.
3) Set up the rate station within the client area: ensure that the scale being used is properly leveled and test that the scale and chosen rate station computer are functioning normally together.
4) Store the jugs cold soaked box fluid (brought from the test site) inside the cold NRC freezer and confirm that the freezer is set to < -30°C.
5) Set up two full six-position test stands within the spray area inside the testing chamber. The initial position of the test stands is dependent upon the first condition being tested; refer to the NRC Continuous Rate form to determine the appropriate starting position for the test stands. Ensure the stands are levelled such that the test surfaces lie at a 10° angle (within 9.8° and 10.2° is acceptable, check each test surface). The angle of the test stand can be adjusted as needed by placing poker chips under the stand legs. Whenever the configuration is adjusted by adding or removing chips ensure that the stand is reasonably stable and that all test surfaces are at the proper angle. Ensure the fluid collection pans are placed beneath the test stands to collect fluid runoff, however equip the collection pans with white covers to prevent their filling with sprayed precipitation.

6) Equip the two six-position test stands with aluminum test plates. Half plates may be used for one test in each duplicate pair of tests in order to increase the number of available test positions. Note that Type I fluids need to be tested on both composite and aluminum test surfaces, test surfaces can be adjusted on the test stands as needed. Note also that a special test surface is used for rain on cold-soaked wing condition testing with all fluid types. See Subsection 5.6 for additional details. All test plates used must be equipped with Smart Buttons that are actively logging temperature data. Ensure that Position #1 on the top stand is left open for the NRC Automated Rate bucket. Figure 5.1 depicts the proper plate set-up for the two test stands.

7) Sync all digital clocks and install them in the large end of the test chamber (near spray area), and in the small end of the test chamber.

8) Confirm that the NRC personnel have properly set-up the closed-circuit camera system. It is critical that the camera system provides a good view of the testing area; the rate station manager must be able to have a clear view of the test stands while seated at the rate station. Ensure that the digital clocks are visible on the camera screens.

9) Post copies of the condition testing schedules and rate tolerance guidelines inside the client area.

10) Fill out the General Session Conformance Checklist (Attachment 1)

11) Prior to departing the facility on setup day, confirm that all personnel (NRC/APS) are aware of the starting time and initial test condition for the first testing day.

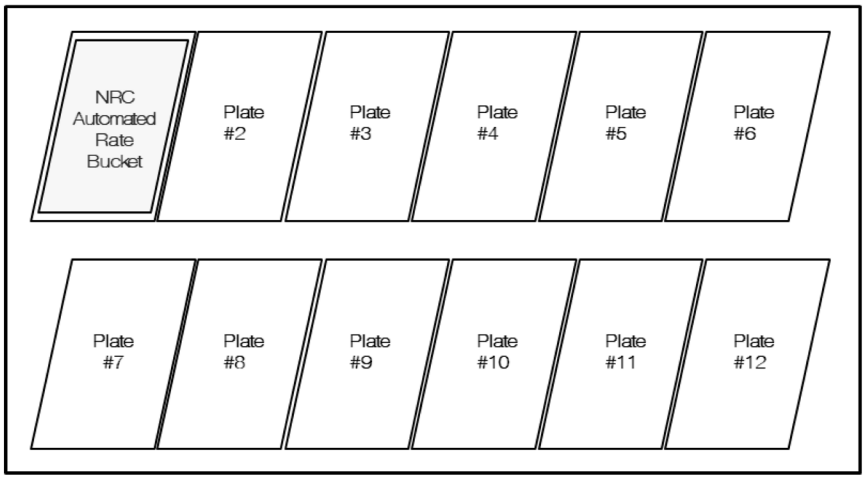

Figure 5.1: Test Stand Set-Up

5.2. Testing Process for a Typical Condition

A simulated freezing precipitation endurance time testing session is comprised of discrete blocks of tests known as conditions. Different conditions will vary in terms of precipitation type, precipitation rate and test chamber temperature.

The general flow of work for each condition is very similar; the steps in the testing process are listed below:

1) Confirm the condition being tested with NRC personnel. NRC personnel will install the proper spraying equipment/needles and set the flow rate specific to the condition precipitation type and will set the testing chamber temperature to the appropriate target test temperature.
2) While NRC personnel are configuring the chamber and spray equipment, APS personnel must confirm that the test stands are in the proper starting position relative to the condition being tested (refer to the NRC Continuous Rate Form for proper stand position coordinates). Ensure that the test stands are equipped with the appropriate test surfaces, and confirm that all fluids to be tested in the upcoming condition are at the appropriate temperature.
3) Once the chamber has reached the appropriate temperature, NRC personnel will activate the spraying equipment and begin precipitation.
4) Once precipitation has begun, pre-test rate collection and calibration takes place. This process continues until stable, in-tolerance rates have been achieved on a sufficient number of test stand positions to allow testing. In order for a position to be used for testing, two consecutive in-tolerance rates must have been recorded on that position.
5) All required endurance time tests are conducted and the results are validated. Note that for a given condition, the number of tests to be conducted will be known beforehand and all tests to be run will be listed on a condition-specific test plan known as a “Condition Sheet”. Two data points must be collected with each dilution of each fluid being tested in a given condition. Note that if the endurance time results obtained failed to satisfy preliminary data validation checks, supplemental test runs may be required.
6) As endurance time tests are completed, post-testing rate collection cycles are performed. Two rate collection cycles are required for a given position after an endurance time test is completed.
7) After the final post-test rate collection cycle is complete, the condition is considered complete. Rate and endurance time data processing takes place, and APS/NRC personnel can begin their set-up steps for the following condition.

5.3. Rate Collection

The rate collection process for simulated freezing precipitation differs significantly from the process employed during natural snow. Unlike natural snow rate collection, where one rate pan in one position is used to collect rates for the entire test stand, rate collection in simulated freezing precipitation is performed on each position of the test stand that is used for testing, resulting in unique rates being obtained for each position.

Additionally, while natural snow rate collection is a continuous process (occurring before, during and after a test), simulated freezing precipitation rate collection is performed only immediately prior and immediately following an endurance time test. The test rate for a given freezing precipitation endurance time test is determined by taking the average of four recorded rates; two rates taken immediately prior to the test, and two rates taken immediately following the test. All rates associated with a test must be collected from the same position on which the test is conducted. Similar to natural snow rate collection, the target time period for a recorded rate is ten minutes.

Test rates for simulated freezing precipitation endurance time tests must fall within a set of tolerances stipulated within ARP5945A and ARP5485B (for Type I and Type II/III/IV fluids, respectively). These tolerances dictate allowable ranges for the average rate of a test, as well as the allowable standard deviation of the individual rate measurements comprising a test rate. These tolerances are condition specific; they vary depending on precipitation type and target test rate. It is the responsibility of the rate station manager to ensure that test rates are falling within these tolerances; out-of-tolerance rates can result in the invalidation of an endurance time test. Table 5.1 lists the average test rate tolerances for the various simulated freezing precipitation conditions.

Table 5.1: Simulated Freezing Precipitation Average Test Rate Tolerances

Precipitation Type	Target Test Rate ($g/dm^2/h$)	Tolerance for Average Test Rate ($g/dm^2/h$)
Freezing Fog	2	±0.3
	5	±0.4
Freezing Drizzle	5	±0.4
	13	±0.5
Freezing Rain	13	±0.5
	25	±1.0
Rain on Cold Soaked Wing	5	±0.4
	75	±3.0

5.3.1. Procedure for Rate Collection

The rate collection process is generally performed by the rate station manager with two Ottawa personnel assisting. The steps for rate collection in simulated freezing precipitation are summarized below:

1) Open the rate station software (RateStation.Winforms). Complete initial configuration of the rate station software by selecting your test condition and specifying the temperature. If any positions on the test stand are not being used for testing in a given condition, retire them immediately in the software by clicking the "Retire" button under the unused positions.

2) Open a copy of the Excel sheet used to record the rates (RateStationTemplate). Rename the Excel sheet with a name that describes the condition being (ex. "ZD -10 5 - 2018-19" for low rate freezing drizzle at -10°C) and close the file.

3) Confirm that the test stands are in the correct starting position for the condition being tested (refer to the NRC Continuous Rate Form which lists the stand starting positions for each condition)

4) Ask NRC personnel to configure the automated rate bucket and the corresponding automated rate software. Note that the automated rate bucket is generally installed on Position 1 and that the automated rate software will run on a separate NRC-owned computer.

5) Ensure that the rate station scale is level, and pre-weigh dry "Inside" rate pans for all unretired positions. To record the pre-weight of the pans in the rate station software, click "Start Rate" under the appropriate position and input the weight from the scale in the "Weight" dialog box. Do not click "Start" after recording the pre-weight – this will signal to the software that the rate collection period has begun for that position.

6) Note that each numbered rate pan set corresponds to a specific numbered position on the test stand (see Figure 5.1) and consists of an "Inside" and an "Outside" plastic pan; whenever a pan is being weighed, only the "Inside" pans are to be placed on the scale. After weighing an "Inside" pan, place it back inside its corresponding "Outside" pan. Once all pans are pre-weighed, arrange them in numerical order on the shelves adjacent to the rate station. Figure 5.2 depicts the rate station software window after all pre-weights have been recorded (but before any rate cycles have begun).

7) Once the NRC personnel have started the precipitation for the condition, begin collecting initial rates for all available positions. In a typical two test stand set up, positions 2 through 12 should all be initially available. Bring the empty pans (Inside + Outside together) into the test chamber, and carefully place them on their respective positions one at a time, taking care

to avoid covering other positions with the rate pan as it is placed on the stand. The rate station manager is to monitor this process closely on the NRC cameras; as each pan is placed on the stand, the rate station manager must click the "Start" button for the position in question to indicate the start of the rate collection period.

8) As the ten-minute mark of the initial rate cycle approaches, begin collecting the rates pans from the test stand and returning them to the rate station, again in numerical order. Ensure that no precipitation is lost from inside each pan as they are transported – any lost precipitation will cause inaccuracies in the measured rate for that collection period. The rate station manager must once again monitor the process closely, and click the appropriate "Stop Rate" button at the moment that each pan is collected, signalling the end of the rate collection period. A dialog box will appear prompting the user for the final weight of the collection pan.

9) Weigh the "Inside" pans, record the weight in the dialog box and click "Save Rate". Repeat this process for each of the pans collected.

10) As the final weights are entered, the program will automatically calculate the measured rate of precipitation over the collection period for each position. The program will show the calculated rate on the screen, highlighted either green (for an in-tolerance rate) or red (for an out-of-tolerance rate). Figure 5.3 depicts the rate station software window after one cycle of rates have been collected for each available position in a standard two stand set-up, with both in and out of tolerance rates being shown.

11) After the initial rate cycle is complete (and prior to starting the second rate cycle), review the measured rates shown on-screen. If most or all positions are out-of-tolerance and a consistent trend is noted in the rates (i.e. all too high or all too low), consider asking the NRC personnel to adjust the back pressure (lower if rates are too high, higher if rates are too low).

12) If changing the back pressure does not bring the rates back in tolerance, or if there is no discernable trend in the rates across the positions, consider adjusting the position of the test stands. If making any adjustments, allow time for the adjustment to be made and come into effect before bringing pans back out to start a new rate cycle.

13) Begin a second rate cycle with all pans, repeating the same process as was completed for the first cycle.

14) After the second cycle is complete, the rate station manager can begin allocating positions to the testing team provided that both measured rates on the position in question are within tolerance. Tests can only be run on positions that have had two consecutive valid rates collected. Making further changes to the back-pressure settings or stand position after testing

has begun is discouraged – it is generally advisable to adjust early in the process with the goal of bringing as many positions in tolerance as possible.

15) Once a given position has been allocated for use to the testing team, click "Start Test" in the rate station software window. The display for this position will change colour, and will indicate that a test is running. At this point, rate pans will no longer need to be placed on this position until the testing team has completed their test(s). Figure 5.4 depicts the rate station software window with several active tests running (test numbers have been added).

16) After the testing team pours a test on an allocated position, input the test number in the "Test #" section in the software.

17) If two tests are poured simultaneously on a position equipped with half-plates, input both test numbers separated by a slash (ex. 6/7, with test 6 being poured on the left-hand half plate and test 7 being poured on the right hand half-plate).

18) If two tests are poured consecutively on a position (known as a "test-test"), input both test numbers separated by a plus sign (ex. 6+7, with test 6 being poured first and test 7 being poured on the same position after test 6 is complete.

19) Continue rate collection cycles on all positions that are not currently allocated for testing. Positions can be allocated to the testing team whenever two consecutive in-tolerance rates are obtained. Ensure that at all times rate cycles are continuously run on a minimum of one position – unexpected changes in the measured rates on this position will highlight changes in precipitation that may be difficult to detect otherwise.

20) When the testing team has completed their tests on a given position, they will communicate to the rate station manager that the position in question is now ready for post-test rates. Click "End Test" in the rate station software window for the position in question, and resume rate collection cycles on this position. A minimum of two post-test rate collection cycles must be completed in order to generate the final test rate for all tests run on that position. If the two post test rate cycles generate in-tolerance rates, the position can immediately be allocated back to the testing team (if more tests are to be run).

21) Once all tests and post-test rate cycles have been completed for a given condition, the rate data must be exported from the rate station software. To do so, click "Fill Excel Sheet" in the rate station software and locate the previously created Excel file.

22) Once the Excel sheet is populated, open the "Output" tab in the Excel file. Click "Update All" – the sheet will now process all of the imported rate

data. Once complete, the rates for all tests run in the condition should be shown in this tab.

23) Double check that test numbers for all tests run in the condition appear in Column D (refer to the condition sheet to confirm nothing was missed), and click "Status Calculator". The sheet will now verify that the rates for each test are conforming to the tolerances stipulated. Results of the checks are shown in columns P, Q and R. If any of the tests fail any of the tolerance checks, advise the testing manager – they will make the decision whether to re-run the affected tests.

24) Once confirmed that all tests are present in the Excel sheet with in-tolerance rates, print out a copy of the details in the Output tab (columns D through S) and provide the printout to the testing assistant for filing.

25) Finally, at the conclusion of each condition, assess the overall difficulty of the rate process for that condition on a scale from 1-5 and note this difficulty on the NRC Continuous Rate Form.



Figure 5.2: Rate Station Software Window after Pre-Weighing of Pans



Figure 5.3: Rate Station Software Window after One Rate Cycle



Figure 5.4: Rate Station Software Window with Active Tests Running

5.3.2. Challenges and Additional Information Concerning Rate Collection

Note that managing the rate station is a challenging role which requires a large amount of focus. The rate station manager should work closely with both the testing manager and NRC personnel in order to obtain valid, in-tolerance rates on as many positions as possible. Obtaining in-tolerance rates is not always straight-forward, and the challenge varies from condition to condition. Frequently, the rate station manager will need to make a decision between allocating fewer in-tolerance plates to the testing team (thus reducing the amount of tests that can be run concurrently) or attempting to tweak the water flow back pressure settings / stand positioning further (which delays the start of testing, with the goal of freeing up more usable positions).

The rate station manager should refer to the "Continuous Rate Form" in order to obtain an understanding of the relative difficulties of rate collection in the different conditions as well as the approximate values to be expected as continuous outputs from the automated rate bucket. This knowledge is helpful when attempting to make the "tweak or test" decisions alluded to in the previous paragraph. Finally, an internal companion document has been developed detailing common issues encountered during rate collection and troubleshooting suggestions. This document is available of the APS server.

5.4. Fluid Endurance Time Tests

The steps for conducting simulated freezing precipitation fluid endurance time tests are summarized below.

5.4.1. Procedure for Testing Unheated Fluids (Type II, III-Unheated, and IV)

1) Prepare the data form / data form app by recording the fluids to be poured in their respective positions.
2) Measure the initial fluid temperature of all fluids that are to be poured during the test session. Confirm that all fluids are within 3°C (ideally 1°C) of the current target test temperature. If fluids are not at the correct temperature, warm them in the client area or cool them in a chest freezer as needed.
3) Coordinate with the rate station manager to determine which positions on the test stand have rates suitable for testing.
4) Once test stand positions have been allocated to the testing team by the rate station manager, clear the test surfaces to be used of existing contamination using a scraper. To ensure that each position is properly cleaned, apply a small quantity of the fluid being tested to the test surface and use a squeegee to spread it across the full test surface.

5) Confirm that the data form manager is ready to begin the fluid application process. At each position, remove the plate cover and pour 1L of the selected fluid onto the test surface from the top of the plate, ensuring that the entire surface of the plate is coated with an even fluid layer. During the pouring process, use the removed plate cover to shield the test surface from the falling precipitation. Record the time of fluid application on the chosen data form.

6) After fluid application is complete, each plate must be inspected periodically in order to assess the condition of the fluid layer. A section of the plate is considered failed when it is covered with frozen contamination.

7) If more than one-third of a given plate is determined to be "failed" (or if fluid failure is noted at any five of the crosshair marks on the plate), the plate as a whole is considered to be failed. Announce the fluid failure and ensure the failure time is recorded by the data form manager. Place a "poker chip" on the plate once failure has been declared to indicate that the plate is no longer running an active test.

8) Alternately, if a test reaches the maximum run time (representing the maximum allowable holdover time for the freezing precipitation condition being tested), the test can be stopped immediately. For freezing fog, the maximum run time is four hours. For all other simulated freezing precipitation conditions, that maximum run time is two hours. The data form manager must note that the test did not fail (typically by noting "Did Not Fail (DNF)" on the data form).

9) If there are no other tests currently running or immediately to be run on the position, reinstall the plate cover and signal the rate station manager to begin post-test rate collection cycles. Note that a given position can be used for no more than two consecutive tests; post-test rate collection cycles must be performed after the second consecutive test.

10) Ensure fluid for the next condition is available and tempered to the correct temperature.

5.4.2. Procedure for Testing Heated Fluids (Type I and III-Heated)

1) Prepare the data form / data form app by recording the fluids to be poured in their respective positions.

2) Measure the initial fluid temperature of all fluids that are to be poured during the test session. Confirm that all fluids are within 5°C (ideally 1°C) of 20°C. If fluids are not at the correct temperature, warm them in the client area or cool them in a chest freezer as needed.

3) Coordinate with the rate station manager to determine which positions on the test stand have rates suitable for testing.

4) Once test stand positions have been allocated to the testing team by the rate station manager, clear the test surfaces to be used of existing contamination using a scraper. To ensure that each position is properly cleaned, apply a small quantity of the fluid being tested to the test surface and use a squeegee to spread it across the full test surface.

5) Confirm that the data form manager is ready to begin the fluid application process. At each position, remove the plate cover and pour 1L of the selected fluid onto the test surface from the top of the plate, ensuring that the entire surface of the plate is coated with an even fluid layer. During the pouring process, use the removed plate cover to shield the test surface from the falling precipitation. Record the time of fluid application on the chosen data form.

6) After fluid application is complete, each test surface must be inspected periodically in order to assess the condition of the fluid layer. A section of the plate is considered failed when it is covered with frozen contamination. For Type I fluids, failure may occur quickly after fluid application.

7) If more than one-third of a given plate is determined to be "failed" (or if fluid failure is noted at any five of the crosshair marks on the plate), the plate as a whole is considered to be failed. Announce the fluid failure and ensure the failure time is recorded by the data form manager. Place a "poker chip" once failure has been declared to indicate that the plate is no longer running an active test.

8) Alternately, if a test reaches the maximum run time (representing the maximum allowable holdover time for the freezing precipitation condition being tested), the test can be stopped immediately. For freezing fog, the maximum run time is four hours. For all other simulated freezing precipitation conditions, that maximum run time is two hours. The data form manager must note that the test did not fail (typically by noting "Did Not Fail (DNF)" on the data form).

9) If there are no other tests currently running or immediately to be run on the position, reinstall the plate cover and signal the rate station manager to begin post-test rate collection cycles.

10) Prepare for the next condition.

5.4.3. Criteria for Validation of Fluid Endurance Time Test Results

Two data points must be collected with each dilution of each fluid being tested in a given condition. After both tests are complete, the endurance time results of the two

tests must be compared to confirm that they conform to the reproducibility criteria outlined in ARP5945A / ARP5845B.

The standard states that if the endurance time of one of the two tests lies outside ±10% from the average, then two additional data points must be collected with the fluid in question. In cases where additional data must be gathered, no data is to be discarded. All four data points will ultimately be used when analyzing the test results and determining fluid holdover times.

It is the responsibility of the testing manager to ensure that all results obtained conform to the reproducibility criteria, and that additional data is collected when the reproducibility criteria is not met. A spreadsheet was developed for quick verification of the reproducibility criteria; as matched pairs of tests are completed, their results should be entered into the spreadsheet for verification of conformance.

5.5. Fluid Film Thickness Testing

In addition to fluid endurance time testing, a standard simulated freezing precipitation endurance time test session will also include fluid film thickness testing for each dilution of each fluid being tested. This testing performed in the “small end” of the test chamber (away from the spray area) as no precipitation is required. The testing is performed at -3°C, and is generally run concurrently to fluid endurance time tests.

The steps for conducting fluid film thickness tests are summarized below.

1) Set up a full six-position test stand in the “small end” of the testing chamber (away from the spray area). The exact position of the test stand is not important, but ensure that the stand is levelled such that the test surfaces lie at a 10° angle (within 9.8° and 10.2° is acceptable, check each test surface). Equip the test stand with aluminum test plates.
2) Prepare the data form by recording the fluids to be poured in their respective positions.
3) Measure the initial fluid temperature of the fluids that are undergoing thickness testing. Unheated fluids (Types II, III-Unheated and IV) must be within 3°C (ideally 1°C) of -3°C. Heated fluids (Types I and III-Heated) must be within 5°C (ideally 1°C) of 20°C. If fluids are not at the correct temperature, warm them in the client area or cool them in a chest freezer as needed.
4) Pour 1L of each fluid onto the test surface from the top of the plate, ensuring that the entire surface of the plate is coated with an even fluid layer. Start recording time on a stopwatch after the first fluid is poured. Stagger each pour in order to ensure that all thickness measurements can

be captured at the appropriate times. Record the time of fluid application on the data form for each pour.

5) At the five minute mark (as noted on the stopwatch), measure the thickness of the first poured fluid layer along the six-inch line of the plate with a film thickness gauge. Confirm the measured value by taking a second reading at a different point along the six-inch line of the plate. If there is disagreement between the first and second thickness values, take a third measurement at another point along the six-inch line. If all three values are different, record all three values obtained. Otherwise, discard the non-conforming value.

6) Repeat the thickness measurement process for the other fluid layers, staggering the measurements in the same manner as the fluid application process, to ensure that each fluid film thickness is measured at its respective five minute mark. Record the measured fluid film thicknesses on the data form.

7) Repeat the thickness measurement process at the 15 minute mark, and again at the 30 minute mark. Ensure that all measurements are recorded for each fluid being tested.

5.6. Procedure for Cold Soaked Box Preparation

For rain on a cold-soaked wing endurance time testing, the test surface to be used is a leading edge thermal equivalent box filled with cold Type I fluid (known as a cold soaked box). As per ARP5945A and ARP5485B, the boxes must be prepared such that the surface temperature of the plate at the start time of an endurance time test is -10 ± 1°C.

The cold soaked box preparation should begin during the initial rate collection cycles of the cold-soaked wing condition in order to ensure that the surfaces are ready for testing as soon as the rate collection process is complete.

The steps for preparing cold soaked boxes for testing are listed below.

1) Close the large door in the test chamber, dividing the chamber into the large end (containing the spray area and the test stands) and the small end. Have the NRC personnel set the temperature of the small end of the chamber to -10°C.

2) Retrieve the containers of cold Type I fluid from the cold (-30°C) freezers and place in the small end of the chamber.

3) Using a combination of the cold Type I fluid jugs removed from the freezers and the warmer Type I fluid found in the barrel at the small end of the

chamber, prepare a large batch of Type I fluid with a fluid temperature of -12 ± 1°C. The Brix of the fluid mixture should fall between 26.00 and 29.00. Note that a very large volume of cold fluid is required to fill the boxes; the batch should be prepared in the largest container available on-hand. Mix the fluid frequently while preparing the batch and monitor the fluid temperature at all times during the box preparation process.

4) Place the empty cold soaked boxes and cold soaked box filling stand on the large metal table found in the small end of the testing chamber.

5) Place a box in the filling stand and fill with the prepared Type I fluid mixture. Once full, agitate the box within the stand to free any trapped air within. Refill the box and agitate once again, repeating the process until the box is completely full with no trapped air.

6) Close the box and verify that the surface temperature of the box is -11 ± 1°. Remove the box from the filling stand and place on a dolly to await transfer to the testing team for use.

7) Repeat the process with the remaining empty boxes. Note that the filled boxes are heavy – avoid placing too many on the dolly at one time.

8) As positions on the test stand become available for testing, the testing team will advise the box preparation team that filled boxes are needed. Transfer prepared boxes to the testing team as needed by raising the doors dividing the testing chamber and passing the dolly underneath. Avoid transferring boxes too early or transferring unneeded boxes, as the surface temperature of the filled boxes will change rapidly in the warmer end of the testing chamber.

9) As tests are completed, filled boxes that have been used by the testing team will be returned to the box preparation team. Empty the used boxes back into the prepared fluid mixture, ensuring that the temperature of the mixture remains at -12 ± 1°C.

10) Continue preparing boxes until a sufficient quantity has been prepared to complete all planned tests (as well as any supplemental tests required, as determined by the testing team).

11) At the end of the cold-soaked wing condition, return all Type I fluid to the barrel for future use.

5.7. End of Testing Day Activities

The steps for concluding a freezing precipitation endurance time testing day are summarized as follows:

1) Ensure all test surfaces are properly cleaned after testing and that all fluid within the collection pans is disposed of appropriately (all glycol waste must be vacuumed up and disposed of in the waste fluid tote);
2) Ensure that all fluids to be tested during the first condition planned for the following day are available and are stored at the proper temperature. Refill empty pour containers as needed;
3) Ensure copies of the rate station Excel outputs for each condition tested have been saved in the Data and Rates folder of the APS Test Site Dropbox;
4) If using the HOT Data Form app to record endurance times, export the data files for each condition tested and save copies in the Data and Rates folder of the APS Test Site Dropbox;
5) If using paper data forms, place the completed forms in an envelope and mark the envelope with the date and number of forms;
6) If it is the final testing day of the week, ensure that all Smart Button data from all test surfaces used is downloaded from the buttons and saved to the APS Test Site Dropbox;
7) If it is the final testing day of the session, ensure that the chamber temperature, relative humidity and video data is obtained from the NRC personnel.
8) Ensure that the Dropbox program is synced and that all saved files have been uploaded; and
9) Confirm starting time for the next testing day with all APS/NRC personnel prior to leaving for the day.

6. EQUIPMENT

The equipment required for endurance time testing in simulated freezing precipitation is listed in Attachment 2. The specific equipment needed for each session is listed in the annual NRC procedure.

7. PERSONNEL

Generally, five to six people are required for simulated freezing precipitation endurance time testing:

1) Testing Manager – responsible for overseeing the test event, determining which tests are to be run, applying fluids and calling all failures;

2) Rate Station Manager – responsible for overseeing the rate collection process and coordinating the testing assistants assigned to the rate station;

3) Data Form Manager – responsible for managing all data forms (paper and electronic) and ensuring all information is properly transcribed and captured; and

4) Testing Assistants (2 or 3) – responsible for set-up activities, rate collection, clean-up and assisting with any other tasks as determined by the testing manager.

Note that for simulated freezing precipitation testing, the testing assistants are generally part-time personnel who are based in the Ottawa area.

8. SAFETY

Testing in cold temperatures can pose significant safety issues. Jackets, gloves and boots should be rated to very low temperatures and must be worn at all times when inside the testing chamber. Employees should be mindful of dangers associated with hypothermia and frostbite.

Additionally, as all simulated freezing precipitation testing takes place at an NRC controlled facility, all employees must adhere to any and all safety guidelines imposed by the NRC or its personnel.

9. DATA FORMS AND SOFTWARE

The following data forms and software are typically used for simulated freezing precipitation endurance time testing:

1) Rate Station Software;

2) General Session Conformance Checklist (Attachment 1)

3) NRC Continuous Rate Form (Attachment 3);

4) End Condition Data Form for Endurance Time Tests – used as backup for app data form (Attachment 4);

5) App Data Form for Fluid Endurance Time Tests (Attachment 5); and

6) Fluid Film Thickness Testing Data Form (Attachment 6)

Attachment 1: General Session Conformance Checklist

LOCATION: CEF (Ottawa) **DATE:**

Safety Issues Discussed ☐

Test Plate Material: ☐
(check the box if material used is Aluminum alloy AMS 4037)

Test Plate Dimensions: ☐
(check the box if the dimensions are 500mm long x 300mm wide x 3.2mm thick)

Test Box Dimensions: ☐
(only for CSW, check the box if the dimensions are 500mm long x 300mm wide x 75mm thick)

Surface Finish: ☐
(check the box if the average surface roughness is ≤ 0.5 µm)

Ice-catch Pan Dimensions: ☐
(check the box if the dimensions are 406mm long x 279mm wide with a 64mm height)

Water Supply to Nozzle: ☐
(check the box if the water supplied to the nozzles conforms to is ASTM D1193 Type IV water or a hardness of less than 300 ppm reported as $CaCO_3$)

Weigh Scale Verification ☐
(check the box if calibration was performed in the previous summer)

Distance between Nozzle and Test Plates ☐
(check the box if distance is 7±0.5, for ZD, ZR and CSW)

Distance between Temperature Sensor and Test Plates ☐
(check the box if distance is within 1.5m)

COMMENTS:

.....

.....

.....

.....

.....

LEADER: _____

Attachment 2: Equipment List for Simulated Freezing Precipitation Testing

SIMULATED FREEZING PRECIPITATION TESTING	
LOCATION: TEST SITE	
Barrel Opener to open CSW fluids	Power bars x 4
Bins for mixing CSW fluid x 5 (60L rubbermaids)	Printer & Ink Cartridge
Brixometer x 3	Rain Suits (all)
Camera x1 (small Canon) with accessories	Rate Pan (aluminum HOT) x1
Cart (IKEA) x2	Rate Pans(white plastic) x all
Clipboards x 5	Sample bottles x 6
Clock (Large digital) x 2	Scrapers x 14
Cold-soak boxes (aluminum) x 16	Shop Vac + 2x18L open top pails
Extension Cords x 4	Smart button kits x 2 + extension wire
Flashlights x 2	Speed tape x 1 and electrical tape x 5
Fluids (separate table)	Squeegees x 4 (small)
Folding table x 1 (small)	Tape measure (large yellow + small)
Freezers (portable) x2	Temperature probes: immersion x 3
Funnels x 4 (big and small)	Temperature probes: surface x 3
Gloves - black and yellow x4	Test plate covers (white plastic) x 15
Gloves - cotton (1 large box)	Test plate covers (wooden boards) x 12
Gloves - latex (2 boxes)	Test Plates - Half plates x 11 (22 halves) w/buttons
Ice Pic	Test Plates (Aluminum): 12 w/buttons + 6 w/out
Inclinometer (yellow level) x 2	Test Stand Collection Pans (one per stand)
Isopropyl x 15	Test Stand Shims (poker chips) x 1 box
Jigaloo x1 and Scotchguard x1	Test Stands: 1 x 6 position (small end)
Lock for truck	Test Stands: 2 x 6-position (main stand)
Marker for Waste x 2	Test Stands: 3 position (side stand) (2+1)
Measuring Cups x 3	Thickness Gauges (4 x small 4 x large)
Pails x 5 (Empty 18L cont. for -30C CSW fluid)	Tuques x10
Paper Towels (4 packs)	Vise grip (large) + rubber opener
Personnel clothing + SB box	Weigh Scale x 2 (sartorius) + wiring
Pour containers (1-litre) - 6 empty	White poster board panels for water run-off
Pour containers (1-litre) - see list of fluids	Yellow Carrying Cases x4
LOCATION: OFFICE	
Blank Waterproof labels (1 page)	Laptop for smart button (MR)
Coffee x 140 (K-Cups)	Laptop x5 (CB, SB, JD, BB, Rate Station)
Condition Sheets x 6	Mouse for Rate Station and keypad
Data Forms (on water phobic paper)	Paper for printer (1 pack)
Envelopes (9x12) x box	Pencils (sharpened) + pens + markers
Falling Ball Viscometer + Syringes	Test Procedures x 6
File Box (for forms, procedures, etc.)	Walkie Talkies x 4
Hard Drive (if necessary)	Waterproof paper (40 sheets)
iPads x 3	

SIMULATED FREEZING PRECIPITATION TESTING	
LOCATION: NRC	
Cold-soak box filling stand	Rubber Mats
Cold-soak fluid pump	Shelving unit x 1 (black one)
Copper tubing insulation (for passing wires)	Tie wraps
Fluid for cold-soak boxes (barrel)	Tools
NRC Auto Rate Form with Historical #'s	Tote for Waste Fluid

Attachment 3: NRC Continuous Rate Form

Condition	Date	Historical Average Calculated Rate - Position 1	Standard Deviation of Historical Average Calculated Rate (Pos. 1) Between Sessions	Historical Average of Session Standard Deviation During Session	Start Position Stand 1 (X_1, Y_1) Stand 2 (X_2, Y_2) (For ZF, coordinates are nozzle position)	Condition Difficulty Rating (1-5, 1 is easiest)	Historical Condition Difficulty Rating (1-5, 1 is easiest)	Comments
ZF, -3, 2		1.8	0.3	0.7	Pos. 10 (2'',0'')		1.3	
ZF, -3, 5		4.9	0.6	2.1	Pos. 4 (0'', 18'')		2.7	
ZF, -10, 2		1.9	0.3	0.6	Pos. 10 (2'',0'')		1.0	
ZF, -10, 5		4.9	1.0	0.9	Pos. 10 (2'',0'')		1.5	
ZF, -14, 2		2.1	0.2	0.7	Pos. 10 (2'',0'')		1.3	
ZF, -14, 5		4.8	0.3	1.1	Pos. 10 (2'',0'')		1.3	
ZF, -25, 2		2.0	0.4	1.0	Pos. 10 (2'',0'')		1.0	
ZF, -25, 5		4.8	0.4	1.2	Pos. 10 (2'',0'')		2.7	
ZF, -35, 2		2.1	0.1	1.0	Pos. 10 (2'',0'')		2.7	
ZF, -35, 5		5.1	0.0	1.5	Pos. 10 (2'',0'')		3.0	
ZD, -3, 5		5.5	0.2	0.9	(23' 11'', 7'), (24' 9'')		3.0	
ZD, -3, 13		13.0	1.8	1.7	(23' 11'', 6'10''), (24' 9'')		3.0	
ZD, -6, 5		n/a	n/a	n/a	n/a		n/a	
ZD, -6, 13		n/a	n/a	n/a	n/a		n/a	
ZD, -10, 5		5.9	0.4	0.8	(23' 11'', 6'7''), (24' 9'')		1.0	
ZD, -10, 13		14.0	0.5	1.7	(23' 11'', 6'7''), (24' 9'')		2.3	
ZR, -3, 13		13.6	0.5	1.2	(23' 11'', 6'7''), (24' 9'')		2.3	
ZR, -3, 25		25.7	0.6	1.5	(23' 11'', 6'7''), (24' 9'')		1.0	
ZR, -6, 13		n/a	n/a	n/a	n/a		n/a	
ZR, -6, 25		n/a	n/a	n/a	n/a		n/a	
ZR, -10, 13		13.9	0.7	1.0	(23' 11'', 6'7''), (24' 9'')		3.7	
ZR, -10, 25		26.1	0.5	1.2	(23' 11'', 6'7''), (24' 9'')		1.0	
CS, 1, 5		4.9	0.2	4.0	(23' 11'', 6'10''), (24' 9'')		2.3	
CS, 1, 75		75.6	3.4	13.1	(23' 11'', 6'10''), (24' 9'')		3.0	

Attachment 4: End Condition Data Form for Endurance Time Tests

REMEMBER TO SYNCHRONIZE TIME

LOCATION:	PRECIP. CONDITION:	DATE:	RUN NUMBER:	STAND # :

Time of Fluid Application:

Time of Fluid Failure:

Fluid Name/Dilution:

PLATE 1	PLATE 2	PLATE 3	PLATE 4	PLATE 5	PLATE 6

Failure Call:
(describe)

Time of Fluid Application:

Time of Fluid Failure:

Fluid Name/Dilution:

PLATE 7	PLATE 8	PLATE 9	PLATE 10	PLATE 11	PLATE 12

Failure Call:
(describe)

AMBIENT TEMPERATURE: _____ °C LEADER / MANAGER: _____ FAILURES CALLED BY: _____

COMMENTS:

NOTE:
Please ensure correct functioning of plate temperature logging system at the start of the test and at the end of the session

Attachment 5: Screenshot of Holdover Time Data Form App



Attachment 6: Fluid Film Thickness Testing Data Form

REMEMBER TO SYNCHRONIZE TIME

LOCATION: DATE: TEMPERATURE °C: RUN NUMBER(S): TEST # : to

Time of Fluid Application: _____ _____ _____ _____ _____ _____

Fluid Name/Dilution: _____ _____ _____ _____ _____ _____

RUN #: _____

PLATE 1		PLATE 2		PLATE 3		PLATE 4		PLATE 5		PLATE 6	
TIME (min)	THICKNESS 6" LINE	TIME (min)	THICKNESS 6" LINE	TIME (min)	THICKNESS 6" LINE	TIME (min)	THICKNESS 6" LINE	TIME (min)	THICKNESS 6" LINE	TIME (min)	THICKNESS 6" LINE

Time of Fluid Application: _____ _____ _____ _____ _____ _____

Fluid Name/Dilution: _____ _____ _____ _____ _____ _____

RUN #: _____

PLATE 1		PLATE 2		PLATE 3		PLATE 4		PLATE 5		PLATE 6	
TIME (min)	THICKNESS 6" LINE	TIME (min)	THICKNESS 6" LINE	TIME (min)	THICKNESS 6" LINE	TIME (min)	THICKNESS 6" LINE	TIME (min)	THICKNESS 6" LINE	TIME (min)	THICKNESS 6" LINE

PERFORMED BY: _____ WRITTEN BY: _____

COMMENTS: _____

NOTES:

- The quantity of fluid that will be poured for each test is 1.0 L on a full plate or 0.5L on a half plate
- Measurements should be made at the 6-inch line at the time of fluid application, and after 5 minutes, 15 minutes, and 30 minutes.
- If the results for one fluid vary by more than 10% repeat the two tests and disregard the highest and lowest values

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PROCEDURE:
ENDURANCE TIME TESTING IN NATURAL SNOW WITH SAE TYPE I, II, III, AND IV DE/ANTI-ICING FLUIDS

300293

PROCEDURE:

ENDURANCE TIME TESTING IN NATURAL SNOW WITH SAE TYPE I, II, III AND IV DE/ANTI-ICING FLUIDS

Prepared for

Transportation Development Centre
Transport Canada

Prepared by: Benjamin Bernier

Reviewed by: John D'Avirro

November 2018
Final Version 1.0

PROCEDURE:
ENDURANCE TIME TESTING IN NATURAL SNOW WITH SAE TYPE I, II, III AND IV DE/ANTI-ICING FLUIDS

1. BACKGROUND

The Society of Automotive Engineers (SAE) has published standards detailing acceptable practices for endurance time testing in natural snow conditions. The Aerospace Recommended Practice (ARP) documents ARP5945 and ARP5485 outline these practices for Type I and Type II/III/IV anti-icing fluids, respectively. These documents set the requirements for fluid samples, testing materials, test conditions, and test practices for anti-icing fluid endurance time testing. These standards are continually reviewed and updated at the discretion of the SAE Holdover Time committee.

APS has been conducting outdoor natural snow endurance time testing with the goal of measuring the effectiveness of new holdover time fluids since the early 1990's. All testing is conducted in accordance with the established SAE standards, ARP5945 and ARP5485.

This procedure serves as an update to the previous APS procedure, *Procedure for Conducting Endurance Time Tests for SAE Deicing/Anti-Icing Fluids – SAE Type II, III and IV*, which was issued in January 2004. This new document serves to incorporate refinements to the procedure that have been made in the intervening years, as well as to provide additional information relating to event planning and APS-specific processes.

2. OBJECTIVE

This procedure describes the testing protocols used to evaluate the endurance time performance of Type I, II, III and IV fluids in natural snow conditions.

3. PRE-TESTING ACTIVITIES

This section describes activities that need to be performed prior to commencing a natural snow testing session.

3.1 Forecasting Natural Snow

Natural snow events are generally identified and monitored up to a week in advance. Storm duration, temperature and expected precipitation type and intensity must all be considered when evaluating a potential event. There are many forecasting resources available, each differing in accuracy and type of information offered. As such, it is generally best to consult multiple sources when attempting to evaluate an upcoming natural snow event.

The weather forecasting resources that are typically used are listed and described below:

3.1.1 Weather Network Montreal Forecast

Found at https://www.theweathernetwork.com/ca/weather/quebec/

The Weather Network forecast contains a wide variety of general weather information for the Montreal area. General forecasts are available for up to 14 days after the search date. Hourly forecasts, including precipitation probabilities and estimated snowfall, are available for up to 72 hours from the search time.

As this forecast covers a relatively long time-period, it can be useful for early identification of upcoming testing opportunities. However, its short-term forecasts tend to be somewhat less accurate than the other forecasts, therefore weather information should be confirmed using another source before making final testing event planning decisions.

3.1.2 Environment Canada Montreal Forecast

Found at http://weather.gc.ca/city/pages/qc-147_metric_e.html/

The Environment Canada forecast provides similar information to the Weather Network forecast and is generally more accurate as the station issuing the reports is located directly adjacent to the APS test site.

General forecasts are available for up to 7 days after the search date. Hourly forecasts are available for up to 24 hours from the search time. Given that the forecasting range is smaller than that of the Weather Network, the Environment Canada forecast is particularly useful in confirming details identified earlier as a prospective snow event approaches.

3.1.3 METAR/TAF Reports

Found at https://flightplanning.navcanada.ca/

In order to access the METAR/TAF reports, select METAR/TAF from the menu and enter CYUL in the aerodrome ID field. Ensure that the output is set to "plain language" in order to obtain the information in an easily comprehensible format.

The TAF is a highly reliable source of short-term forecasting which is issued by airport authorities for use by air operators. Updated forecasts issued every three/four hours and generally provide a forecast for the 24 hours following the time of publication.

A sample TAF report is shown in Figure 3.1. Note that all times listed in the TAF are in UTC (five hours ahead of EST during standard time). Wind direction is measured in degrees clockwise from due north. For example, a wind direction value of 90° would indicate that the wind is blowing due west (originating from due east). Snowfall intensity can be determined by comparing the predicted visibility to the Snowfall Intensities as a Function of Prevailing Visibility Table, published annually in the TC/FAA Holdover Time Guidelines.

TIMES [UTC]	WIND [DEGREES TRUE]	VISIBILITY [STAT. MILES]	WEATHER	CLOUDINESS [FEET AGL]
02 NOV - 1500 to 02 NOV - 1700	150 @ 7 KNOTS	6+	NIL	600 SCATTERED 3000 OVERCAST
TEMPORARY CHANGES 02 NOV - 1500 to 02 NOV - 1700		5	LIGHT RAIN MIST	600 BROKEN 3000 OVERCAST
02 NOV - 1700 to 02 NOV - 2300	180 @ 12 KNOTS	6+	NIL	1500 SCATTERED 2500 OVERCAST
TEMPORARY CHANGES 02 NOV - 1700 to 02 NOV - 2300		5	LIGHT RAIN SHOWER MIST	800 SCATTERED 1500 BROKEN
02 NOV - 2300 to 03 NOV - 0500	180 @ 12 KNOTS	6+	LIGHT RAIN SHOWER	3000 OVERCAST
03 NOV - 0500 to 03 NOV - 1200	190 @ 12 KNOTS	5	LIGHT RAIN MIST	1000 OVERCAST
BECOMING 03 NOV - 0700 to 03 NOV - 0900	260 @ 10 KNOTS			
REMARKS THE NEXT FORECAST WILL BE ISSUED BY 1800 UTC ON DAY 02				

Figure 3.1 – Sample YUL TAF Report

METAR reports are real-time weather bulletins providing similar information to the TAF bulletins. They are issued on the hour, 24 hours a day and are meant to provide real-time weather information to air operators.

In cases where a sudden change in the current weather is observed, a special type of METAR report known as a SPECI is generally issued (this is to ensure that there is always up-to-date information on the current weather available to operators).

These reports can be used to confirm the current weather, particularly when a sudden change is observed. From a testing perspective, they are particularly useful for confirming suspected changes in wind direction or precipitation type.

3.1.4 BUFKIT Software (short-term)

The BUFKIT software package draws data from several meteorological models. The software has a lot of functionality, however due to its complexity it is generally used by APS personnel to estimate total snowfall and corresponding temperatures for discrete one or three hour blocks (depending on the forecasting models used).

Note that BUFKIT forecasting is generally supplementary and is most often used to confirm details on storms for remote testing opportunities, however it can be used to obtain or confirm information relating to snowfall for test events at the APS test site if additional information is desired.

3.1.5 McGill Weather Radar

Found at: http://weather.gc.ca/radar/index_e.html?id=WMN

The McGill weather radar provides a radar view of the island of Montreal and the surrounding area. This view allows the user to visualize the path and intensity of an on-going storm over a one or three hour period.

This resource is primarily used during an event to determine upcoming changes to an on-going storm's intensity. By monitoring the path of the storm throughout the event, sudden changes in precipitation can be predicted and testing plans can be adjusted accordingly.

3.2 Event Coordination

It is the responsibility of the testing manager to determine personnel and appropriate start/end times for each testing session. Arrangements should be made for all

personnel to arrive approximately one hour prior to the start of snowfall to allow for sufficient time for set-up activities and to maximize the usable testing time.

If a specific temperature range or snowfall intensity is being targeted, the testing manager can adjust start times such that testing will only begin once the desired conditions are present. It should be noted however that natural conditions can be unpredictable and it is generally better to err on the side of caution (i.e. arrive early in case the weather does not cooperate).

The testing manager should review the fluids planned to be used prior to an event and should have an idea of the expected endurance times of the fluids in the expected snow conditions. This will allow the manager to make informed decisions when determining what tests to pour and in what order. Different fluids will have different measured endurance times and therefore differing test durations; having an understanding of these differences is critical to ensure that testing sessions proceed in an efficient and timely fashion.

The testing manager should also monitor the status of the storm throughout the testing event. Upcoming changes to temperature, wind direction and precipitation rate should be considered when determining what tests to run, in order to avoid unnecessary scrapped tests.

3.3 Data Requirements and Test Planning

The testing manager should be mindful of the data requirements and current data set status for each of the fluids being tested in a given session. This information should be used to steer testing decisions, both when deciding what events to pursue and what tests to run during an event.

3.3.1 Type I Fluid Data Requirements

For Type I fluids, a minimum of 20 natural snow data points is the target for validation of the existing holdover times. Tests run with Type I fluids should be equally divided between aluminium and composite test surfaces (in order to validate both sets of holdover times). Note that for each natural snow test run with a new Type I fluid, a baseline test must be run simultaneously with a known Type I fluid to serve as a point of comparison.

Natural snow data gathered with a specific dilution of a fluid should cover the full range of precipitation rates and temperatures as outlined in the Type I fluid holdover time tables.

3.3.2 Type II/III/IV Fluid Data Requirements

For neat and 75/25 dilutions of Type II/III/IV fluids, a minimum of 25 natural snow data points is required to generate the regression curves that are used to determine the fluid endurance times. For 50/50 dilutions of Type II/III/IV fluids, the minimum is 12 natural snow data points.

Table 3.1 lists the range of ambient temperatures and precipitation rates in which natural snow endurance time testing is conducted with Type II/III/IV fluids.

Table 3.1 – Natural Snow Test Rates and Temperatures for Type II/III/IV Fluids

Fluid Type, Dilution	Air Temperature	Precipitation Rate
Type II/III/IV, Neat	≥2°C below LOUT	Any, ideally 3-25 g/dm²/h
Type II/IV, 75/25	≥-16°C	Any, ideally 3-25 g/dm²/h
Type III, 75/25	≥-12°C	Any, ideally 3-25 g/dm²/h
Type II/III/IV, 50/0	≥-5°C	Any, ideally 3-25 g/dm²/h

Data gathered with a specific dilution of a fluid should cover the full range of precipitation rates and temperatures as outlined in Table 3.1.

3.3.2.1 Very Cold Snow Data Requirements

For the development of the cold snow regression curves that are used to determine fluid specific HOTs, a minimum of 20 natural snow data points, during a minimum of 4 different events, is required.

This testing is optional and at the discretions of the fluid manufacturer.

Table 3.2 lists the recommended minimum data points required to determine fluid specific holdover times for very cold snow.

Table 3.2: Minimum Natural Snow Data Points Required to Determine Fluid-Specific HOTs for Very Cold Snow

Temperature	Precipitation Rate (g/dm²/h)				
	0 to <4	4 to <10	10 to	≥25	All
<-14 to -18°C	2	2	0	0	**6**
<-18 to -22°C	1	2	0	0	**4**
<-22 to -25°C	0	1	0	0	**2**
<-25°C	0	0	0	0	**1**
All	**5**	**7**	**1**	**0**	**20**

3.4 Fluid Preparation and Management

This section describes the steps necessary to ensure that the fluids to be tested are properly prepared for testing.

3.4.1 Type I Fluid Preparation

Type I fluids will generally be sent to APS by the manufacturer in concentrate form. Prior to commencing a test session, an appropriately buffered mixture of the fluid must be prepared. As per ARP5945A, Type I fluids must be tested at dilutions where the freezing point of the solution is 10°C colder than the OAT at which testing is taking place.

To prepare the buffered solution, you must first determine the range of temperatures that the testing will take place in. The solution should be prepared such that it is properly buffered for the coldest temperature to be experienced during the test session. If a very large change in temperature is expected during the test session, (>10°C), consideration should be given to preparing two distinct batches of Type I fluid, with freeze points appropriate to the different expected phases of testing.

The Type I concentrate must be diluted with hard water, which is prepared by dissolving 400mg of calcium acetate dehydrate and 280 mg of magnesium sulfate heptahydrate into 1L of water (the quantities can be scaled up proportionally if preparing a larger batch). Consult the dilution chart associated with the Type I fluid being tested in order to determine the appropriate glycol/hard water ratio necessary to achieve the desired freeze point. Dilution charts are generally available on the fluid manufacturer's website or directly from the manufacturer.

Confirm that the glycol concentration in your prepared solution is appropriate by measuring the Brix (generally Type I dilution charts will indicate the target Brix for the desired fluid freeze point). Ensure that the container in which the solution is mixed is clearly marked with the freeze point and Brix of the fluid. Pour container labels listing the fluid name, Brix and freeze point should also be created and affixed to all pour containers to be used during the test session.

Note that although ARP5945A stipulates that Type I fluid samples be sheared in a laboratory blender prior to testing, previous work has indicated that the effects of this shearing process on resulting Type I fluid endurance times are negligible. The Type I fluid shearing process is generally not performed with fluid samples as part of the typical natural snow testing process.

3.4.2 Type II/III/IV Fluid Management

In order to ensure that a testing session runs smoothly with minimal disruptions, it is critical that a sufficient number of filled 1L pour containers are prepared and tempered prior to the start of the test session. The targeted amount is a minimum of four pour containers per fluid/dilution to be tested.

Used pour containers should be periodically refilled when time permits to prevent delays in the fluid application process. All pour containers must be affixed with labels listing the fluid name, batch number and dilution and special care must be taken when refilling to ensure that the proper fluid, batch and dilution are used.

All fluids to be used in natural snow endurance time testing must be properly stored in order to ensure that they are at the correct temperature when a test session begins. As per Subsection 11.1.1 of ARP5485B, the temperature of Type II, III (unheated) or IV fluid being applied to a test surface in a natural snow endurance time test must be within 3°C of the OAT. Valuable testing time can be lost waiting for fluids to temper if the proper storage procedures have not been followed.

Fluid jugs and pour containers of neat and 75/25 formulations of Type II/III/IV fluids that are to be used in a given test event should be stored outside such that their temperature consistently reflects the changing OAT. Note the following exceptions:

1) All containers containing 75/25 formulations of Type II/III/IV fluids must be temporarily stored inside the main trailer if the outdoor temperature on a given day is scheduled to drop below -14°C for a period exceeding four hours.
2) In the case of extreme cold (temperatures falling below -22°C for a period exceeding four hours), neat formulations of certain fluids may also need to be temporarily stored inside the main trailer. The freezing points of the individual

fluids need to be consulted in order to determine which (if any) fluids will need to be moved.

Fluid jugs of 50/50 formulations of Type II/III/IV fluids that are to be used in a given test event are to be stored inside the main trailer at all times due to the relatively warm freezing point of 50/50 fluids. Pour containers of 50/50 formulations of fluids to be used are to be stored inside a chest freezer set at a temperature of -3°C.

All fluids that are stored in clear jugs must be covered with an opaque covering in order to ensure that the fluid is not exposed to light in storage.

4. TEST SITES

This section documents the test sites where APS conducts natural snow endurance time testing with Type I, II, III and IV fluids.

4.1 Pierre-Elliott-Trudeau International Airport Test Site

Natural snow testing is typically and predominantly performed at the APS test site located at the Montréal Pierre-Elliott-Trudeau International Airport. The test site is located near Environment Canada's Meteorological Services of Canada automated weather observation station, as shown in Figure 4.1 on a plan view of the airport.

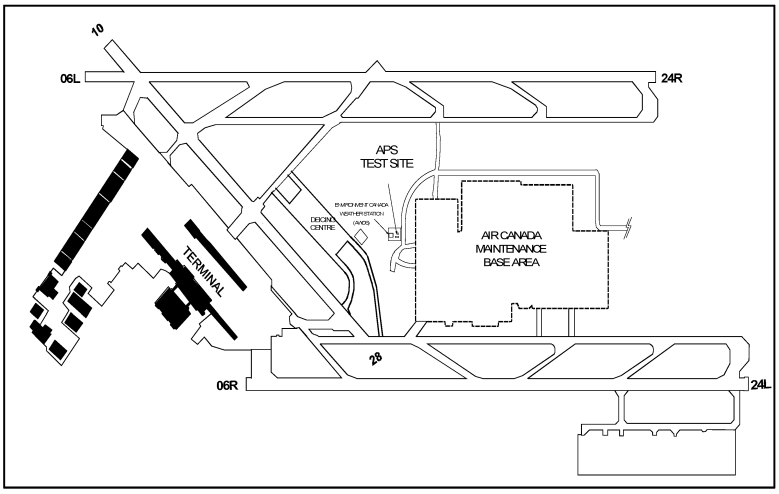


Figure 4.1: APS Test Site at Montréal-Pierre-Elliott-Trudeau International Airport

4.2 Remote Test Sites

There are instances where data requirements will necessitate natural snow testing at a location other than the APS test site. In the past, this has typically been due to a need to obtain data at specific temperatures (generally colder temperatures than typically experienced in Montreal) or times of the year (generally after the conclusion of the winter season when natural snow data is no longer obtainable in Montreal).

Remote test sites can be set-up in any region where the desired natural snow conditions are expected to occur, using test stands that have been specially modified for improved transportability. When using a remote site for testing, the testing trailers are generally replaced by either rented vehicles or a rented hotel room (location permitting).

Several factors must be considered when choosing a location for a remote test site, including:

1) **Ground Surface**

   The ground surface should be level and firm to simplify the process of levelling the test stands.

2) **Wind Direction**

   The selected location must also be open to oncoming wind; all possible wind directions that may be experienced during a given event should be considered.

3) **Foot/Vehicle Traffic**

   The selected location should also be out of the way of foot and vehicle traffic, if possible, to minimize the chance of outside forces interfering with a test session.

5. TESTING PROCEDURE

This section describes the procedure to be followed during a natural snow test event.

The procedure conforms to the requirements for natural snow testing outlined in Section 11 of the *Aerospace Recommended Practice (ARP) 5485B – Endurance Time Tests for Aircraft Deicing/Anti-icing Fluids, SAE Type II, III, and IV*.

The procedure also conforms to the requirements for natural snow testing outlined in Section 11 of *ARP5945A – Endurance Time Tests for Aircraft Deicing/Anti-icing Fluids, SAE Type I*.

5.1 Set-Up

The set-up steps for a natural snow endurance time testing session are listed below:

1) Ensure that the fluids to be tested are properly prepared as per the guidelines in Subsection 3.4. Prepare appropriately buffered mixtures of all Type I fluids to be tested. Confirm that all Type II/III/IV fluids being tested were stored correctly and are at the proper temperature relative to the current OAT.

2) Confirm the current wind direction and orient two full six-position test stands into the wind. Ensure they are levelled such that the test surfaces lie at a 10° angle (within 9.8° and 10.2° is acceptable, check each test surface). The angle of the test stand can be adjusted as needed by placing poker chips under the stand legs. Whenever the configuration is adjusted by adding or removing chips ensure that the stand is reasonably stable and that all test surfaces are at the proper angle. Ensure the fluid collection pans are placed beneath the test stands to collect fluid runoff.

3) Equip the two six-position test stands with the appropriate test surfaces (leading edge thermal equivalent boxes if testing Type I or heated Type III fluid, aluminum test plates if testing unheated Type II/III/IV fluids). All test surfaces used must be equipped with Smart Buttons that are actively logging temperature data. Ensure that one position on one stand is equipped with a rate collection pan. Figure 5.1 depicts the proper plate set-up for the two test stands.

4) Clean the surface of the test surfaces by removing any adhered ice or contamination. If any solvent or heat is used in the cleaning process, ensure the plates are allowed to cold-soak long enough.

5) Prepare the rate station inside the main trailer: ensure that the scale being used is properly leveled, open the latest version of the APS rate program on the rate computer (an Excel spreadsheet created to record frost rate measurements), and test that the scale and computer are functioning normally together.

6) If using paper data forms, prepare the forms to be used during the test session. Fill out as much information as possible ahead of time in order to streamline the subsequent fluid application process. If using the Data Form app to record the test data, ensure all fluids to be tested during the session have been added to the app database.

7) Prepare a digital camera for use by formatting the memory card and syncing the device time with the time that is displayed on the test site clocks.

8) Arrange all unheated fluids to be poured by placing the filled pour containers behind their respective positions on the test stands.



Figure 5.1 – Test Stand Set-Up

5.2 Procedure for Rate Collection

The steps for rate collection in natural snow are summarized below:

1) After initial set-up is complete, fill an empty rate collection pan with a thin layer of anti-icing fluid from the container near the rate station (container will be marked "rate fluid"). This fluid layer allows natural snow collected in the rate pan to dissolve. Note that overfilling the pan should be avoided, as accurate rate collection will be compromised if any fluid is spilled during the collection process.

2) Open the APS Rate Program spreadsheet on the designated rate laptop and save a copy of the sheet with the current date in the file name. Measure and record the initial weight of the filled rate collection pan in the first empty cell in the Interface tab of the spreadsheet. Once recorded, place the rate collection pan outside on the test stand in the designated position.

3) Approximately once every ten minutes, the rate pan must be brought inside and weighed. Note that this rate cycle must be shortened during periods of high precipitation rate or wind speed (cycle can be shortened to as little as 2 minutes). Carefully transport the pan from the test stand to the rate station inside the main trailer, ensuring that none of the contents are lost in transit. If any fluid is lost from the pan, the rate cycle must be restarted by recording a new initial weight in the spreadsheet (ensure that a row is

skipped in the spreadsheet to indicate to the program that a new cycle has begun).

4) Once inside the main trailer, clear off any precipitation accumulated on the outer edges of the pan (do not dump this mass into the pan). Weigh the rate pan and record the weight and time in the next empty cell of the spreadsheet.

5) Once recorded, return the pan to its position outside on the test. Note that this process should be completed as quickly as possible, ideally the rate pan should not be inside the main trailer for more than 14 seconds before being returned to the test stand (as 14 seconds is the amount of buffer time programmed into the rate spreadsheet).

6) Repeat this cycle every ten minutes. The rate collection cycle can be abbreviated as necessary; a new rate is generally collected whenever a failure is noted on an active endurance time test, for example.

7) At the halfway mark of the "outside" phase of each rate cycle, invert the orientation of the rate pan (the edge that previously rested on the lower end of the test stand should now rest on the upper end).

8) If at any point the rate pan begins to become overly saturated with absorbed precipitation, a new rate pan can be prepared and swapped in at the completion of a rate cycle. When introducing a new rate pan, a new initial weight must be recorded (ensure that a row is skipped in the spreadsheet to indicate to the program that a new cycle has begun).

9) Rate collection is to continue throughout the entire test session, with the last rate being collected after the failure of the last endurance time test.

5.3 Procedure for Fluid Endurance Time Tests

The steps for conducting natural snow fluid endurance time tests are summarized below.

5.3.1 Procedure for Unheated Fluids (Type II, III-Unheated and IV)

1) Prepare the data form / data form app by recording the fluids to be poured in their respective positions.

2) Measure the initial fluid temperature of all fluids that are to be poured during the test session. Confirm that all fluids are within 3°C of the current OAT. If fluids are not at the correct temperature, warm them in the main trailer or cool them in a chest freezer as needed.

3) Clear the test surfaces to be used of existing contamination using a squeegee. To ensure that each position is properly cleaned, apply a small quantity of the fluid being tested to the test surface and use a squeegee to spread it across the full test surface.

4) Confirm that the data form manager is ready to begin the fluid application process. At each position, pour 1L of the selected fluid onto the test surface from the top of the plate, ensuring that the entire surface of the plate is coated with an even fluid layer. Record the time of fluid application on the chosen data form.

5) After fluid application is complete, each plate must be inspected periodically in order to assess the condition of the fluid layer. The fluid is considered failed when the accumulating snow is no longer being absorbed by the fluid. Typically, there are two types of failure observed in natural snow tests. Dilution failure occurs when the fluid layer has thinned due to exposure to precipitation and snow beings to accumulate on the plate surface. Snow-bridging failure occurs when the fluid layer does not thin considerably but instead eventually fails to absorb incoming snow, leading to white snow visibly accumulating on the top of the fluid.

6) If more than one-third of a given plate is determined to be "failed" (or if fluid failure is noted at any five of the crosshair marks on the plate), the plate as a whole is considered to be failed. Announce the fluid failure and ensure the failure time is recorded by the data form manager. It is good practice to collect a rate whenever a plate is deemed failed (foregoing the typical 10-minute rate period). A poker chip should be placed on the plate once failure has been declared to denote that the plate is no longer running an active test.

7) Ensure all test surfaces are properly cleaned after testing and that all fluid within the collection pans is disposed of appropriately (all glycol waste must be vacuumed up and subsequently disposed of in the waste fluid tote).

5.3.2 Procedure for Heated Fluids (Type I and III-Heated)

1) Prepare the data form / data form app by recording the fluids to be poured in their respective positions.

2) Clear the test surfaces to be used of existing contamination using a squeegee. To ensure that each position is properly cleaned, apply a small quantity of the fluid being tested to the test surface and use a squeegee to spread it across the full test surface. Note that the small quantity of fluid used to clean the surface must not be heated. If heat is required to clear

the test surfaces, they must be allowed to cold soak prior to fluid application.

3) Heat a batch of the fluid(s) to be applied using the microwaves within the main trailer. As fluids are to be applied at 60°C, a temperature of 62°C should be targeted when heating. Ensure that a microwave-safe container is used. It can take upwards of 10 minutes to attain the required temperature; the temperature of the mixture should be checked periodically during the heating process using a hand-held thermistor. Knowing that 0.5L of fluid must be applied to each test surface, ensure that a sufficient total volume of fluid is heated. Once the full batch is heated, transfer the fluid to thermos' to preserve the temperature until the fluid is applied.

4) Confirm that the data form manager is ready to begin the fluid application process. At each position, pour 0.5L of the heated fluid onto the top of the test surface using a 12-hole spreader to ensure even distribution. This process must be completed quickly after the fluid is heated to ensure that the fluid temperature is as close to 60°C as possible at the time of application. Record the time of fluid application on the chosen data form.

5) After fluid application is complete, each test surface must be inspected periodically in order to assess the condition of the fluid layer. The fluid is considered failed when the accumulating snow is no longer being absorbed by the fluid. For heated fluids, failure may occur quickly as the test surface cools after fluid application. It is best to remain close to the test stand after application to ensure that the failure time is not missed.

6) If more than one-third of a given plate is determined to be "failed" (or if fluid failure is noted at any five of the crosshair marks on the plate), the plate as a whole is considered to be failed. Announce the fluid failure and ensure the failure time is recorded by the data form manager. It is good practice to collect a rate whenever a plate is deemed failed (foregoing the typical 10-minute rate period). A poker chip should be placed on the plate once failure has been declared to denote that the plate is no longer running an active test.

The primary types of failure are depicted below in Photo 5.1 and Photo 5.2. Photo 5.1 depicts dilution failure of an anti-icing fluid on an aluminum plate. Photo 5.2 depicts snow-bridging failure of an anti-icing fluid on an aluminum plate.

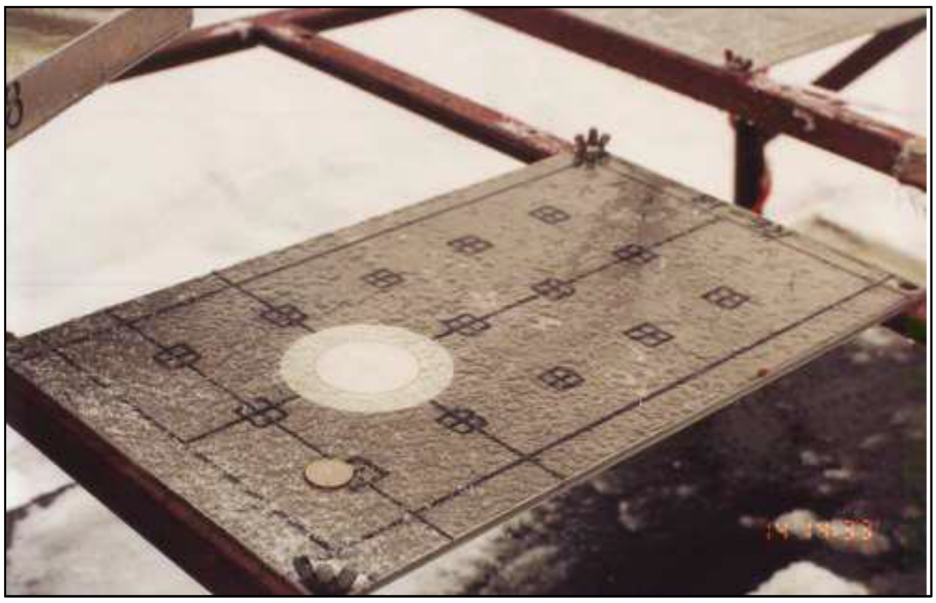


Photo 5.1 – Dilution Failure of Anti-Icing Fluid on an Aluminum Plate



Photo 5.2 – Snow-Bridging Failure of Anti-Icing Fluid on an Aluminum Plate

5.4 End of Test Session Activities

The steps for concluding a natural snow endurance time testing session are summarized below.

1) Ensure all test surfaces are properly cleaned after testing and that all fluid within the collection pans is disposed of appropriately (all glycol waste must be vacuumed up and disposed of in the waste fluid tote). Ensure that the fluid collection pans are flipped upside down so that they do not fill up with precipitation in between test sessions.
2) Save a copy of the completed APS Rate Program spreadsheet in the Data and Rates folder of the APS Test Site Dropbox.
3) If using the HOT Data Form app to record endurance times, export the data file and save a copy in the Data and Rates folder of the APS Test Site Dropbox.
4) If using paper data forms, place the completed forms in an envelope and mark the envelope with the date and number of forms.
5) Ensure that all Smart Button data from all test surfaces used is saved and uploaded to the APS Test Site Dropbox.
6) Complete a Test Session Summary form (available on the APS Test Site Dropbox). Save a completed copy in the Test Session Forms folder of the APS Test Site Dropbox. Print a copy of the completed form and place it in the data form envelope. Ensure that this envelope is brought to the APS offices the following day.
7) Ensure that the Dropbox program is synced and that all saved files have been uploaded.
8) Ensure that the heating system and lights are turned off, all doors are locked, and that the alarm system is armed prior to leaving the site.

6. EQUIPMENT

The equipment required for endurance time testing in natural snow at the APS test site is listed in Attachment 1. The equipment required for testing at remote test sites is listed in Attachment 2.

7. PERSONNEL

Generally, three people are required for natural snow endurance time testing:

1) **Testing Manager** – responsible for overseeing the test event, determining which tests are to be run, applying fluids and calling all failures;
2) **Data Form Manager** – responsible for managing all data forms and ensuring all information is properly transcribed and captured; and
3) **Testing Assistant** – responsible for set-up activities, rate collection, clean-up and assisting with any other tasks as determined by the testing manager.

Note that the above roles are not necessarily strict; any person participating in a test event may be required to perform tasks associated with any of the above roles at a given time.

8. SAFETY

Testing in cold temperatures can pose significant safety issues. Jackets, gloves and boots should be rated to very low temperatures. Eye protection (ski goggles) and face protection should be worn if testing in very cold temperatures (< -20°C). Employees should be mindful of dangers associated with hypothermia and frostbite. Additional information can be found in the Test Site Safety Management manual, of which copies are available at the test site.

If ever one person is conducting testing alone, they must make use of the "Loner" monitoring system to ensure their safety during the testing event.

9. DATA FORMS AND SOFTWARE

The following data forms and software programs are typically used for natural snow endurance time testing:

1) End Condition Data Form for Endurance Time Tests (Attachment 3);
2) App Data Form for Fluid Endurance Time Tests (Attachment 4);
3) APS Rate Program Spreadsheet (Attachment 5); and
4) Test Session Summary Form (Attachment 6).

Attachment 1: Equipment List for Natural Snow Testing

NATURAL SNOW APS SITE TESTING
LOCATION: TEST SITE
6–position test stand x 2
Air Temperature gauge x 1
Aluminum test plates (as needed)
Compass x 1
Data forms (as needed - if app not being used)
Digital Camera and accessories
Fluid collection pans x 2
Fluid pour containers x 4 per fluid
Fluids (as needed)
Immersion temperature probe x 1
Inclinometer x 1
iPad with data form app x 1
Leading edge thermal equivalent boxes aluminum + composite (as needed)
Microwave x 1
Poker chips (for stand levelling) x 1 pack
Rate collection pan x 1
Rate computer x 1
Rate fluid (10L) x 1
Scrapers x 2
Shop vacuum x 1
Smart Buttons and Smart Button Kit (as needed)
Spreader (for heated fluid application) x 1
Squeegees x 2
Thermos (as needed)
Weigh scale + connectors x 1

Attachment 2: Equipment List for Remote Natural Snow Testing

NATURAL SNOW REMOTE TESTING	
LARGE LUGGAGE : GENERAL EQUIPMENT	
Air Probe x 1	Pencils, Sharpies, Erasers and Sharpener
APS Hats	Poker Chips x 3 Small Packs
Backup Scale (Ice Crystal Scale) x 1	Power Bars x 2
Batteries (16 AA and 2 x 9V)	Rate Pans x 2
Brixometer x 2	Scrapers x 2
Car Antenna Wind Sock x 1	Shop Towels x 2
Clipboards x 2	Shovel x 1
Compass x 1	Ski Goggles x 3
Cotton Gloves x 2	Small Garbage Bags x 3
Extension Cords x 2	Small Squeegies x 2
Extra Black Gloves x 3	Small White Extension Cords x 1
Extra Jacket x 1	Speed and Electrical Tape x 1 Each
First Aid Kit x 1	Standard Set of Tools x 1
Flashlights x 4	Stopwatch x 1
Garbage Bags x 2	Surface Probes x 2
Hammer x 1	Tarp x 1
Hand & Toe Warmers (many included)	Thickness Gauges (Octogonal) x 2
Immersion Probes x 2	Thickness Gauges (Rectangular) x 2
Inclinometers x 2	Tie Wraps x 10
Inverter x 2	Water Phobic Paper
Isopropyl x 1	Working Hands Cream
Latex Gloves x 1 Box	
SMALL LUGGAGES: FLUIDS	
Small luggage #1 with 20 pour containers	Small luggage #2 with 20 pour containers
LONG LUGGAGE : SCALES	
Sartorius Scales with Styrofoam Top x 2 (Including Cables & Power Adapters)	
SKI CASE LUGGAGE : TEST STAND EQUIPMENT	
All Supporting Hardware and Crossbars	Remote Test Stand
Aluminum Test Plates x 5 Sets (10 half plates total)	
RATE STATION AND DATA FORMS	
Data Forms on water phobic paper	iPad with Sim Card
Electronic Copy of Log	Laptop and cables/adapters with Rate Program
ADDITIONAL EQUIPMENT FOR TYPE I	
Spreader (for heated fluid application) x 1	Dilution Charts
Hard Water	Measuring Cups
Microwave	Thermos (as needed)
Leading edge thermal equivalent boxes aluminum + composite (as needed) and boards	
PHOTOGRAPHY	
Camera Batteries x 3	Digital Camera x 2
Camera Memory Cards x 3	Small Tripod Mountable to Stand (Optional)
PERSONNEL CLOTHING	
Cold Rated Gloves	Winter Hats
Face Covers (Belaclava and Face Shield)	Winter Jackets
Winter Boots	

Attachment 3: End Condition Data Form for Endurance Time Tests

REMEMBER TO SYNCHRONIZE TIME

LOCATION: PRECIP. CONDITION: DATE: RUN NUMBER: STAND # :

Time of Fluid Application: _____ _____ _____ _____ _____ _____

Time of Fluid Failure: _____ _____ _____ _____ _____ _____

Fluid Name/Dilution: _____ _____ _____ _____ _____ _____

PLATE 1	PLATE 2	PLATE 3	PLATE 4	PLATE 5	PLATE 6

Failure Call: (describe) _____ _____ _____ _____ _____ _____

Time of Fluid Application: _____ _____ _____ _____ _____ _____

Time of Fluid Failure: _____ _____ _____ _____ _____ _____

Fluid Name/Dilution: _____ _____ _____ _____ _____ _____

PLATE 7	PLATE 8	PLATE 9	PLATE 10	PLATE 11	PLATE 12

Failure Call: (describe) _____ _____ _____ _____ _____ _____

AMBIENT TEMPERATURE: _____ °C LEADER / MANAGER: _____ FAILURES CALLED BY: _____

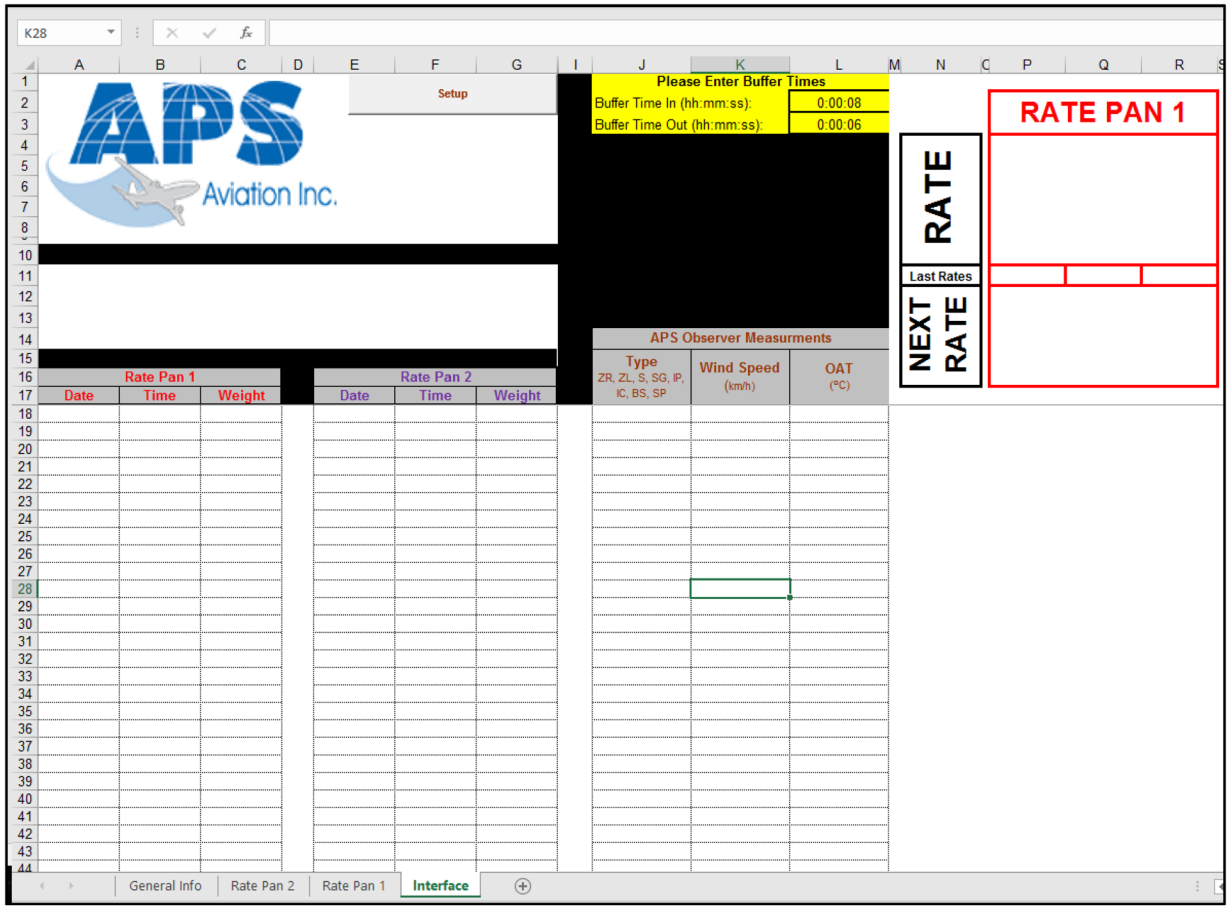
COMMENTS: _____

NOTE:
Please ensure correct functioning of plate temperature logging system at the start of the test and at the end of the session.

Attachment 4: Screenshot of Holdover Time Data Form



Attachment 5: Screenshot of Rate Program Spreadsheet



Attachment 6: Example of Test Session Summary Form

TEST SESSION SUMMARY
OUTDOOR/OTHER

TEST MANAGER: _____ DATE: _____

LOCATION: _____

# of Tests Conducted	Project	Person Responsible	Data Forms (# or electronic)	Rate File (#)	Logger Files (#)	Photos (#)	Comments
	NATURAL SNOW						
	HOT Snow						
	Flaps and Slats						
	Other _____						
	Other _____						
	ARTIFICIAL SNOW						
	HOT Snowmaker						
	Other _____						
	FROST						
	HOT Frost						
	Frost Substantiation						
	Other _____						
	OTHER NON TC/FAA PROJECTS (DO NOT INCLUDE IN CALENDAR OF COMPLETED TESTS)						
	SureWx						
	Other _____						
	Other _____						

FOR OFFICE USE ONLY

Verification of Electronic and Paper Filing PERSON: _____ DATE: _____

M:\Projects\PM2480.004 (TC Deicing 2017-18)\Data\Test Session Summaries\Test Session Summary v2.0
11/29/2017

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PROCEDURE:
ENDURANCE TIME TESTING IN SIMULATED SNOW
WITH SAE TYPE I, II, III, AND IV FLUIDS DE/ANTI-ICING FLUIDS

300293

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ENDURANCE TIME TESTING IN SIMULATED SNOW WITH SAE TYPE I, II, III, AND IV DE/ANTI-ICING FLUIDS

Winter 2018-19

Prepared for

Transportation Development Centre
Transport Canada

Prepared by: David Youssef Nov. 29, 2018

Reviewed by: John D'Avirro

November 2018
Final Version 1.0

PROCEDURE:
ENDURANCE TIME TESTING IN SIMULATED SNOW WITH SAE TYPE I, II, III, AND IV DE/ANTI-ICING FLUIDS

1. BACKGROUND

The National Center for Atmospheric Research (NCAR) in Boulder, Colorado, developed an artificial snow generation system for conducting snow endurance time testing in controlled laboratory environments. This system has been used for all indoor snow tests conducted by APS Aviation Inc. (APS) since 1998.

Artificial snow generation systems allow testing agencies to evaluate the endurance times of de/anti-icing fluids in snow at any time of year. The specifications for their use were first described in the Society of Automotive Engineers (SAE) Aerospace Standard (AS) 5485, *Endurance Time Tests for Aircraft Deicing/Anti-icing Fluids: SAE Type I, II, III, and IV, October 2000*. The document was later renamed Aerospace Recommended Practice (ARP) 5485.

Currently, the snow machine cannot accurately simulate natural snow conditions to the point where it can completely replace natural snow endurance time testing. Therefore, the snow machine should continue to be used in a similar capacity as it has been used in the past years. Some examples of this are described below.

- To support the use of generic Holdover Times (HOTs) for one winter when there is not sufficient data to provide fluid-specific HOTs. This is done by running tests at boundary temperatures / rates and comparing the results to the generic HOTs.
- To do comparative evaluations with two or more different fluids under the same conditions to compare their relative performance. For example, compare HOTs of a coloured/uncoloured fluid.
- To support other research activities such as the evaluation of HOTs for heavy snow and the evaluation/verification of HOTs at very cold (-25°C) temperatures.

The details of the operation of the snow machine are in the snowmaking machine operators' manual supplied by NCAR (refer to TP 14148E, *Endurance Time Tests in Snow: Comparison of Indoor and Outdoor Data for 2002-03*).

Any person operating the snow machine should be trained on how to operate the snow machine. Note, this procedure serves as a testing-specific guide and does not provide instruction on the operation of the snow machine.

2. OBJECTIVE

This procedure provides a brief summary of the test requirements and data forms needed for simulated snow flat plate testing. ARP5485 contains a detailed description of the test equipment, test parameters, snow measurement methods, snow test conditions, and snow test procedure for conducting endurance time tests for SAE Type II, III and IV de/anti-icing fluids. For testing SAE Type I fluids, a detailed description can be found in ARP5945.

3. PRE-TESTING ACTIVITIES

This section describes activities that need to be performed prior to commencing a simulated snow testing session.

3.1 Event Coordination and Scheduling

Artificial Snow testing is a highly coordinated activity requiring the use of advanced testing facilities, numerous personnel, and significant resources. To that end, a significant effort must be put into planning these activities to allow testing to run as smoothly, with as few costly disruptions as possible.

It is the responsibility of the event coordinator to arrange the schedule of conditions in such a way as to ensure that each testing day will conclude at an appropriate time, and that time between conditions is minimized. To this end, like temperatures should be grouped as much as possible to avoid unnecessary temperature changes.

3.2 Data Requirements and Test Planning

The test plan for an artificial snow endurance time test session is considered project-specific. For many projects, the test plan has been dynamic in nature. Therefore, changes to the test plan can occur during testing. These changes are usually based upon testing results and/or shifting priorities.

3.2.1 Validating Use of Generic HOTs for New Fluids in Very Cold Snow

When a new fluid is submitted for endurance time testing, its performance in very cold snow must be assessed to ensure it can safely be used with the generic very cold snow HOTs.

This section provides the data targets for validating very cold snow generic HOTs for new Type II and Type IV fluids. Note; no generic HOTs currently exist for Type III fluids.

In order to validate the Type II/IV generic HOTs for very cold snow, testing with the snow machine at rates of 3g, 4g, 10g, and 25g/dm^2/h is required at -18°C, -25°C, and the LOUT. It should be noted that tests at the LOUT are only required if the LOUT of the fluid is below -29°C. If the endurance time of the fluid is shorter than the historical results of other fluids, conduct duplicate tests.

3.2.2 Determining Fluid Specific HOTs in Very Cold Snow for Fluids with LOUTs below -29°C

For determining fluid specific HOTs for fluids with LOUTs below -29, testing with the snow machine at rates of 3 g, 4 g, 10 g, and 25 g/dm^2/h is required at -25°C and at the LOUT of the fluid being tested. This testing is optional and at the discretion of the fluid manufacturer. In order to derive HOTs at the LOUT, performance in artificial snow at -25°C and the LOUT is compared. The average relative performance at the LOUT, less 2 sigma, is then applied to the natural snow derived HOTs for -25°C.

3.3 Equipment Preparation

In advance of testing, the snow machine must be setup according the snow machines operators manual. The chamber should be cold-soaked to the desired ambient temperature. To ensure that the snow machine enclosure reaches ambient temperature, the enclosure doors should remain open during cold-soak.

All timepieces should be synced to local time. This includes PC internal clocks and all cameras.

3.4 Fluid Preparation and Management

This section describes the steps necessary to ensure that the fluids to be tested are properly prepared for testing. Fluid selection is considered project specific. All fluids must be indicated in a separate test plan prior to testing.

3.4.1 Type I Fluid Preparation

Type I fluids will generally be sent to APS by the manufacturer in concentrate form. Prior to commencing a test session, appropriately buffered mixtures of the fluid must be prepared for each test temperature that is planned for the session. As per ARP5945A, Type I fluids must be tested at dilutions where the freezing point of the solution is 10°C colder than the OAT at which the test is taking place.

To prepare the buffered solution, you must first identify the temperatures at which the testing will take place. Separate solutions must be prepared for each discrete testing temperature, and each prepared solution must be stored at the correct temperature. For example, if the daily schedule calls for tests at both -3°C and -10°C, two separate batches of Type I fluid must be prepared (with freezing points of -13°C and -20°C respectively). Each batch must be stored at ambient room temperature (20°C).

The Type I concentrate must be diluted with hard water, which is prepared by dissolving 400 mg of calcium acetate dehydrate and 280 mg of magnesium sulfate heptahydrate into 1L of water (the quantities can be scaled up proportionally if preparing a larger batch). Consult the dilution chart associated with the Type I fluid being tested in order to determine the appropriate glycol/hard water ratio necessary to achieve the desired freeze point. Dilution charts are provided by the manufacturer. Confirm that the glycol concentration in your prepared solution is appropriate by measuring the Brix (generally Type I dilution charts will indicate the target Brix for the desired fluid freeze point). Ensure that the container in which the solution is mixed is clearly marked with the freeze point and the Brix of the fluid. Pour container labels listing the fluid name, Brix and freeze point should also be created and affixed to all pour containers to be used during the test session.

Note that although ARP5945A stipulates that Type I fluid samples be sheared in a laboratory blender prior to testing, previous work has indicated that the effects of this shearing process on resulting Type I fluid endurance times are negligible. The Type I fluid shearing process is generally not performed with fluid samples as part of the typical simulated freezing precipitation testing process.

3.4.2 Type II/III/IV Fluid Management

In order to ensure that a testing session runs smoothly with minimal disruptions, it is critical that a sufficient number of filled 1L pour containers for each fluid to be tested are prepared and tempered prior to the start of a given test condition. The required amount of each fluid for each condition will be known in advance; it is good practice to have additional fluid ready for testing in the event of unexpected circumstances.

Used pour containers should be periodically refilled when time permits to prevent delays in the fluid application process. All pour containers must be affixed with labels listing the fluid name, batch number and dilution and special care must be taken when refilling to ensure that the proper fluid, batch and dilution are used. At the testing manager's discretion, the fluid names on the pour container labels may need to be coded to preserve fluid anonymity in the presence of visitors.

All fluids to be used in simulated snow endurance time testing must be properly stored in order to ensure that they are at the correct temperature when a test session begins. Given that simulated snow testing takes place at several discrete testing temperatures, a series of temperature controlled chest freezers set to the various testing temperatures should be available such that a sufficient quantity of fluid can be kept at each temperature being tested.

Fluid can also be stored within the test chamber itself, provided that the temperature of the chamber is the desired storage temperature for the fluid in question.

As stated in ARP5485B, the temperature of Type II, III (unheated) or IV fluid being applied to a test surface in a simulated snow precipitation endurance time test must be within 3°C (ideally 1°C) of the OAT. Valuable testing time can be lost waiting for fluids to temper if the proper storage procedures have not been followed.

4. TEST SITES

Indoor tests may be conducted in any temperature controlled test chamber such as the refrigerated trailer at the APS test facility (limited to tests above -14°C), or the climate controlled test chambers at PMG Technologies, Centre de recherche industrielle du Québec (CRIQ) the National Research Council (NRC), or L'Institut de recherche d'Hydro-Québec (IREQ).

5. TESTING PROCEDURE

5.1 Preparation of Ice Core

An ice core tube should be filled with deionized water to a level 10 cm from the top edge of the metal tube. Styrofoam insulation should be affixed to the upper portion of the tube to allow water to freeze from the bottom to the top.

The ice core tube should be allowed to freeze for about 24 to 48 hours. The ice core should be allowed to temper to room temperature (approximately 20°C) for

approximately 25 minutes before extraction from the ice tube. The ice core is ready to be extracted when it can be freely rotated within the tube using a finger. The ice core should be placed within the cold room for a minimum of 10 minutes before loading it into the machine.

5.2 Calibration and Verification of Precipitation Rate Distribution

The intensity of the snowfall produced by the snow machine is a controlled input into the software. However, the distribution of the snowfall across the test plate is not controlled.

The methods described in the following sections are described in greater detail in an internal document and are available during all testing activities with the snow machine.

Verification of the snow distribution can be completed in two ways:

- Calibration of Snow Distribution (Primary method used at start-up of a new session); and
- Visual Verification of Snow Distribution (Secondary method used during testing).

5.2.1 Calibration of Snow Distribution

Although the frequency in which a calibration is performed is not specifically outlined in any standard, it should be conducted under the following conditions:

- At the beginning of any test session;
- If the machine is relocated in any way (i.e. from test site to a chamber facility); and
- When a major part is changed or repair is performed on the machine (i.e. change of a drill bit, or repair of broken translator).

Snow distribution across the test plate can be measured by sub-dividing the surface area of the test plate into 6 (2x3) equal sections. Snow catch pans are used to calculate the rate of participation for each individual section of the test plate.

ARP5485 indicates that the snow must be evenly distributed over the test plates. Therefore, each section must fall within a specified tolerance. For example, when conducting a calibration at a rate of 3 g/dm^2/h, each of the individual sections should

be within a tolerance of ±0.9 g/dm^2/h from the average rate. Table 5.1 provides the ARP5485 recommended tolerances for rate distribution across the test plate.

Table 5.1: Range of Snow Intensity Differences Across Test Plate

Rate (g/dm^2/h)	Range of snow intensity differences from the average rate across a test plate (g/dm^2/h)
3	± 0.9
4	± 1.2
10	± 2.0
25	± 5.0

Once an acceptable calculated distribution is achieved, it is imperative that a visual snow distribution (see next section) be conducted, as this will serve as the "baseline picture" for subsequent visual verifications.

5.2.2 Visual Verification of Snow Distribution

This baseline visual documentation is performed by placing a black felt covered board (30 x 50 cm) onto the test plate. The snow machine will then precipitate onto this felt board until the operator observes approximately 50% snow coverage. By visual inspection, the observer will note the even distribution that should be exhibited across the plate and take a representative picture (90° with respect to the plate) of the felt board. This 90° top view picture must show the full plate and will be used as the baseline standard for subsequent visual snow distribution checks.

Subsequent visual snow distribution checks are performed in the exact same manner. Results of these checks should be verified against the baseline picture.

This method of distribution verification should be conducted under the following conditions:

- At the beginning of each day;
- When the rate of precipitation is changed; and
- When the test temperature is changed.

5.3 Test Temperatures and Rate of Precipitation Set Points

The following parameters must be set and/or regulated for each test:

- Condition / Chamber temperature;
- Enclosure temperature;
- Test plate temperature;
- Fluid temperature;
- Toggle switch to set plate surface area; and
- Rate of precipitation set point.

More detailed guidelines to condition temperature and standard temperature set points are provided in Attachment 1 and Attachment 2.

Sections 5.3.1 to 5.3.4 indicate the specific requirements for each of these temperatures.

5.3.1 Condition / Chamber Temperature

The condition temperature is defined in accordance with the temperature breakdowns in the HOT tables. The actual chamber temperature, however, is typically set to approximately 2°C colder than the test plate temperature. Further details are provided in Attachment 1.

5.3.2 Enclosure Temperature

The enclosure temperature must be within 0.5°C of the test plate temperature.

5.3.3 Test Plate Temperature

The plate temperature set point is directly entered into the program. Research has shown that the best correlation between indoor and outdoor results is achieved when the plate temperature is set according to the following equation:

$$P_T = T_T - 0.065 * I_I - 0.5$$

where: P_T = plate temperature in °C;

T_T = test condition temperature in °C; and

I_I = icing intensity (g/dm^2/h).

5.3.4 Fluid Temperature

The fluid temperature before application for Type II, III (unheated), and IV fluids should be within 3°C of the enclosure temperature, but ideally within 1°C. Type I fluids should be applied at 60°C.

5.3.5 Toggle Switch to Set Plate Surface Area

The snow machine is designed to test both Type I and Type II, III, and IV fluids. There is a difference in tray area when testing Type I fluids on an insulated box vs. Type II, III and IV fluids on a plate. For this reason, the tray area switch must be set within the LabVIEW software to ensure proper rate calculation.

Under the tab "set points" in the program, toggle the tray area switch as follows:

- "New" – 18.57 dm^2 tray area for Type I heated fluids using an insulated box; or
- "Old" – 16.84 dm^2 tray area for all Type II, III, and IV fluids with no insulated box.

5.3.6 Rate of Precipitation Set Point

To achieve the desired rate, enter the rate into the program as described in the snow machine manual. Limitations with the snow machine can sometimes result in the indicated set point not being achieved. In this case, it may be necessary to enter an adjusted set point that is higher or lower in order to effectively achieve the desired rate. For example, if the required set point is 5 g/dm^2/h, but the rate achieved is only 4.8 g/dm^2/h, a set point of 5.2 g/dm^2/h can be used to offset the difference. With the offset, the rate should settle to 5 g/dm^2/h.

Table 5.2 provides the ARP5485 recommended rate of precipitation tolerance.

Table 5.2: Rate of Precipitation Tolerance

Rate ($g/dm^2/h$)	Rate Tolerance ($g/dm^2/h$)
3	± 0.2
4	± 0.3
10	± 0.6
25	± 1.5

5.4 Fluid Application

The procedures for fluid application for simulated snow endurance time tests are summarized below.

Note that the balance used in this testing has a maximum capacity of 15,000 g. It is therefore important to empty the bucket assembly of spent fluid frequently in order to not exceed the capacity of the balance. The fluid should be poured directly onto the plate and no fluid should be allowed to accumulate on the sides of the bucket.

5.4.1 Heated Fluid Application

For Type I and Type III (heated) fluids; heat a batch of the fluid to be applied using a microwave (ensure that a microwave-safe container is used) to 60°C (+2°C, -0°C). Once the fluid is heated, transfer it to a thermos to preserve the temperature until it is applied. Pour 0.5 L of heated fluid, onto the top of the test surface using a 12-hole spreader to ensure even distribution.

5.4.2 Unheated Fluid Application

For Type II, Type III (unheated) and Type IV fluids, pour one litre of fluid at ambient temperature directly on the test surface from the top of the plate, ensuring that the entire surface of the plate is coated with an even fluid layer.

5.5 Execution of Test

The following indicates the steps required to conduct a test using the snow machine:

- Clean and prepare the test plate/box;
- Prepare a data form with the pertinent details required;
- Set required rate of precipitation and plate temperature parameters into Labview;
- Apply Type I, II, III, or IV de/anti-icing fluid as per Section 5.4;
- Begin the test by pushing "start experiment" and toggle the "set linear rate function" to on;
- Record the start of the endurance time test after fluid is applied;
- Continue testing until at least five crosshairs or 30% of the plate has failed;
- End the test by pushing "***end experiment***"; and recording the pertinent data in Labview;
- Record all pertinent data on data form; and
- Update log of tests in shared folder (if applicable).

5.6 Post-Test Measurements and Photos

Standard refractive index measurements should be taken at the end of each test. At minimum, measurement should be taken at position C2 (approximately 15 cm from the top of the plate). This is indicated on the data form.

At failure, three different photographs should be taken of the entire test plate:

- At a 10˚to 30˚ incident from the top end of the plate;
- At a 10˚to 30˚ incident from the bottom end of the plate; and
- At a 10˚to 30˚ incident from a 30˚ lateral position from the top end of the plate.

5.7 Guidance for Improved Test Efficiency

Increased efficiency in testing is required when trying to conduct many tests. A typical test day has both a fixed and a variable component.

The fixed component is comprised of activities in which the operator has no control over the time needed. Examples of this are: chamber cool down time, and test endurance times.

The variable component is comprised of the test turnaround activities in between tests. This component is mostly characterized by activities such as: failure of the previous test including photos, refractive index measurements, removal of spent fluid from the previous test, retraction of the translator to the load position, loading of a new ice core, advancement of the ice core to the start position, application of a new fluid for a new test, and scale stabilization period of 1 to 2 minutes.

Testing efficiency can be improved by proper planning and efficient management.

5.7.1 Efficient Turnaround Times

Attempts should be made to reduce the time spent in between tests. Efficiency can be obtained by proactive setup of a test day. The following activities can reduce turnaround times: remove and prepare enough ice cores to last the entire test day, prepare and temper all fluids for entire day; sequence tests in such a way to maximize use of each ice core (e.g. one long test and one short test using the same ice core); and take refractive index measurements and photos up to 3 minutes before failure.

6. EQUIPMENT

The equipment required for endurance time testing in simulated snow is listed in Attachment 3.

All additional equipment required for the operation of the snowmaking system is included in the snowmaking machine operators' manual, supplied by NCAR (refer to TP 14148E, *Endurance Time Tests in Snow: Comparison of Indoor and Outdoor Data for 2002-03).*

7. PERSONNEL

Personnel requirements differ based on the nature of the testing and locations.

- APS Test Facility: Testing at the test facility requires one senior experienced employee. An optional junior employee could be employed when numerous short tests are anticipated.
- Chamber Facility: Testing at a chamber facility would require one senior employee and one junior employee when testing with one snow machine.

When two snow machines will be used simultaneously, two senior employees and one junior employee is recommended.

The senior experienced employee should have advanced knowledge in operating the snow machine, and a junior employee shall provide support.

8. SAFETY

Special attention will be given to working in a cold environment, and employees should be mindful of dangers associated with hypothermia and frost bite.

Employees will adhere to APS specific safety requirements when working in the refrigerated trailer at the APS test site. An employee who is working alone should use the employee safety monitoring device (Loner Device) located at the test site.

Employees working at a contracted facility shall adhere to the indicated safety regulations of that facility.

The following general precautions should be taken when executing tests to ensure the safety of all personnel:

Appropriate footwear is to be worn by all personnel at the test site to prevent slipping;

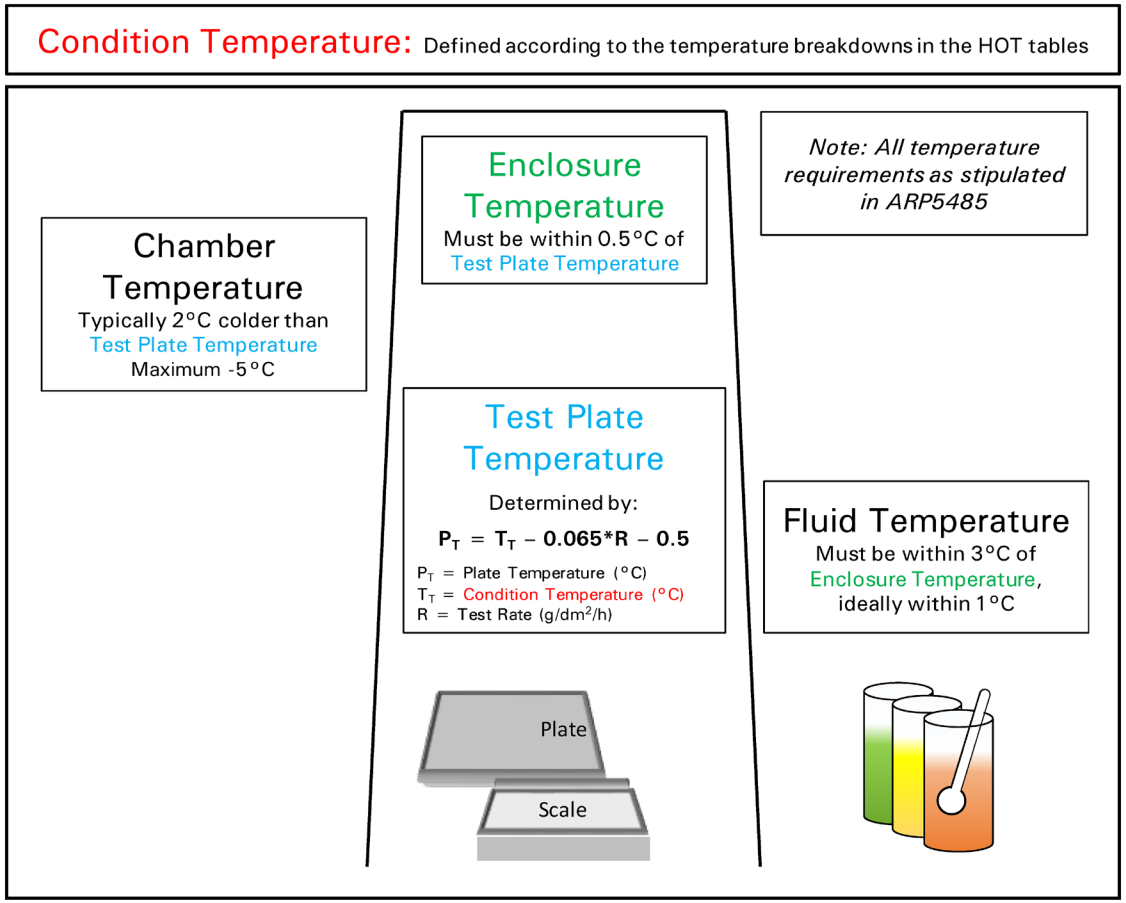
- Warm clothing is to be worn by all personnel to prevent frostbite;
- Electrical appliances (including computers) are to be unplugged before any wires or connections are altered. If necessary, the affected breaker is to be turned off;
- If fluid comes into contact with skin, rinse hands under running water;
- If fluid comes into contact with eyes, flush with a portable eye wash station;
- Care must be taken when working inside the snow machine; and
- Ensure that drill is off when changing the ice core.

9. DATA FORMS AND SOFTWARE

The following data forms and software programs are typically used for simulated snow endurance time testing:

1) End Condition Data Form for Simulated Snow Endurance Time Tests (Attachment 4); and
2) LabVIEW Software.

Attachment 1: Snow Machine Temperature Guidelines



Attachment 2: Temperature Requirements at Start of Test

Condition Temperature (°C)	Target Test Rate (g/dm²/h)	Test Plate Temperature Setting (°C)	Enclosure Temperature (°C) (Test Plate Temp ± 0.5°C)	Chamber Temperature (°C) -5°C or Below (Typically 2°C Below Test Plate Temperature)	Acceptable Fluid Application Temperature Range (°C) (Enclosure Temperature ± 3°C Ideally within 1°C)
-3	3	-3.7	-3.2 to -4.2	-5.7	-0.2 to -7.2
	4	-3.8	-3.3 to -4.3	-5.8	-0.3 to -7.3
	10	-4.2	-3.7 to -4.7	-6.2	-0.7 to -7.7
	25	-5.1	-4.6 to -5.6	-7.1	-1.6 to -8.6
-14	3	-14.7	-14.2 to -15.2	-16.7	-11.2 to -18.2
	4	-14.8	-14.3 to -15.3	-16.8	-11.3 to -18.3
	10	-15.2	-14.7 to -15.7	-17.2	-11.7 to -18.7
	25	-16.1	-15.6 to -16.6	-18.1	-12.6 to -19.6
-18	3	-18.7	-18.2 to -19.2	-20.7	-15.2 to -22.2
	4	-18.8	-18.3 to -19.3	-20.8	-15.3 to -22.3
	10	-19.2	-18.7 to 19.7	-21.2	-15.7 to -22.7
	25	-20.1	-19.6 to -20.6	-22.1	-16.6 to -23.6
-25	3	-25.7	-25.2 to -26.2	-27.7	-22.2 to -29.2
	4	-25.8	-25.3 to -26.3	-27.8	-22.3 to -29.3
	10	-26.2	-25.7 to -26.7	-28.2	-22.7 to -29.7
	25	-27.1	-26.6 to -27.6	-29.1	-23.6 to -30.6

Attachment 3: Equipment List for Simulated Snow Testing

SIMULATED SNOW TESTING
LOCATION: TEST SITE
18 litre containers of water x 10
Additional PVC Sheild Complete with extra liners (Wizz Pads)
Air Compressor
All Large Ice Core Molds, 2-3 short Ice core molds
Aluminum test plates with heating pads
Backup Drill Bit
Blue Towel
Clean Bucket and Clean Funnel for Ice Core Filling
Electronic NCAR files
Extension cord
Extra Coupler and GTCA coupler
Heat Gun
Insulated box for heated tests
Measuring Cup
Mettler Toledo Weigh Scale x2
NCAR Computer, Monitor and Control Box
NCAR tool box
PVC Pipe for Temporary Storage of Ice Cores
Revco Freezer for Ice Cores
Sartorius 2 g Scale for Distribution Analysis
Small box to transport small Allen keys and other equip
Small Folding Tables x 2
Small Important Allen Keys
Snow Distribution Pans 100mm X 150mm (6 Pans)
Snow machine and related equipment
Squeegee/scraper
Styrofoam Covers for Ice Core Molds
Thermos x 1 and spreader x 1
Waste Container
Wet vacuum
LOCATION: OFFICE
Data Forms
Procedures
Rate Distribution Excel file

Attachment 4: End Condition Data Form for Simulated Snow Endurance Time Tests

Date: _____ Location: _____ Project: _____ Test Plan #: _____

Fluid: _____ Dilution: _____ Fluid Type: _____ Batch #: _____

SNOW MACHINE

First Generation APS: _____ (✓)

Second Generation APS: _____ (✓)

NCAR Machine _____ (✓)

TEMPERATURES

Condition Temp.: _____ °C

Fluid Temp.: _____ °C

Fluid Quantity Applied: _____ litres

Plate Temp. Set point: _____ litres

PRECIPITATION RATE

Test Plan Precip. Rate: _____ g/dm^2/h

Adjusted Precip. Rate: _____ g/dm^2/h

TEST DATA

Output File Name: _____.txt

Time of Fluid Application: _____ hh:mm:ss

Time of Fluid Failure: _____ hh:mm:ss

Calculated Failure In Minutes: _____ minutes

Last Average Rate: _____ g/dm^2/h

B1	B2	B3
C1	C2	C3
D1	D2	D3
E1	E2	E3
F1	F2	F3

Refractive Index Measurements
(Standard 15cm line)

Position C2: _____ °Brix *Additional brix measurements should be indicated directly on diagram in respective locations.*

Comments: _____

PROCEDURE:
ENDURANCE TIME TESTING IN ACTIVE FROST WITH SAE TYPE I, II, III, AND IV DE/ANTI-ICING FLUIDS

300293

PROCEDURE:

ENDURANCE TIME TESTING IN ACTIVE FROST WITH SAE TYPE I, II, III AND IV DE/ANTI-ICING FLUIDS

Prepared for

Transportation Development Centre
Transport Canada

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Reviewed by: John D'Avirro

November 2018
Final Version 1.0

PROCEDURE:
ENDURANCE TIME TESTING IN ACTIVE FROST WITH SAE TYPE I, II, III AND IV DE/ANTI-ICING FLUIDS

1. BACKGROUND

The active frost holdover time table was initially developed prior to the year 2000, based on limited data from earlier testing in a laboratory setting. Further research had indicated that testing active frost in an indoor setting was not an appropriate method for determining holdover times, and as a result, an outdoor testing program was initiated to update the active frost holdover times.

APS began outdoor testing in natural active frost conditions in 2002-03 and testing was continued over the course of six winter testing seasons. This work was concluded in 2008-09 and is documented in the Transport Canada Report, TP 14938E, *Substantiation of Aircraft Ground Deicing Holdover Times in Frost Conditions*. A new, more conservative, frost holdover time table was developed based on the data that was collected and was published in the 2009-10 Holdover Time Guidelines.

The active frost holdover time table underwent a further revision in 2009-10 as a result of a project investigating the use of Type I fluids on composite aircraft surfaces. This work was documented in the Transport Canada Report, TP 15052E, *Development of Type I Fluid Holdover Times for Use on Aircraft with Composite Surfaces*. Active frost holdover times for Type I fluids used on composite surfaces were added to the existing active frost table as of the 2010-11 Holdover Time Guidelines.

Frost holdover times remain generic to this day, and testing continues each year to ensure that new fluids meet the existing generic holdover times.

This procedure serves as an update to the original APS procedure, *Experimental Program – Endurance Time Testing in Frost with Type I, II, III and IV Fluids*, which was issued in November 2003. This new document serves to incorporate refinements to the procedure that have been made in the interim years.

2. OBJECTIVE

This procedure describes the testing protocols used to evaluate the endurance time performance of Type I, II, III and IV fluids in natural active frost conditions.

This procedure is to be used for testing new holdover time fluids as well as older holdover time fluids for which lowest on-wing viscosity (LOWV) samples are available. For the testing of new holdover time fluids, two tests per dilution is the minimum required for fluid qualification.

3. PRE-TESTING ACTIVITIES

This section describes activities that need to be performed prior to commencing an active frost testing session.

3.1 Forecasting Active Frost

Active frost events are less predictable than natural snow events. Most weather forecasts do not explicitly indicate if active frost will occur in a given night, therefore forecasts must be closely monitored to determine if conditions are conducive to the formation of active frost.

The ideal conditions for the development of frost are:

1) Outside air temperature (OAT) near or below 0°C (the temperature of the test surface must be below 0°C for active frost to form and this can happen with OAT's of +6°C or more if the radiative cooling is very effective);
2) Wind speeds of less than 10 km/h (lower is better as winds disrupt radiative cooling);
3) Clear skies/minimal cloud cover overnight (cloud cover prevents radiative cooling); and
4) High relative humidity. The higher the relative humidity, the closer the dew (or frost) point will be to the current OAT. As a result, less radiative cooling will be required for frost formation.

Perfect conditions are not necessarily required for active frost formation. However, if one of the weather indicators is less-than-ideal (some cloud cover, winds at or near 10 km/h) it is best if the other indicators are strong.

3.2 Event Coordination

It is the responsibility of the testing manager to determine personnel and appropriate start/end times for each testing session. Arrangements should be made for all

personnel to arrive approximately 90 minutes prior to the planned pour time to allow for sufficient time for set-up activities and to maximize the usable testing time.

Prior to beginning a test event, it is critical that the temperature band(s) at which testing will occur is identified and that the corresponding generic holdover times for the fluids that are to be tested are known. Active frost endurance time tests are not considered valid if the duration of the active frost event is shorter than the holdover time corresponding to the fluid being tested and the temperature at which the test is run. Therefore, it is critical that fluids with long holdover times are poured sufficiently early to allow for a valid test.

As active frost formation ceases as the sun rises, test sessions will generally end at or near sunrise (around 7:00 AM). Prior to commencing a test session, the latest possible time that each fluid being tested can be poured while still providing a sufficient window to meet its holdover time should be determined.

Example:

A frost test session is planned for a night with temperatures ranging from -4 to -8°C. In this temperature band, neat Type IV fluids have an active frost holdover time of 10 hours. Given that sunrise is estimated to occur at 7:00 AM the following morning, any neat Type IV fluids being tested must be applied prior to 9:00 PM in order to allow the tests to run for the minimum 10 hours before sunrise.

Performing this exercise for all fluids being tested will allow the tester to determine the appropriate start time for the test event (determined by the longest corresponding generic holdover time). It will also allow a tester to stagger fluid application in a way that makes sense (i.e. if frost rates are weak/nil at the start of a test event, application can be delayed until rates improve for certain fluids with shorter holdover times).

It should also be noted that there is additional value in running frost tests as long as possible (ideally to the point where the fluid fails). Obtaining a large database of frost tests with times that exceed the current generic holdover times could potentially allow for future revisions of these holdover times.

Table 3.1 shows the 2018-19 generic active frost holdover times. Reference the latest publication of the TC or FAA HOT guidelines for the most up to date information.

Table 3.1 – 2018-19 Active Frost Generic Holdover Times*

Outside Air Temperature		Approximate Holdover Times (hours:minutes)
Degrees Celsius	Degrees Fahrenheit	Active Frost
		Type I
-1 and above	30 and above	0:45 – aluminum *(0:35) - composite*
below -1 to -3	below 30 to 27	
below -3 to -10	below 27 to 14	
below -10 to -14	below 14 to 7	
below -14 to -21	below 7 to -6	
below -21 to LOUT	below -6 to LOUT	

Outside Air Temperature		Concentration Neat Fluid/Water (Volume %/ Volume %)	Approximate Holdover Times (hours:minutes)		
Degrees Celsius	Degrees Fahrenheit		Active Frost		
			Type II	Type III	Type IV
-1 and above	30 and above	100/0	8:00	2:00	12:00
		75/25	5:00	1:00	5:00
		50/50	3:00	0:30	3:00
below -1 to -3	below 30 to 27	100/0	8:00	2:00	12:00
		75/25	5:00	1:00	5:00
		50/50	1:30	0:30	3:00
below -3 to -10	below 27 to 14	100/0	8:00	2:00	10:00
		75/25	5:00	1:00	5:00
below -10 to -14	below 14 to 7	100/0	6:00	2:00	6:00
		75/25	1:00	1:00	1:00
below -14 to -21	below 7 to -6	100/0	6:00	2:00	6:00
below -21 to -25	below -6 to -13	100/0	2:00	2:00	4:00
Below -25	below -13	100/0	No Holdover Time Guidelines Exist		

*See current HOT guidelines for most recent table.

3.3 Data Requirements and Test Planning

The testing manager should be mindful of the data requirements and current data set status for each of the fluids being tested in a given session. This information should be used to steer testing decisions, both when deciding what events to pursue and what tests to run during an event.

For Type I fluids, a minimum of two data points per fluid is required for validation of the existing generic active frost holdover times. The preferred target is four data points; ideally covering a range of temperatures.

For Type II/III/IV fluids, a minimum of two data points for each dilution of a fluid being tested is required for validation of the existing generic active frost holdover times. The preferred targets are six / four / two data points for 100/0, 75/25, and 50/50 fluids respectively. These tests ideally should cover a range of temperatures.

Holdover time fluids that do not meet the preferred data targets in their initial testing season may be retained for one additional test season, with the goal of achieving the preferred data targets with all dilutions.

3.4 Fluid Preparation and Management

This section describes the steps necessary to ensure that the fluids to be tested are properly prepared for testing.

3.4.1 Type I Fluid Preparation

Type I fluids will generally be sent to APS by the manufacturer in concentrate form. Prior to commencing a test session, an appropriately buffered mixture of the fluid must be prepared. As per ARP5945A, Type I fluids must be tested at dilutions where the freezing point of the solution is 10°C colder than the OAT at which testing is taking place.

To prepare the buffered solution, you must first determine the range of temperatures that the testing will take place in. The solution should be prepared such that it is properly buffered for the coldest temperature to be experienced during the test session. If a very large change in temperature is expected during the test session, (>10°C), consideration should be given to preparing two distinct batches of Type I fluid, with freeze points appropriate to the different expected phases of testing.

The Type I concentrate must be diluted with hard water, which is prepared by dissolving 400mg of calcium acetate dehydrate and 280 mg of magnesium sulfate

heptahydrate into 1L of water (the quantities can be scaled up proportionally if preparing a larger batch). Consult the dilution chart associated with the Type I fluid being tested in order to determine the appropriate glycol/hard water ratio necessary to achieve the desired freeze point. Dilution charts are generally available on the fluid manufacturer's website or directly from the manufacturer.

Confirm that the glycol concentration in your prepared solution is appropriate by measuring the Brix (generally Type I dilution charts will indicate the target Brix for the desired fluid freeze point). Ensure that the container in which the solution is mixed is clearly marked with the freeze point and Brix of the fluid. Pour container labels listing the fluid name, Brix and freeze point should also be created and affixed to all pour containers to be used during the test session.

Note that although ARP5945A stipulates that Type I fluid samples be sheared in a laboratory blender prior to testing, previous work has indicated that the effects of this shearing process on resulting Type I fluid endurance times are negligible. The Type I fluid shearing process is generally not performed with fluid samples as part of the typical active frost testing process.

3.4.2 Type II/III/IV Fluid Management

In order to ensure that a testing session runs smoothly with minimal disruptions, it is critical that a sufficient number of filled 1L pour containers are prepared and tempered prior to the start of the test session. The targeted amount is a minimum of two pour containers per fluid/dilution to be tested.

Used pour containers should be periodically refilled when time permits to prevent delays in the fluid application process. All pour containers must be affixed with labels listing the fluid name, batch number and dilution and special care must be taken when refilling to ensure that the proper fluid, batch and dilution are used.

All fluids to be used in active frost endurance time testing must be properly stored in order to ensure that they are at the correct temperature when a test session begins. As per Subsection 12.1.1 of ARP5485B, the temperature of Type II, III (unheated) or IV fluid being applied to a test surface in an active frost endurance time test must be within 3°C of the OAT. Valuable testing time can be lost waiting for fluids to temper if the proper storage procedures have not been followed.

Fluid jugs and pour containers of neat and 75/25 formulations of Type II/III/IV fluids that are to be used in a given test event should be stored outside such that their temperature consistently reflects the changing OAT. Note the following exceptions:

1) All containers containing 75/25 formulations of Type II/III/IV fluids must be temporarily stored inside the main trailer if the outdoor temperature on a given day is scheduled to drop below -14°C for a period exceeding four hours.

2) In the case of extreme cold (temperatures falling below -22°C for a period exceeding four hours), neat formulations of certain fluids may also need to be temporarily stored inside the main trailer. The freezing points of the individual fluids need to be consulted in order to determine which (if any) fluids will need to be moved.

Fluid jugs of 50/50 formulations of Type II/III/IV fluids that are to be used in a given test event are to be stored inside the main trailer at all times due to the relatively warm freezing point of 50/50 fluids. Pour containers of 50/50 formulations of fluids to be used are to be stored inside a chest freezer set at a temperature of -3°C.

All fluids that are stored in clear jugs must be covered with an opaque covering in order to ensure that the fluid is not exposed to light in storage.

4. TEST SITE

This section documents the test sites where APS conducts active frost endurance time testing with Type I, II, III and IV fluids.

4.1 Pierre-Elliott-Trudeau International Airport Test Site

Active frost is typically and predominantly performed at the APS test site located at the Montréal Pierre-Elliott-Trudeau International Airport. The test site is located near Environment Canada's Meteorological Services of Canada automated weather observation station, as shown in **Figure 4.1** on a plan view of the airport.

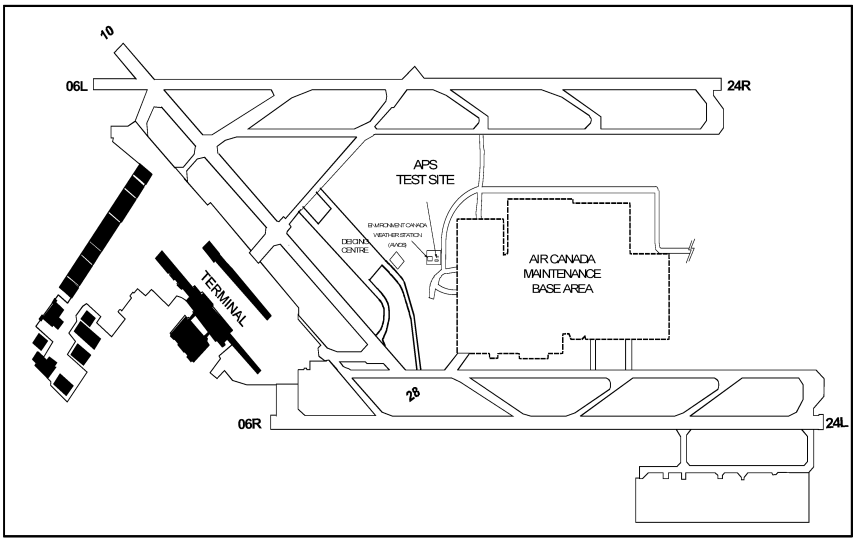


Figure 4.1: APS Test Site at Montréal-Pierre-Elliott-Trudeau International Airport

4.2 Mobile Test Sites

Although rare, there are instances where data requirements will necessitate active frost testing at a location other than the APS test site. In the past, this has typically been due to a need to obtain data at specific temperatures or time of year (generally after the conclusion of the winter season when active frost data is no longer obtainable in Montreal).

Mobile test sites can be set-up in any region where the desired active frost conditions are expected to occur, using test stands that have been specially modified for improved transportability. When using a mobile site for testing, the testing trailers are generally replaced by either rented vehicles or a rented hotel room (location permitting).

Several factors must be considered when choosing a location for a mobile test site, including:

1) Ground Surface

The ground surface should be level and firm to simplify the process of levelling the test stands.

2) Foot/Vehicle Traffic

The selected location should also be out of the way of foot and vehicle traffic, if possible, to minimize the chance of outside forces interfering with a test session.

5. TESTING PROCEDURE

This section describes the procedure to be followed during an active frost test event.

The procedure conforms to the requirements for natural frost testing outlined in section 12 of the *Aerospace Recommended Practice (ARP) 5485B – Endurance Time Tests for Aircraft Deicing/Anti-icing Fluids, SAE Type II, III, and IV*.

There is no section related to natural frost testing in the current edition of *ARP5945 – Endurance Time Tests for Aircraft Deicing/Anti-icing Fluids, SAE Type I*, however it is expected that this section will be added in a future revision.

5.1 Set-Up

The initial set-up for frost testing is very similar to the initial set-up for standard natural snow endurance time testing, with some minor differences. The steps are summarized below.

3) Ensure that the fluids to be tested are at the proper temperatures. Type II, Type III unheated and Type IV fluids are to be applied at a fluid temperature equivalent to the OAT and should be kept outdoors. Type I and Type III heated fluids are to be applied at a fluid temperature of 20°C and should be kept within the main trailer. If there is Type I fluid to be tested, prepare a mixture of Type I fluid buffered to the appropriate temperature (freezing point should be 10°C colder than OAT).

4) Confirm the current wind direction using the most recent YUL METAR report (available at https://flightplanning.navcanada.ca). Orient two full six-position test stands and an additional one-position test stand into the wind and ensure they are levelled such that the test surfaces lie at a 10° angle (within 9.8° and 10.2° is acceptable). Ensure the fluid collection pans are placed beneath the test stands to collect fluid runoff.

5) Equip the two six-position test stands and the one-position test stand with frosticator test plates (white-painted aluminum test plate with a 5cm R:10 insulation backing) in all positions. Two of the frosticator plates will be used as rate plates and one will be used as a visual frost check plate. The

visual frost check plate is generally equipped on the one-position test stand and placed to the left of the six-position test stands; this positioning is intended to simplify the rate collection process. Figure 4.1 depicts the proper plate set-up for the three test stands.

6) Clean the surface of the frosticator plates by removing any adhered ice or contamination. If any solvent or heat is used in the cleaning process, ensure the plates are allowed to cold-soak long enough.

7) Deactivate all lighting that may illuminate the test pad (lighting can interfere with active frost formation by imparting heat to the test surfaces).

8) Prepare the rate station inside the main trailer: ensure that the scale being used is properly leveled, open the latest version of the frost rate program (an Excel spreadsheet created to record frost rate measurements), and test that the scale and computer are functioning normally together.

9) Prepare the data forms to be used during the test session. Fill out as much information as possible ahead of time in order to streamline the subsequent fluid application process.

10) Prepare a digital camera for use by formatting the memory card and syncing the device time with the time that is displayed on the test site clocks.

11) Arrange all fluids to be poured by placing the filled pour containers behind their respective plates.



Figure 5.1 – Test Stand Set-Up

5.2 Procedure for Rate Collection

Rate collection for frost is performed using two rate plates. Rates are to be measured in 30-minute periods, with the two plates staggered such that a rate measurement is performed every fifteen minutes. The steps for rate collection are summarized below.

1) After initial set-up is complete, measure and record the initial weight of each of the rate plates. Once recorded, position both rate plates outside on the test stand. Note that the first rate measurement on rate plate #1 is to be performed after a 15 minute period in order to off-set the timing of the two rate plates, and that the rate collection process can be simplified by measuring rates at the :00, :15, :30 and :45 minute mark of every hour.
2) When collecting a rate, begin by measuring the surface temperature of the frost check plate using a handheld surface temperature probe. Note that the probe will be able to measure an accurate surface temperature more quickly if it is left outside to cold soak between rate measurements.
3) Scrape the surface of the frost check plate on the left hand side (if rate plate #1 is being measured) or the right hand side (if rate plate #2 is measured) to determine if there is visible frost accumulation. Once this is done, wipe clean the side of the plate used to perform the visual check to allow for the accumulation of new frost during the following rate period.
4) Bring the rate plate inside and record the weight of the rate plate as well as the measured surface temperature of the frost check plate and the results of the visual frost check (yes/no) in the frost rate program. Save the rate file after each measurement. Once done, return the plate to the test stand outdoors.
5) Repeat this process until the test session is complete. Ensure that final rates are taken on both plates after all tests have stopped running. At the conclusion of the test session, copy the completed rate file into the appropriate location.

5.3 Procedure for Fluid Endurance Time Tests

The steps for conducting active frost fluid endurance time tests are summarized below.

1) Measure the initial fluid temperature and Brix of all fluids that are to be poured during the test session. Record these values on the data form. Ensure that fluids are at the appropriate temperature (OAT for Type II/III-Unheated/IV fluids, 20°C for Type I/III-heated fluids).

2) Pour 0.5 L of Type I/III-heated fluid or 1 L Type II/III-Unheated/IV fluid onto the test surface from the top of the plate, ensuring that the entire surface of the plate is coated with an even fluid layer. Heated Type I/III fluids should be applied using a 12-hole spreader. If possible, fluid should only be applied once positive frost rates have been recorded for the session (i.e. visual frost check confirms presence of frost and an increase in weight is noted on the rate plates). If no positive rates have been recorded, fluid can still be applied early in order to ensure that a test is given a chance to run for a duration equivalent to its holdover time. After each fluid application, a photo is to be taken of the plate.

3) Five minutes after fluid application, measure the thickness of the fluid layer at the six-inch line of the plate with a fluid thickness gauge. Repeat this measurement at multiple points along the six-inch line to confirm that the reading is accurate. Record the measured thickness on the data form.

4) After every rate measurement, perform an inspection of each plate in order to assess its condition. Fluid failure in active frost can be determined by interacting with the fluid layer using a pencil. A healthy (i.e. "non-failed") fluid layer will have a smooth appearance and will not form a hard crust when displaced with a pencil, and the displaced area will be readily replenished by the surrounding fluid. A "failed" fluid layer will appear rough or ridged. It will form a hard, jagged crust when displaced with a pencil, and the displaced area will not be readily replenished by the surrounding fluid. When surface temperature nears the fluid freeze point temperature, a different "freeze-point-failure" may occur which is described as freezing nucleation points starting at the interface of the plate and the fluid which are sporadically spread on the surface and spread quickly.

5) If more than one-third of a given plate is determined to be "failed" (or if fluid failure is noted at any five of the crosshair marks on the plate), the plate as a whole is considered to be failed and the failure time is to be recorded. A final brix measurement and a photo of the failed plate are also to be taken for each failed surface.

6) A given test event is to continue until all surfaces have failed or until sunrise the following morning. Once the sun has risen, any unfailed surfaces should be photographed and have their final Brix measured. Their test end time is to be recorded as the time when the sun rose (or shortly thereafter), and "did not fail" will be indicated on the associated data form.

7) Ensure all test surfaces are cleaned after testing and that all fluid within the collection pans is disposed of appropriately.

It should be noted that at warmer OAT's (at or near 0°C) that unfrozen dew can accumulate on test surfaces over the course of the test duration. If this dew has accumulated on a surface and the OAT (or surface temperature of the plate) drops

sufficiently, this dew may freeze and trigger a rapid fluid failure (dew frost failure) on the test surfaces. Special attention should be given to all plates when testing at these temperatures as this process can occur very quickly.

A similar phenomenon is observed when testing with diluted fluids at OATs at or near their lowest operational use temperature (LOUT). Because the surface temperature of a test surface can be several degrees colder than the OAT during a frost event due to radiation cooling, fluids applied to these surfaces can be cooled to temperatures below the OAT. For fluids that are being tested near their LOUT, this can result in a rapid freezing of the entire fluid layer on these cooled surfaces. This is known as a "freeze point failure", and like the aforementioned dew frost failure, this can occur very quickly.

6. EQUIPMENT

The equipment required for endurance time testing in active frost is listed in Attachment 1.

7. PERSONNEL

One person is required for testing; however, having a second person present for the initial set-up is beneficial. If one person is conducting the testing alone, they should make use of the "Loner" monitoring system to ensure their safety during the testing event.

8. SAFETY

Testing in cold temperatures can pose significant safety issues. Jackets, gloves and boots should be rated to very low temperatures. Eye protection (ski goggles) and face protection should be worn if testing in very cold temperatures (< -20°C). Employees should be mindful of dangers associated with hypothermia and frostbite. Additional information can be found in the Test Site Safety Management manual, of which copies are available at the test site.

If ever one person is conducting testing alone, they must make use of the "Loner" monitoring system to ensure their safety during the testing event.

9. DATA FORMS AND SOFTWARE

The following data forms are typically used for active frost endurance time testing:

1) End Condition Data Form for Endurance Time Tests (Attachment 2);

2) App Data Form for Fluid Endurance Time Tests (Attachment 3);

3) APS Rate Program Spreadsheet (Attachment 4); and

4) Test Session Summary Form (Attachment 5).

Attachment 1: Equipment List for Active Frost Testing

ACTIVE FROST TESTING
LOCATION: TEST SITE
1 or 2–position test stand
6–position test stand
Compass
Data Forms
Digital Camera
Fluid collection pans
Fluid Thickness Gauge
Fluids
Immersion Temperature Probe
Inclinometer
Rate Computer
Scrapers
Squeegees
Surface Temperature Probe
Temperature Gauge
Weigh Scale + Connectors
White–painted aluminum test plate with insulated backing (frosticator plates)

Attachment 2: End Condition Data Form for Endurance Time Tests

REMEMBER TO SYNCHRONIZE TIME

LOCATION:	PRECIP. CONDITION:	DATE:	RUN NUMBER:	STAND # :

Time of Fluid Application:

Time of Fluid Failure:

Fluid Name/Dilution:

PLATE 1	PLATE 2	PLATE 3	PLATE 4	PLATE 5	PLATE 6

Failure Call:
(describe)

Time of Fluid Application:

Time of Fluid Failure:

Fluid Name/Dilution:

PLATE 7	PLATE 8	PLATE 9	PLATE 10	PLATE 11	PLATE 12

Failure Call:
(describe)

AMBIENT TEMPERATURE: _____ °C

LEADER / MANAGER: _____

FAILURES CALLED BY: _____

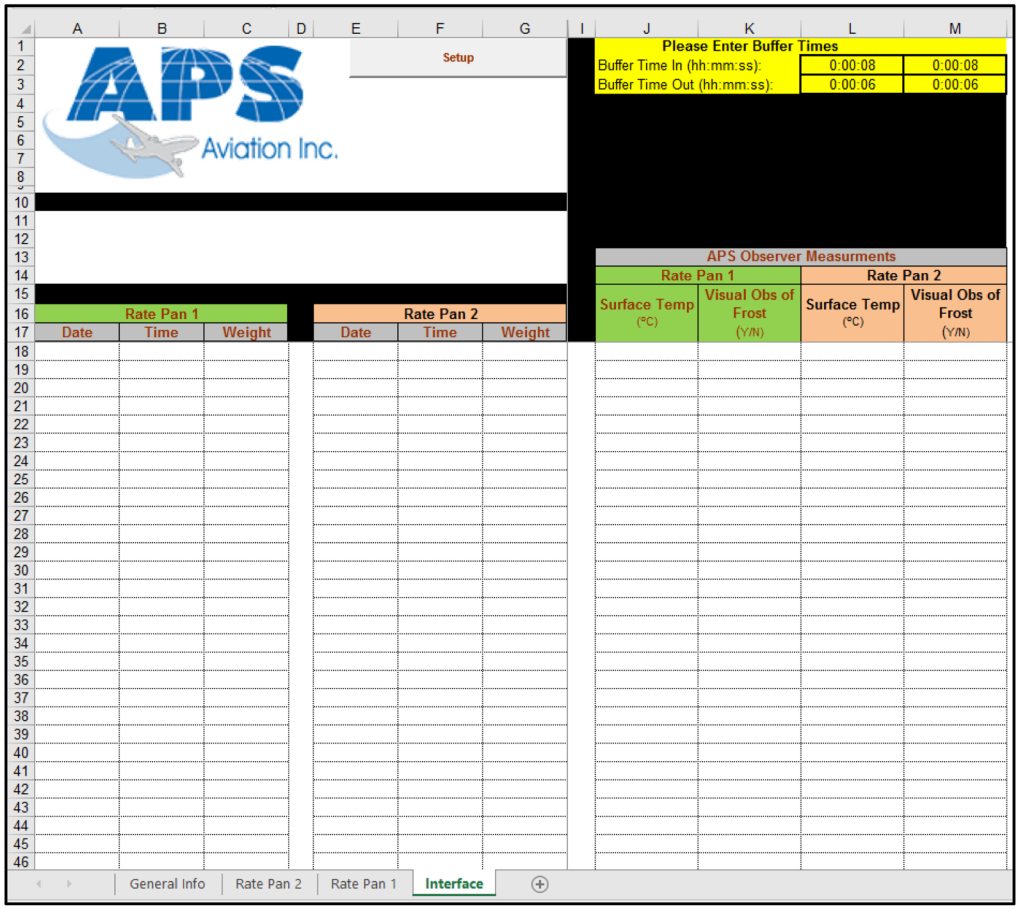
COMMENTS: _____

NOTE:
Please ensure correct functioning of plate temperature logging system at the start of the test and at the end of the session

Attachment 3: Screenshot of Holdover Time Data Form



Attachment 4: Screenshot of Frost Rate Program



Attachment 5: Example of Test Session Summary Form

TEST SESSION SUMMARY
OUTDOOR/OTHER

TEST MANAGER: _____ DATE: _____

LOCATION: _____

# of Tests Conducted	Project	Person Responsible	Data Forms (# or electronic)	Rate File (#)	Logger Files (#)	Photos (#)	Comments
	NATURAL SNOW						
	HOT Snow						
	Flaps and Slats						
	Other _____						
	Other _____						
	ARTIFICIAL SNOW						
	HOT Snowmaker						
	Other _____						
	FROST						
	HOT Frost						
	Frost Substantiation						
	Other _____						
	OTHER NON TC/FAA PROJECTS (DO NOT INCLUDE IN CALENDAR OF COMPLETED TESTS)						
	SureWx						
	Other _____						
	Other _____						

FOR OFFICE USE ONLY

Verification of Electronic and Paper Filing PERSON: _____ DATE: _____

M:\Projects\PM2480.004 (TC Deicing 2017-18)\Data\Test Session Summaries\Test Session Summary v2.0
11/29/2017

OVERALL PROGRAM OF TESTS AT NRC, APRIL 2019

300293

OVERALL PROGRAM OF TESTS AT NRC, APRIL 2019

Winter 2018-19

Prepared for

Transport Canada
Innovation Centre

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March 27, 2019
Final Version 1.0

OVERALL PROGRAM OF TESTS AT NRC, APRIL 2019

Winter 2018-19

1. INTRODUCTION

This document was prepared to bring together several elements of a project that require testing at the National Research Council Canada (NRC) Climactic Engineering Facility in Ottawa, Ontario. Tests will be carried out from April 2 to April 12, 2019.

The primary objective of the test session is to measure the endurance times of new de/anti-icing fluids. Thickness testing for new de/anti-icing fluids will be scheduled around the endurance time tests as time and space permit. This document provides the schedule, personnel, fluid, and equipment requirements for the project.

A tentative test schedule is included in Figure 1.

2. PROJECTS, PROCEDURES AND OBJECTIVES

The projects that will be carried out at the April 2019 NRC test session are listed in this section. Each project has been given a shortened name (shown in brackets following full title) which is used in subsequent sections of this document. A description of each project, its objective and its test procedure are provided. The test procedures for some projects are provided in separate detailed documents, which are referenced in the appropriate subsection and listed in Section 9.

General comments on procedures and setup are listed below.

- There will be two test stands positioned under the sprayer (known as the main stand with two 6-position stands) and an additional stand that will be positioned outside the spray area in the small area of the climate chamber. The test stands should be situated in the cold chamber as per the measurements provided in Figure 2.
- A complex rate management program was developed in the early 2000s to assist in managing the measurement of precipitation rates. An update to the interface of this program was completed in 2014. This program will be used.
- To further assist in rate management, NRC has developed a precipitation rate monitoring system. This system will be positioned on a 1-position stand next to the main stand.

2.1 Endurance Times of New Fluids (New Fluid ETs)

The objective of this project is to measure endurance times of new fluids. This will include Type II and Type IV fluid tests, as listed below. Each fluid will be tested over the entire range of freezing precipitation conditions encompassed by the holdover time (HOT) table format that applies to its fluid type.

- New Type II fluid: Coded as 014A, 015A, and 016A
- New Type IV fluid: Coded as 011A, 012A, and 013A
- New Type IV fluid: Coded as 017A (100/0 only, no dilutions)
- New Type IV fluid: Coded as 020A (100/0 only, no dilutions)
- New Type IV fluid: Coded as 025A (100/0 only, no dilutions)

Endurance time tests will be carried out according to the protocol provided in Aerospace Recommended Practice (ARP) 5485B, *Endurance Time Test Procedures for SAE Type II/III/IV Aircraft Deicing/Anti-Icing Fluids* (1), except as noted.

The procedure for conducting endurance time tests is given in the document *Endurance Time Testing in Simulated Freezing Precipitation with SAE Type I, II, III, and IV De/Anti-Icing Fluids* (2). Cold-soak boxes should be prepared using the procedure provided in Attachment 1.

The test plan for new fluid endurance time tests is given in Table 1. All tests will be conducted on the main test stand.

2.2 Thickness of New Fluids (New Fluid Thickness)

The objective of these tests is to measure the thickness of new fluids on flat plates. The procedure for these tests is entitled *Experimental Program to Establish Film Thickness Profiles for De-Icing and Anti-Icing Fluids on Flat Plates* (3) and can be found in Appendix I of Transport Canada report, TP 13991E. All tests will be conducted with fluid at -3°C.

The test plan for Fluid Thickness tests is given in Table 2. The tests will be conducted at the small end of the chamber outside of the spray area.

3. PERSONNEL REQUIREMENTS/RESPONSIBILITIES

The personnel requirements and responsibilities are provided in Table 3.

4. FLUIDS

The required fluids and fluid quantities are shown in Table 4. Fluids that will be used the first day of testing should be packed into coolers at the APS Aviation Inc. (APS) test site and plugged into power overnight. (In the event that the setup at NRC is done the day before testing, the coolers will not be required.)

5. PRE-TESTING SETUP ACTIVITIES

The following activities need to be completed prior to arrival at the NRC:

1. Mark plates with plate numbers on back and front – marking should be at bottom (RA/CB);
2. Locate rate pans: check quantity, check all pans are properly labelled, and verify spares are available (CB);
3. Ensure plates are equipped with operational and verified thermistors or SmartButtons and make sure they are set for logging the whole session (RA/BB);
4. Prepare coded labels for pour containers as per fluids list (CB);
5. Ensure fluids are prepared in advance according to Table 4 (RA);
6. Clean and label 1 litre pour containers (RA);
7. Check laptops (2) work for rate station (BB);
8. Review “NRC Rate Station 101” (BB);
9. Rent cube truck (JS);
10. Book hotel (JS);
11. Print data forms and procedures (CB);
12. Print chamber condition sheets (CB);
13. Contact Medhat (CB/JD):
    - Confirm availability of NRC camera system + black shelving unit;
    - Waste tote + floor mats in chamber for setup day;
    - Cold-soak fluid + wooden stand + pump in chamber for setup day;
    - Rate monitoring system;
    - Update chamber settings file with the latest data available;
    - Make sure that the freezer works and is ON the day before testing;
    - Set up test area temperature sensors for morning of test;

- Have the desks in the test area and in NRC office cleaned-up and available to avoid mixing up NRC/APS equipment;
- Ensure hallways and chamber are free of clutter;
- Make sure dryer is operational and hooked up; and
- Confirm daily start time (JD).

14. Ensure sufficient propylene glycol (PG) fluid is available for cold-soak boxes and get more if necessary (BB);
15. Put CSW fluid into freezer at -30°C (BB);
16. Make all necessary purchases prior to NRC (CB);
17. Ensure fluids for research projects are available (RA/JD);
18. Determine team travel plans (JD);
19. Measure falling ball and viscosity of HOT fluids (BB/CB);
20. Confirm lowest operational use temperature (LOUT) of all Type II, III and IV fluids (JD);
21. If any LOUTs are -29.5°C or colder, schedule testing in freezing fog at the LOUT (CB/JD);
22. Provide final test plan to data form programmer (CB); and
23. Gather equipment and pack truck (CB/RA/YOW1/YOW2).

6. EQUIPMENT

Table 9 provides a list of required equipment.

7. SAFETY

Managers of each subproject must ensure that personnel involved in the set-up and conduct of their respective projects are aware of the following:

1. Fluid SDS sheets are available for review;
2. Waterproof clothing and gloves are available;
3. Fluid(s) should only be handled with protective gloves. If any fluid gets onto the skin, wash the effected area thoroughly;
4. Rubber mats must be properly placed in and around the test area and cleaned as necessary;
5. Care should be taken when circulating near the test stand due to slipperiness;

6. First aid kit, water and fire extinguisher are available; and
7. All NRC safety guidelines must be followed.

8. DATA FORMS

The data forms required for each project are listed below.

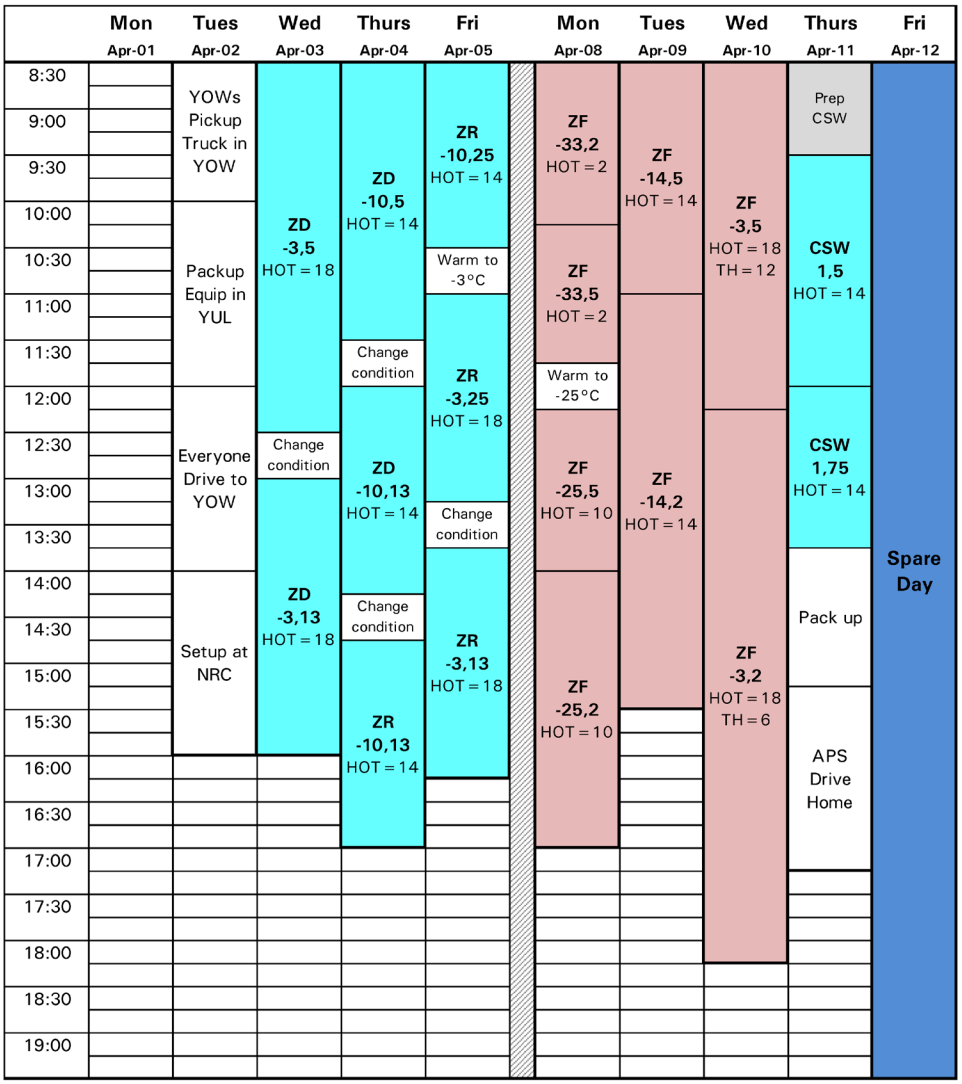
1. New Fluid ETs
   - Freezing Precipitation Endurance Time Electronic Data Form
   - NRC Continuous Rate Form (Figure 2)
   - Rate Management Form (Figure 3)
   - End Condition Data Form for Endurance Time Tests – used as backup for electronic data form (Figure 4)
2. New Fluid Thickness
   - Fluid Thickness Data Form (Figure 5)

9. REFERENCES

1. SAE International Aerospace Recommended Practice 5485B, *Endurance Time Test Procedures for SAE Type II/III/IV Aircraft Deicing/Anti-Icing Fluids*, October 2017.
2. *Endurance Time Testing In Simulated Freezing Precipitation with SAE Type I, II, III, and IV De/Anti-Icing Fluids,* Final Version 1.0, November 2018.
3. *Experimental Program to Establish Film Thickness Profiles for De-Icing and Anti-Icing Fluids on Flat Plates*, Version 1.0, April 3, 2002.

OVERALL PROGRAM OF TESTS AT NRC, APRIL 2019

Figure 1: Test Schedule



Project Abbreviations	
HOT = New Fluid ETs	TH = New Fluid Thickness

Figure 2: NRC Continuous Rate Form

Condition	Historical Average Calculated Rate - Position 1	Standard Deviation of Historical Average Calculated Rate (Pos. 1)	Historical Average of Session Standard Deviation	Suggested Start Position (For ZF, coordinates are nozzle position with respect to the plate)	Condition Difficulty Rating (1-5, 1 is easiest)	Historical Condition Difficulty Rating (1-5, 1 is easiest)	Comments
ZF, -3, 2	1.8	0.3	0.7	Pos. 10 (2",0")		1.3	
ZF, -3, 5	4.9	0.6	2.1	Pos. 4 (0", 18")		2.3	
ZF, -10, 2	1.9	0.3	0.6	Pos. 10 (2",0")		1.0	
ZF, -10, 5	4.9	1.0	0.9	Pos. 10 (2",0")		1.5	
ZF, -14, 2	2.1	0.2	0.7	Pos. 10 (2",0")		1.3	
ZF, -14, 5	4.8	0.3	1.1	Pos. 10 (2",0")		1.3	
ZF, -25, 2	2.0	0.4	1.0	Pos. 10 (2",0")		1.0	
ZF, -25, 5	4.8	0.4	1.2	Pos. 10 (2",0")		2.8	
ZF, -35, 2	2.1	0.1	1.0	Pos. 10 (2",0")		2.7	
ZF, -35, 5	5.1	0.0	1.5	Pos. 10 (2",0")		3.0	
ZD, -3, 5	5.5	0.2	0.9	(23' 11", 6' 7"), (24', 9')		2.5	If rates prove difficult, move top stand as close to bottom as possible
ZD, -3, 13	13.0	1.8	1.7	(23' 11", 6' 7"), (24', 9')		3.5	If rates prove difficult, move top stand as close to bottom as possible
ZD, -6, 5	n/a	n/a	n/a	n/a		n/a	
ZD, -6, 13	n/a	n/a	n/a	n/a		n/a	
ZD, -10, 5	5.9	0.4	0.8	(23' 11", 6' 7"), (24', 9')		1.5	
ZD, -10, 13	14.0	0.5	1.7	(23' 11", 6' 7"), (24', 9')		2.3	If rates prove difficult, move top stand as close to bottom as possible
ZR, -3, 13	13.6	0.5	1.2	(23' 11", 6' 7"), (24', 9')		2.0	
ZR, -3, 25	25.7	0.6	1.5	(23' 11", 6' 7"), (24', 9')		1.0	
ZR, -6, 13	n/a	n/a	n/a	n/a		n/a	
ZR, -6, 25	n/a	n/a	n/a	n/a		n/a	
ZR, -10, 13	13.9	0.7	1.0	(23' 11", 6' 7"), (24', 9')		4.0	
ZR, -10, 25	26.1	0.5	1.2	(23' 11", 6' 7"), (24', 9')		1.0	
CS, 1, 5	4.9	0.2	4.0	(23' 11", 6' 10"), (24', 9')		3.0	If rates prove difficult, move top stand as close to bottom as possible
CS, 1, 75	75.6	3.4	13.1	(23' 11", 6' 10"), (24', 9')		2.5	If rates prove difficult, move top stand as close to bottom as possible

Attachment 1: Cold-Soak Box Preparation Procedure

1. Put containers (5 x 20 L) of CSW box fluid (propylene 65/35, approximate Brix of 39.0) in cold (-30 ± 5°C) freezer overnight. Freezers to be kept in large end of the chamber.

2. Put all filled CSW boxes in warmer (-11 ± 1°C) freezer overnight.

3. Next morning, if freezer in step (2) does not provide fluid and box temperature of -11 ± 1°C, then empty boxes in pail and achieve fluid at -12 ± 1°C in pail.

4. Prepare step (3) in corner of large chamber that is at +1°C; ensure boxes are cooled to about -11°C. Go to step (6).

5. After first series of tests, empty fluid from boxes into separate pail. Put empty boxes in freezer to keep cool at -11 ± 2°C.

6. Prepare fluid to -12 ± 1°C by mixing (use small amounts of hot water and/or cold fluid). Agitate fluid mixture frequently.

7. Fill boxes, ensure -11 ± 1°C on surface of box. This process shall be done while rates are being measured.

8. Position on stand with cover, but no insulation on top surface. Connect thermocouples.

9. Allow warming to -10 ± 0.5°C. This process needs monitoring with rates measurement to not overshoot temperature (place insulation on top surface if required).

10. Start test.

11. At end of test, remove box from stand, measure rates, and go to step (5).

Table 1: New Fluid Endurance Times Test Plan

Test #	Condition Name	Fluid Code	Fluid Dilution (%)	Test Surface	Comments
1	Cold-Soak Box,1,5	014A	100	Al. Box	
2	Cold-Soak Box,1,5	014A	100	Al. Box	
3	Cold-Soak Box,1,5	015A	75	Al. Box	
4	Cold-Soak Box,1,5	015A	75	Al. Box	
5	Cold-Soak Box,1,5	011A	100	Al. Box	
6	Cold-Soak Box,1,5	011A	100	Al. Box	
7	Cold-Soak Box,1,5	012A	75	Al. Box	
8	Cold-Soak Box,1,5	012A	75	Al. Box	
9	Cold-Soak Box,1,5	017A	100	Al. Box	
10	Cold-Soak Box,1,5	017A	100	Al. Box	
11	Cold-Soak Box,1,5	020A	100	Al. Box	
12	Cold-Soak Box,1,5	020A	100	Al. Box	
13	Cold-Soak Box,1,5	025A	100	Al. Box	
14	Cold-Soak Box,1,5	025A	100	Al. Box	
15	Cold-Soak Box,1,75	014A	100	Al. Box	
16	Cold-Soak Box,1,75	014A	100	Al. Box	
17	Cold-Soak Box,1,75	015A	75	Al. Box	
18	Cold-Soak Box,1,75	015A	75	Al. Box	
19	Cold-Soak Box,1,75	011A	100	Al. Box	
20	Cold-Soak Box,1,75	011A	100	Al. Box	
21	Cold-Soak Box,1,75	012A	75	Al. Box	
22	Cold-Soak Box,1,75	012A	75	Al. Box	
23	Cold-Soak Box,1,75	017A	100	Al. Box	
24	Cold-Soak Box,1,75	017A	100	Al. Box	
25	Cold-Soak Box,1,75	020A	100	Al. Box	
26	Cold-Soak Box,1,75	020A	100	Al. Box	
27	Cold-Soak Box,1,75	025A	100	Al. Box	
28	Cold-Soak Box,1,75	025A	100	Al. Box	
29	Freezing Drizzle,-3,5	014A	100	Al. Plate	
30	Freezing Drizzle,-3,5	014A	100	Al. Plate	
31	Freezing Drizzle,-3,5	015A	75	Al. Plate	
32	Freezing Drizzle,-3,5	015A	75	Al. Plate	
33	Freezing Drizzle,-3,5	016A	50	Al. Plate	
34	Freezing Drizzle,-3,5	016A	50	Al. Plate	
35	Freezing Drizzle,-3,5	011A	100	Al. Plate	
36	Freezing Drizzle,-3,5	011A	100	Al. Plate	
37	Freezing Drizzle,-3,5	012A	75	Al. Plate	
38	Freezing Drizzle,-3,5	012A	75	Al. Plate	
39	Freezing Drizzle,-3,5	013A	50	Al. Plate	
40	Freezing Drizzle,-3,5	013A	50	Al. Plate	
41	Freezing Drizzle,-3,5	017A	100	Al. Plate	

Table 1: New Fluid Endurance Times Test Plan (cont'd)

Test #	Condition Name	Fluid Code	Fluid Dilution (%)	Test Surface	Comments
42	Freezing Drizzle,-3,5	017A	100	Al. Plate	
43	Freezing Drizzle,-3,5	020A	100	Al. Plate	
44	Freezing Drizzle,-3,5	020A	100	Al. Plate	
45	Freezing Drizzle,-3,5	025A	100	Al. Plate	
46	Freezing Drizzle,-3,5	025A	100	Al. Plate	
47	Freezing Drizzle,-3,13	014A	100	Al. Plate	
48	Freezing Drizzle,-3,13	014A	100	Al. Plate	
49	Freezing Drizzle,-3,13	015A	75	Al. Plate	
50	Freezing Drizzle,-3,13	015A	75	Al. Plate	
51	Freezing Drizzle,-3,13	016A	50	Al. Plate	
52	Freezing Drizzle,-3,13	016A	50	Al. Plate	
53	Freezing Drizzle,-3,13	011A	100	Al. Plate	
54	Freezing Drizzle,-3,13	011A	100	Al. Plate	
55	Freezing Drizzle,-3,13	012A	75	Al. Plate	
56	Freezing Drizzle,-3,13	012A	75	Al. Plate	
57	Freezing Drizzle,-3,13	013A	50	Al. Plate	
58	Freezing Drizzle,-3,13	013A	50	Al. Plate	
59	Freezing Drizzle,-3,13	017A	100	Al. Plate	
60	Freezing Drizzle,-3,13	017A	100	Al. Plate	
61	Freezing Drizzle,-3,13	020A	100	Al. Plate	
62	Freezing Drizzle,-3,13	020A	100	Al. Plate	
63	Freezing Drizzle,-3,13	025A	100	Al. Plate	
64	Freezing Drizzle,-3,13	025A	100	Al. Plate	
65	Freezing Drizzle,-10,5	014A	100	Al. Plate	
66	Freezing Drizzle,-10,5	014A	100	Al. Plate	
67	Freezing Drizzle,-10,5	015A	75	Al. Plate	
68	Freezing Drizzle,-10,5	015A	75	Al. Plate	
69	Freezing Drizzle,-10,5	011A	100	Al. Plate	
70	Freezing Drizzle,-10,5	011A	100	Al. Plate	
71	Freezing Drizzle,-10,5	012A	75	Al. Plate	
72	Freezing Drizzle,-10,5	012A	75	Al. Plate	
73	Freezing Drizzle,-10,5	017A	100	Al. Plate	
74	Freezing Drizzle,-10,5	017A	100	Al. Plate	
75	Freezing Drizzle,-10,5	020A	100	Al. Plate	
76	Freezing Drizzle,-10,5	020A	100	Al. Plate	
77	Freezing Drizzle,-10,5	025A	100	Al. Plate	
78	Freezing Drizzle,-10,5	025A	100	Al. Plate	
79	Freezing Drizzle,-10,13	014A	100	Al. Plate	
80	Freezing Drizzle,-10,13	014A	100	Al. Plate	
81	Freezing Drizzle,-10,13	015A	75	Al. Plate	
82	Freezing Drizzle,-10,13	015A	75	Al. Plate	
83	Freezing Drizzle,-10,13	011A	100	Al. Plate	

Table 1: New Fluid Endurance Times Test Plan (cont'd)

Test #	Condition Name	Fluid Code	Fluid Dilution (%)	Test Surface	Comments
84	Freezing Drizzle,-10,13	011A	100	Al. Plate	
85	Freezing Drizzle,-10,13	012A	75	Al. Plate	
86	Freezing Drizzle,-10,13	012A	75	Al. Plate	
87	Freezing Drizzle,-10,13	017A	100	Al. Plate	
88	Freezing Drizzle,-10,13	017A	100	Al. Plate	
89	Freezing Drizzle,-10,13	020A	100	Al. Plate	
90	Freezing Drizzle,-10,13	020A	100	Al. Plate	
91	Freezing Drizzle,-10,13	025A	100	Al. Plate	
92	Freezing Drizzle,-10,13	025A	100	Al. Plate	
93	Freezing Fog,-3,2	014A	100	Al. Plate	
94	Freezing Fog,-3,2	014A	100	Al. Plate	
95	Freezing Fog,-3,2	015A	75	Al. Plate	
96	Freezing Fog,-3,2	015A	75	Al. Plate	
97	Freezing Fog,-3,2	016A	50	Al. Plate	
98	Freezing Fog,-3,2	016A	50	Al. Plate	
99	Freezing Fog,-3,2	011A	100	Al. Plate	
100	Freezing Fog,-3,2	011A	100	Al. Plate	
101	Freezing Fog,-3,2	012A	75	Al. Plate	
102	Freezing Fog,-3,2	012A	75	Al. Plate	
103	Freezing Fog,-3,2	013A	50	Al. Plate	
104	Freezing Fog,-3,2	013A	50	Al. Plate	
105	Freezing Fog,-3,2	017A	100	Al. Plate	
106	Freezing Fog,-3,2	017A	100	Al. Plate	
107	Freezing Fog,-3,2	020A	100	Al. Plate	
108	Freezing Fog,-3,2	020A	100	Al. Plate	
109	Freezing Fog,-3,2	025A	100	Al. Plate	
110	Freezing Fog,-3,2	025A	100	Al. Plate	
111	Freezing Fog,-3,5	014A	100	Al. Plate	
112	Freezing Fog,-3,5	014A	100	Al. Plate	
113	Freezing Fog,-3,5	015A	75	Al. Plate	
114	Freezing Fog,-3,5	015A	75	Al. Plate	
115	Freezing Fog,-3,5	016A	50	Al. Plate	
116	Freezing Fog,-3,5	016A	50	Al. Plate	
117	Freezing Fog,-3,5	011A	100	Al. Plate	
118	Freezing Fog,-3,5	011A	100	Al. Plate	
119	Freezing Fog,-3,5	012A	75	Al. Plate	
120	Freezing Fog,-3,5	012A	75	Al. Plate	
121	Freezing Fog,-3,5	013A	50	Al. Plate	
122	Freezing Fog,-3,5	013A	50	Al. Plate	
123	Freezing Fog,-3,5	017A	100	Al. Plate	
124	Freezing Fog,-3,5	017A	100	Al. Plate	
125	Freezing Fog,-3,5	020A	100	Al. Plate	

Table 1: New Fluid Endurance Times Test Plan (cont'd)

Test #	Condition Name	Fluid Code	Fluid Dilution (%)	Test Surface	Comments
126	Freezing Fog,-3,5	020A	100	Al. Plate	
127	Freezing Fog,-3,5	025A	100	Al. Plate	
128	Freezing Fog,-3,5	025A	100	Al. Plate	
129	Freezing Fog,-14,2	014A	100	Al. Plate	
130	Freezing Fog,-14,2	014A	100	Al. Plate	
131	Freezing Fog,-14,2	015A	75	Al. Plate	
132	Freezing Fog,-14,2	015A	75	Al. Plate	
133	Freezing Fog,-14,2	011A	100	Al. Plate	
134	Freezing Fog,-14,2	011A	100	Al. Plate	
135	Freezing Fog,-14,2	012A	75	Al. Plate	
136	Freezing Fog,-14,2	012A	75	Al. Plate	
137	Freezing Fog,-14,2	017A	100	Al. Plate	
138	Freezing Fog,-14,2	017A	100	Al. Plate	
139	Freezing Fog,-14,2	020A	100	Al. Plate	
140	Freezing Fog,-14,2	020A	100	Al. Plate	
141	Freezing Fog,-14,2	025A	100	Al. Plate	
142	Freezing Fog,-14,2	025A	100	Al. Plate	
143	Freezing Fog,-14,5	014A	100	Al. Plate	
144	Freezing Fog,-14,5	014A	100	Al. Plate	
145	Freezing Fog,-14,5	015A	75	Al. Plate	
146	Freezing Fog,-14,5	015A	75	Al. Plate	
147	Freezing Fog,-14,5	011A	100	Al. Plate	
148	Freezing Fog,-14,5	011A	100	Al. Plate	
149	Freezing Fog,-14,5	012A	75	Al. Plate	
150	Freezing Fog,-14,5	012A	75	Al. Plate	
151	Freezing Fog,-14,5	017A	100	Al. Plate	
152	Freezing Fog,-14,5	017A	100	Al. Plate	
153	Freezing Fog,-14,5	020A	100	Al. Plate	
154	Freezing Fog,-14,5	020A	100	Al. Plate	
155	Freezing Fog,-14,5	025A	100	Al. Plate	
156	Freezing Fog,-14,5	025A	100	Al. Plate	
157	Freezing Fog,-25,2	014A	100	Al. Plate	
158	Freezing Fog,-25,2	014A	100	Al. Plate	
159	Freezing Fog,-25,2	011A	100	Al. Plate	
160	Freezing Fog,-25,2	011A	100	Al. Plate	
161	Freezing Fog,-25,2	017A	100	Al. Plate	
162	Freezing Fog,-25,2	017A	100	Al. Plate	
163	Freezing Fog,-25,2	020A	100	Al. Plate	
164	Freezing Fog,-25,2	020A	100	Al. Plate	
165	Freezing Fog,-25,2	025A	100	Al. Plate	
166	Freezing Fog,-25,2	025A	100	Al. Plate	
167	Freezing Fog,-25,5	014A	100	Al. Plate	

Table 1: New Fluid Endurance Times Test Plan (cont'd)

Test #	Condition Name	Fluid Code	Fluid Dilution (%)	Test Surface	Comments
168	Freezing Fog,-25,5	014A	100	Al. Plate	
169	Freezing Fog,-25,5	011A	100	Al. Plate	
170	Freezing Fog,-25,5	011A	100	Al. Plate	
171	Freezing Fog,-25,5	017A	100	Al. Plate	
172	Freezing Fog,-25,5	017A	100	Al. Plate	
173	Freezing Fog,-25,5	020A	100	Al. Plate	
174	Freezing Fog,-25,5	020A	100	Al. Plate	
175	Freezing Fog,-25,5	025A	100	Al. Plate	
176	Freezing Fog,-25,5	025A	100	Al. Plate	
177	Freezing Fog,-33,2	019A	100	Al. Plate	
178	Freezing Fog,-33,2	019A	100	Al. Plate	
179	Freezing Fog,-33,5	019A	100	Al. Plate	
180	Freezing Fog,-33,5	019A	100	Al. Plate	
181	Light Freezing Rain,-3,13	014A	100	Al. Plate	
182	Light Freezing Rain,-3,13	014A	100	Al. Plate	
183	Light Freezing Rain,-3,13	015A	75	Al. Plate	
184	Light Freezing Rain,-3,13	015A	75	Al. Plate	
185	Light Freezing Rain,-3,13	016A	50	Al. Plate	
186	Light Freezing Rain,-3,13	016A	50	Al. Plate	
187	Light Freezing Rain,-3,13	011A	100	Al. Plate	
188	Light Freezing Rain,-3,13	011A	100	Al. Plate	
189	Light Freezing Rain,-3,13	012A	75	Al. Plate	
190	Light Freezing Rain,-3,13	012A	75	Al. Plate	
191	Light Freezing Rain,-3,13	013A	50	Al. Plate	
192	Light Freezing Rain,-3,13	013A	50	Al. Plate	
193	Light Freezing Rain,-3,13	017A	100	Al. Plate	
194	Light Freezing Rain,-3,13	017A	100	Al. Plate	
195	Light Freezing Rain,-3,13	020A	100	Al. Plate	
196	Light Freezing Rain,-3,13	020A	100	Al. Plate	
197	Light Freezing Rain,-3,13	025A	100	Al. Plate	
198	Light Freezing Rain,-3,13	025A	100	Al. Plate	
199	Light Freezing Rain,-3,25	014A	100	Al. Plate	
200	Light Freezing Rain,-3,25	014A	100	Al. Plate	
201	Light Freezing Rain,-3,25	015A	75	Al. Plate	
202	Light Freezing Rain,-3,25	015A	75	Al. Plate	
203	Light Freezing Rain,-3,25	016A	50	Al. Plate	
204	Light Freezing Rain,-3,25	016A	50	Al. Plate	
205	Light Freezing Rain,-3,25	011A	100	Al. Plate	
206	Light Freezing Rain,-3,25	011A	100	Al. Plate	
207	Light Freezing Rain,-3,25	012A	75	Al. Plate	
208	Light Freezing Rain,-3,25	012A	75	Al. Plate	
209	Light Freezing Rain,-3,25	013A	50	Al. Plate	

Table 1: New Fluid Endurance Times Test Plan (cont'd)

Test #	Condition Name	Fluid Code	Fluid Dilution (%)	Test Surface	Comments
210	Light Freezing Rain,-3,25	013A	50	Al. Plate	
211	Light Freezing Rain,-3,25	017A	100	Al. Plate	
212	Light Freezing Rain,-3,25	017A	100	Al. Plate	
213	Light Freezing Rain,-3,25	020A	100	Al. Plate	
214	Light Freezing Rain,-3,25	020A	100	Al. Plate	
215	Light Freezing Rain,-3,25	025A	100	Al. Plate	
216	Light Freezing Rain,-3,25	025A	100	Al. Plate	
217	Light Freezing Rain,-10,13	014A	100	Al. Plate	
218	Light Freezing Rain,-10,13	014A	100	Al. Plate	
219	Light Freezing Rain,-10,13	015A	75	Al. Plate	
220	Light Freezing Rain,-10,13	015A	75	Al. Plate	
221	Light Freezing Rain,-10,13	011A	100	Al. Plate	
222	Light Freezing Rain,-10,13	011A	100	Al. Plate	
223	Light Freezing Rain,-10,13	012A	75	Al. Plate	
224	Light Freezing Rain,-10,13	012A	75	Al. Plate	
225	Light Freezing Rain,-10,13	017A	100	Al. Plate	
226	Light Freezing Rain,-10,13	017A	100	Al. Plate	
227	Light Freezing Rain,-10,13	020A	100	Al. Plate	
228	Light Freezing Rain,-10,13	020A	100	Al. Plate	
229	Light Freezing Rain,-10,13	025A	100	Al. Plate	
230	Light Freezing Rain,-10,13	025A	100	Al. Plate	
231	Light Freezing Rain,-10,25	014A	100	Al. Plate	
232	Light Freezing Rain,-10,25	014A	100	Al. Plate	
233	Light Freezing Rain,-10,25	015A	75	Al. Plate	
234	Light Freezing Rain,-10,25	015A	75	Al. Plate	
235	Light Freezing Rain,-10,25	011A	100	Al. Plate	
236	Light Freezing Rain,-10,25	011A	100	Al. Plate	
237	Light Freezing Rain,-10,25	012A	75	Al. Plate	
238	Light Freezing Rain,-10,25	012A	75	Al. Plate	
239	Light Freezing Rain,-10,25	017A	100	Al. Plate	
240	Light Freezing Rain,-10,25	017A	100	Al. Plate	
241	Light Freezing Rain,-10,25	020A	100	Al. Plate	
242	Light Freezing Rain,-10,25	020A	100	Al. Plate	
243	Light Freezing Rain,-10,25	025A	100	Al. Plate	
244	Light Freezing Rain,-10,25	025A	100	Al. Plate	

Table 2: New Fluid Thickness Test Plan

Test #	Ambient Air Temp	Fluid Code	Fluid Dilution	Test Surface	Fluid Temp
TH1	-3°C	014A	100/0	Al. Plate	-3°C
TH2	-3°C	014A	100/0	Al. Plate	-3°C
TH3	-3°C	015A	75/25	Al. Plate	-3°C
TH4	-3°C	015A	75/25	Al. Plate	-3°C
TH5	-3°C	016A	50/50	Al. Plate	-3°C
TH6	-3°C	016A	50/50	Al. Plate	-3°C
TH7	-3°C	011A	100/0	Al. Plate	-3°C
TH8	-3°C	011A	100/0	Al. Plate	-3°C
TH9	-3°C	012A	75/25	Al. Plate	-3°C
TH10	-3°C	012A	75/25	Al. Plate	-3°C
TH11	-3°C	013A	50/50	Al. Plate	-3°C
TH12	-3°C	013A	50/50	Al. Plate	-3°C
TH13	-3°C	017A	100/0	Al. Plate	-3°C
TH14	-3°C	017A	100/0	Al. Plate	-3°C
TH15	-3°C	020A	100/0	Al. Plate	-3°C
TH16	-3°C	020A	100/0	Al. Plate	-3°C
TH17	-3°C	025A	100/0	Al. Plate	-3°C
TH18	-3°C	025A	100/0	Al. Plate	-3°C

Notes:

- The quantity of fluid that will be poured for each test is 1.0 L on a full plate or 0.5L on a half plate.
- Measurements should be made at the 15-cm line at the time of fluid application, and after 5 minutes, 15 minutes, and 30 minutes.
- If the results for one fluid vary by more than 10 percent, repeat the two tests and disregard the highest and lowest values.

Table 3: Personnel Requirements / Responsibilities

PERSONNEL ASSIGNMENTS	MAIN STAND	SMALL END CHAMBER
	ET	HOT Thickness
Manager	JD/CB	CB/JD
Assistant	YOW2	YOW2
Data Form Manager	CB	CB
Rate Station Manager	BB	n/a
Rate Station Assistant	YOW1	n/a

OTHER TASKS	PERSONNEL ASSIGNMENTS
Pre-Test Setup	JD
Equipment Manager	JD
Fluid Management	JD/CB
Data Logging	CB
Box Prep (in CSW)	YOW3
Fluid Collection + Filling	YOW1/YOW2
Relief Rate Station Manager	CB/SB

Table 4: List of Fluids

Fluid Code	Viscosity Type	Batch #	Fluid Temp	Fluid Dilution	Litres Required per Project		Total Litres Required	Total Litres Required +50% extra	Pour Bottles	Large Containers	Notes
					ET	TH-HOT					
Type II, III, IV (HOT)											
014A	LOWV	112118MH	OAT	100/0	32	2	**34**	**51**	**8**	2 x 20 litre jugs	
015A	LOWV	112118MH	OAT	75/25	28	2	**30**	**45**	**8**	2 x 20 litre jugs	
016A	LOWV	112118MH	OAT	50/50	12	2	**14**	**21**	**8**	1 x 20 litre jug	
011A	LOWV	1440	OAT	100/0	32	2	**34**	**51**	**8**	2 x 20 litre jugs	
012A	LOWV	1440	OAT	75/25	28	2	**30**	**45**	**8**	2 x 20 litre jugs	
013A	LOWV	1440	OAT	50/50	12	2	**14**	**21**	**8**	1 x 20 litre jug	
017A	LOWV	IV 3131801	OAT	100/0	32	2	**34**	**51**	**8**	2 x 20 litre jugs	
020A	LOWV	120718	OAT	100/0	32	2	**34**	**51**	**8**	2 x 20 litre jugs	
025A	LOWV	45S010219L	OAT	100/0	32	2	**34**	**51**	**8**	2 x 20 litre jugs	May not have enough fluid.
019A	LOWV	45SN051218L	OAT	100/0	4	0	**4**	**6**	**6**	1 x 5 litre jug	Ensure enough fluid for AS testing.
			All Fluids		**244**	**18**	**262**	**393**	**78**		

Table 5: Equipment List

HOT AND GENERAL EQUIPMENT	
LOCATION: TEST SITE	
Barrel Opener to open CSW fluids	Pour containers (1-litre) - see list of fluids
Bins for mixing CSW fluid x 5 (60L rubbermaids)	Power bars x 4
Blender for shearing (if required)	Printer & Ink Cartridge
Brixometer x 3	Rain Suits (all)
Camera x 1 (small Canon) with accessories	Rate Pan (aluminum HOT) x 1
Cart (IKEA) x 2	Rate Pans (white plastic) x all
Clipboards x 5	Sample bottles x 6
Clock (Large digital) x 2	Scrapers x 14
Cold-soak boxes (aluminum) x 16	Shop Vac + 2x18L open top pails
Duct Tape x 1	SmartButton kits x 2 + extension wire
Empty 20L fluid cont. x 5 (for -30°C CSW fluid)	Speed tape x 1 and electrical tape x 5
Extension Cords x 4	Squeegees x 4 (small)
Flashlights x 2	Tape measure (large yellow + small)
Fluids (separate table)	Temperature probes: immersion x 3
Fluid Carrying Cases x 4	Temperature probes: surface x 3
Folding table x 1 (small)	Test plate covers (white plastic) x 15
Freezers (portable) x 2	Test plate covers (wooden boards) x 12
Fridge for food at NRC	Test Plates - Half plates x 11 (22 halves) w/buttons
Funnels x 4 (big and small)	Test Plates (Aluminum): 12 w/buttons + 6 w/out
Gloves - black and yellow x 4	Test Stand Collection Pans (one per stand)
Gloves - cotton (1 large box)	Test Stand Shims (poker chips) x 1 box
Gloves - latex (2 boxes)	Test Stands: 1 x 6 position (small end)
Ice Pic	Test Stands: 2 x 6 position (main stand)
Inclinometer (yellow level) x 2	Test Stands: 3 position (side stand) (2+1)
Isopropyl x 5	Thickness Gauges (4 x small 4 x large)
Lock for truck	Tuques x10
Marker for Waste x 2	Type I fluid for CSW (1 jug to top off what's at NRC)
Measuring Cups x 3	Vise grip (large) + rubber opener
Paper Towels (4 packs)	Weigh Scale x 2 (sartorius) + wiring
Personnel clothing + SB box	White poster board panels for water run-off
Pour containers (1-litre) - 6 empty	
LOCATION: OFFICE	
File box x 2	Laptop for SmartButton (MR)
Blank Waterproof labels (1 page)	Laptop x 5 (CB, SB, JD, BB, Rate Station)
Coffee x 140 (K-Cups)	Mouse for Rate Station and keypad
Condition Sheets x 6	Paper for printer (1 pack)
Data Forms (on water phobic paper)	Pencils (sharpened) + pens + markers
Envelopes (9 x 12) x box	Test Procedures x 2 (1 sided)
Falling Ball Viscometer + Syringes	Walkie Talkies and Accessories x 4
Hard Drive (if necessary)	Waterproof paper (40 sheets)
iPads x 2	

Table 5: Equipment List (cont'd)

HOT AND GENERAL EQUIPMENT	
LOCATION: NRC	
Cold-soak box filling stand	Rubber Mats
Cold-soak fluid pump	Shelving unit x 1 (black one)
Copper tubing insulation (for passing wires)	Tie wraps
Fluid for cold-soak boxes (barrel)	Tools
NRC Auto Rate Form with Historical #'s	Tote for Waste Fluid

Note: Pack coolers with first day fluids and plug into power overnight.

Figure 3: NRC Rate Management Form

DATE: _____

CONDITION: _____ TECHNICIAN: _____

PAN #	TAB	TIME OUT	1st or 2nd Rate	PAN #	TAB	TIME OUT	1st or 2nd Rate

Figure 4: Freezing Precipitation Endurance Time Data Form

REMEMBER TO SYNCHRONIZE TIME

LOCATION: PRECIP. CONDITION: DATE: RUN NUMBER: STAND # :

Time of Fluid Application: _____

Time of Fluid Failure: _____

Fluid Name/Dilution: _____

PLATE 1 | PLATE 2 | PLATE 3 | PLATE 4 | PLATE 5 | PLATE 6

Failure Call: (describe) _____

Time of Fluid Application: _____

Time of Fluid Failure: _____

Fluid Name/Dilution: _____

PLATE 7 | PLATE 8 | PLATE 9 | PLATE 10 | PLATE 11 | PLATE 12

Failure Call: (describe) _____

AMBIENT TEMPERATURE: _____ °C LEADER / MANAGER: _____ FAILURES CALLED BY: _____

COMMENTS: _____

NOTE:
Please ensure correct functioning of plate temperature logging system at the start of the test and at the end of the session.

Figure 5: Fluid Thickness Data Form

DATE: _____ TEMPERATURE °C (beg.): _____ PERFORMED BY: _____

TEST #: _____to_____ WIND SPEED, kph (beg.): _____ WRITTEN BY: _____

STAND: _____ LOCATION: CEF (NRC)

THICKNESS (mil)											
Plate: U Run #: Fluid: Application Time:		Plate: V Run #: Fluid: Application Time:		Plate: W Run #: Fluid: Application Time:		Plate: X Run #: Fluid: Application Time:		Plate: Y Run #: Fluid: Application Time:		Plate: Z Run #: Fluid: Application Time:	
TIME	6" LINE	TIME	6" LINE	TIME	6" LINE	TIME	6" LINE	TIME	6" LINE	TIME	6" LINE

I:\Groups\Cm1680 (01-02)\Procedures\Thickness\Thickness Form

Notes:

- The quantity of fluid that will be poured for each test is 1.0 L
- Measurements should be made at the 15-cm line at the time of fluid application, and after 5, 15 and 30 minutes
- If the results for one fluid vary by more than 10% repeat the two tests and disregard the highest and lowest values

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OVERALL PROGRAM OF TESTS AT PMG, APRIL 2019

300293

OVERALL PROGRAM OF TESTS AT PMG, APRIL 2019

Winter 2018-19

Prepared for

Transport Canada
Innovation Centre

Prepared by: David Youssef

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March 28, 2019
Final Version 1.0

OVERALL PROGRAM OF TESTS AT PMG, APRIL 2019

Winter 2018-19

1. INTRODUCTION AND OBJECTIVE

The objective of this project is to collect data with the current holdover time fluids at very cold temperatures of -18°C and -25°C. Additional tests will be carried out with specific fluids at their respective Lowest Operational Use Temperature (LOUT).

Testing will occur in a climate-controlled chamber at PMG Technologies Inc. (PMG) in Blainville, Quebec. This chamber is capable of reaching temperatures as low as -50°C.

A test schedule is provided in Table 1.

A second snow machine that was purchased by Transport Canada in 2018 has been constructed by the National Center for Atmospheric Research (NCAR) and will arrive on approximately Day 3 of testing. Full use of this new machine will require completion of the following activities:

1) Setup new machine and ensure all systems are functioning correctly;
2) Familiarize new personnel on the snow machine operation and testing; and
3) Run a series of ad hoc tests to compare the performance of the new snow machine with that of the old one. No official test plan is provided for this, however, between 2-3 tests per day will be run.

Table 2 provides a schedule for testing with the new snow machine.

2. PROCEDURE

Endurance time tests will be conducted using the test protocols outlined in the procedure *Endurance Time Testing in Simulated Snow with SAE Type I, II, III, and IV De/Anti-icing Fluids* (1).

The test plan is provided in Table 3. A total of 52 tests are planned. Priorities are provided for each test.

It is expected that testing will occur in the period from April 1, 2019 to April 26, 2019; 15 long test days (from 6 am to 6 pm) are planned based on the budgeting.

It has been estimated that a total of five tests (in some cases four tests) per day is feasible.

3. PERSONNEL REQUIREMENTS/RESPONSIBILITIES

Due to the complexity of operating one snow machine, at least two and possibly three employees will be required:

- Senior Employee #1 – operation of snow machine;
- Junior Employee #1 – support for testing; and
- Junior Employee #2 – operation of second snow machine.

4. FLUIDS

Table 4 provides a list of fluids that will be tested.

5. PRE-TESTING SETUP ACTIVITIES

The following activities need to be completed prior to testing at PMG:

1. Finalize list of participants for PMG;
2. Finalize contract with PMG;
3. Finalize and arrange shipping of NCAR-owned snow machine;
4. Contact and arrange shipping of snow machine;
5. Finalize test plan;
6. Verify fluid list;
7. Test backup scale;
8. Develop Excel file for daily communication of results;
9. Develop personnel plan;
10. Develop drop-off equipment day plan (setting up freezer, water, ice core tubes etc.);
11. Dismantle snow machine and pack; and
12. Assembly of snow machine at PMG.

5.1 Packing Day

The packing day is scheduled for Thursday, March 28, 2019. The following activities will take place on this day:

- Dismantling and packing of snow machine;
- Preparation of all fluids;
- Packing of all supporting equipment and fluids; and
- Ensuring PMG places freezer next to chamber.

5.2 Setup Day

The setup day is scheduled for Friday, March 29, 2019. The following activities will take place on this day:

- Rental of moving truck;
- Packing of all equipment into rental truck;
- Moving all equipment to PMG; and
- Preparation of ice cores set to freeze.

6. EQUIPMENT

Table 5 includes a list of the required equipment for this testing.

7. SAFETY

Employees will adhere to both APS-specific and PMG-specific safety requirements when working in and around PMG facilities. Special attention will be given to working in a cold environment, and employees should be mindful of dangers associated with hypothermia and frost bite.

Managers of each subproject must ensure that personnel involved in the setup and conduct of their respective projects are aware of the following:

1. Fluid SDS sheets are available for review;
2. Waterproof clothing and gloves are available;
3. Fluid(s) should only be handled with protective gloves. If any fluid gets onto the skin, wash the effected part thoroughly;
4. Care should be taken when circulating near the test area due to slipperiness;
5. First aid kid, water and fire extinguishers are available; and
6. All PMG safety guidelines must be followed.

8. DATA FORM

The data form required for this project is included in Figure 1.

9. REFERENCES

1. *Endurance Time Testing in Simulated Snow Test with SAE Type I, II, III, and IV De/Anti-icing Fluids*, November, 2018.

Table 1: Test Schedule

March 2019

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Mar 24	Mar 25	Mar 26	Mar 27	Mar 28 Packing Day	Mar 29 Move to PMG	Mar 30

April 2019

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Mar 31	Apr 1 -25°C • Calibration at -25C • 2 Tests Tests 2/26	Apr 2 -25°C • 5 Tests Tests 7/26	Apr 3 -25°C • 5 Tests Tests 12/26	Apr 4 -25°C • 5 Tests Tests 17/26	Apr 5 -25°C • 5 Tests Tests 22/26	Apr 6
Apr 7	Apr 8 -25°C • 4 Tests Tests 26/26	Apr 9 -25°C / -33°C • Calibration at -33C • 2 Tests Tests 2/6	Apr 10 -33°C • 4 Tests Tests 6/6	Apr 11 -18°C • Calibration • 2 Tests Tests 2/20	Apr 12 -18°C • 2 Tests Tests 4/20 PMG Closed for Afternoon	Apr 13
Apr 14	Apr 15 -18°C • Calibration • 2 Tests Tests 8/20	Apr 16 -18°C • 4 Tests Tests 12/20	Apr 17 -18°C • 4 Tests Tests 16/20	Apr 18 -18°C • 5 Tests Tests 20/20	Apr 19 Good Friday PMG Closed	Apr 20
Apr 21	Apr 22 TBD • Spare Day	Apr 23 TBD • Spare Day	Apr 24 TBD • Spare Day	Apr 25 TBD • Spare Day	Apr 26 TBD • Spare Morning Pack up Start at 2:00 pm	Apr 27
Apr 28	Apr 29	Apr 30	May 1	May 2	May 3	May 4

Table 2: Test Schedule – Second Snow Machine

Monday	Tuesday	Wednesday	Thursday	Friday
Apr 1 No Activity	Apr 2 No Activity	Apr 3 No Activity	Apr 4 PK – 7.5 Hrs. • Receive 2nd machine • Uncrate and Setup	Apr 5 PK – 7.5 Hrs. • Finish machine setup • Run with older Fluid to check systems
Apr 8 PK – 10 Hrs. • Calibrate distribution • Run 1 simultaneous comparative test	Apr 9 PK – 10 Hrs. • Run 2-3 simultaneous comparative tests • Communicate results for approval to proceed	Apr 10 PK – 10 Hrs. • If approval, Run 2-3 simultaneous comparative tests	Apr 11 PK – 7.5 Hrs. • Run 2-3 simultaneous comparative tests	Apr 12 No Activity
Apr 15 PK – 10 Hrs. • Run 2-3 simultaneous comparative tests	Apr 16 PK – 10 Hrs. • Run 2-3 simultaneous comparative tests	Apr 17 PK – 10 Hrs. • Run 2-3 simultaneous comparative tests	Apr 18 PK – 7.5 Hrs. • Run 2-3 simultaneous comparative tests	Apr 19 No Activity
Apr 22 PK – 10 Hrs. • Run 2-3 simultaneous comparative tests	Apr 23	Apr 24	Apr 25	Apr 26
Apr 29	Apr 30	May 1	May 2	May 3

Table 3: Test Plan

Test No.	Objective	Fluid Code	Fluid Dilution	Fluid Type	Plate Set Temp (°C)	Precip Rate (g/dm²/h)	Ambient Temp (°C)
AS1	HOT	025A	100	IV	-18.7	3	-18
AS2	HOT	025A	100	IV	-18.8	4	-18
AS3	HOT	025A	100	IV	-19.2	10	-18
AS4	HOT	025A	100	IV	-20.1	25	-18
AS5	HOT	025A	100	IV	-25.7	3	-25
AS6	HOT	025A	100	IV	-25.8	4	-25
AS7	HOT	025A	100	IV	-26.2	10	-25
AS8	HOT	025A	100	IV	-27.1	25	-25
AS9	HOT	014A	100	II	-18.7	3	-18
AS10	HOT	014A	100	II	-18.8	4	-18
AS11	HOT	014A	100	II	-19.2	10	-18
AS12	HOT	014A	100	II	-20.1	25	-18
AS13	HOT	014A	100	II	-25.7	3	-25
AS14	HOT	014A	100	II	-25.8	4	-25
AS15	HOT	014A	100	II	-26.2	10	-25
AS16	HOT	014A	100	II	-27.1	25	-25
AS17	HOT	011A	100	IV	-18.7	3	-18
AS18	HOT	011A	100	IV	-18.8	4	-18
AS19	HOT	011A	100	IV	-19.2	10	-18
AS20	HOT	011A	100	IV	-20.1	25	-18
AS21	HOT	011A	100	IV	-25.7	3	-25
AS22	HOT	011A	100	IV	-25.8	4	-25
AS23	HOT	011A	100	IV	-26.2	10	-25
AS24	HOT	011A	100	IV	-27.1	25	-25

Table 3: Test Plan (cont'd)

Test No.	Objective	Fluid Code	Fluid Dilution	Fluid Type	Plate Set Temp (°C)	Precip Rate (g/dm²/h)	Ambient Temp (°C)
AS25	HOT	017A	100	IV	-18.7	3	-18
AS26	HOT	017A	100	IV	-18.8	4	-18
AS27	HOT	017A	100	IV	-19.2	10	-18
AS28	HOT	017A	100	IV	-20.1	25	-18
AS29	HOT	017A	100	IV	-25.7	3	-25
AS30	HOT	017A	100	IV	-25.8	4	-25
AS31	HOT	017A	100	IV	-26.2	10	-25
AS32	HOT	017A	100	IV	-27.1	25	-25
AS33	HOT	020A	100	IV	-18.7	3	-18
AS34	HOT	020A	100	IV	-18.8	4	-18
AS35	HOT	020A	100	IV	-19.2	10	-18
AS36	HOT	020A	100	IV	-20.1	25	-18
AS37	HOT	020A	100	IV	-25.7	3	-25
AS38	HOT	020A	100	IV	-25.8	4	-25
AS39	HOT	020A	100	IV	-26.2	10	-25
AS40	HOT	020A	100	IV	-27.1	25	-25
AS41	LOUT of -33°C[1]	019A	100	IV	-25.8	4	-25
AS42	LOUT of -33°C[1]	019A	100	IV	-25.8	4	-25
AS43	LOUT of -33°C[1]	019A	100	IV	-26.2	10	-25
AS44	LOUT of -33°C[1]	019A	100	IV	-26.2	10	-25
AS45	LOUT of -33°C[1]	019A	100	IV	-27.1	25	-25
AS46	LOUT of -33°C[1]	019A	100	IV	-27.1	25	-25
AS47	LOUT of -33°C[1]	019A	100	IV	-34	4	-33
AS48	LOUT of -33°C[1]	019A	100	IV	-34	4	-33

Table 3: Test Plan (cont'd)

Test No.	Objective	Fluid Code	Fluid Dilution	Fluid Type	Plate Set Temp (°C)	Precip Rate (g/dm²/h)	Ambient Temp (°C)
AS49	LOUT of -33°C(1)	019A	100	IV	-34	10	-33
AS50	LOUT of -33°C(1)	019A	100	IV	-34	10	-33
AS51	LOUT of -33°C(1)	019A	100	IV	-35	25	-33
AS52	LOUT of -33°C(1)	019A	100	IV	-35	25	-33

1) When conducting duplicate testing the following acceptance criteria must be respected:

Test 1 and 2 are accepted if the difference from either endurance time to the average endurance time divided by the average endurance time is within 10%. Otherwise a third test must be run. This third test is accepted if the difference from the test 3 endurance time to the average endurance time of tests 1 and 2 divided by the average endurance time of tests 1 and 2 is ±5%. Otherwise a fourth test must be run.

Table 4: List of Fluids

Fluid	Viscosity Type	Fluid Temp	Fluid Dilution	Litres Required for Planned Tests	Litres Required (including Spare + 2nd snow machine)	Pour Bottles	Extra Fluid in Large Containers	Notes
Type II, III, IV (HOT)								
025A	LOWV	OAT	100	8	15	8	1 x 20 litre jug	
014A	LOWV	OAT	100	8	12	8	1 x 20 litre jug	
011A	LOWV	OAT	100	8	12	8	1 x 20 litre jug	
017A	LOWV	OAT	100	8	12	8	1 x 20 litre jug	
020A	LOWV	OAT	100	8	12	8	1 x 20 litre jug	
019A	LOWV	OAT	100	12	18	12	1 x 20 litre jug	Limited Quantities Available
			All Fluids	**52**	**81**	**52**		

Table 5: Equipment List

EQUIPMENT	LOCATION	STATUS
Snow machine and related equipment	Site	
NCAR computer, monitor and control box	Site	
Mettler Toledo weigh scale x 2	Site	
Heat gun	Site	
Small important Allen keys	Site	
Ice Core Production freezer	PMG	
All large ice core molds, 2-3 short ice core molds	Site	
Styrofoam covers for ice core molds	Site	
PVC pipe for temporary storage of ice cores	Site	
Clean bucket and clean funnel for ice core filling	Site	
Large Quantity of Distilled Water	Site	
Sartorius 2g scale with cabling for comm with laptop	Site	
Aluminum plates with heating pads	Site	
Insulated box for heated tests	Site	
Snow distribution pans 100mm X 150mm (6 pans)	Site	
Extra wizz pads	Site	
Additional PVC wizz pad apparatus	Site	
Backup drill bit	Site	
Extra coupler and GTCA coupler	Site	
2 additional small folding tables	Site	
Rate Distribution Black Felt	Site	
Electronic NCAR files	Site	
Squeegee/scraper	Site	
Extension cord	Site	
Wet vacuum	Site	
Blue towel	Site	
Waste container	Site	
Measuring cup	Site	
Thermos x 1 and spreader x 1	Site	
Small box to transport small Allen keys and other equip	Site	
NCAR tool box	Site	
Rate distribution excel file	Office	
Data forms	Office	
Procedures	Office	

OVERALL PROGRAM OF TESTS AT PMG, APRIL 2019

Date: _____ Location: _____ Project: _____ Test Plan #: _____

Fluid: _____ Dilution: _____ Fluid Type: _____ Batch #: _____

SNOW MACHINE

First Generation APS: _____ (✓)

Second Generation APS: _____ (✓)

NCAR Machine _____ (✓)

TEMPERATURES

Condition Temp.: _____ °C

Fluid Temp.: _____ °C

Fluid Quantity Applied: _____ litres

Plate Temp. Set point: _____ litres

PRECIPITATION RATE

Test Plan Precip. Rate: _____ g/dm^2/h

Adjusted Precip. Rate: _____ g/dm^2/h

TEST DATA

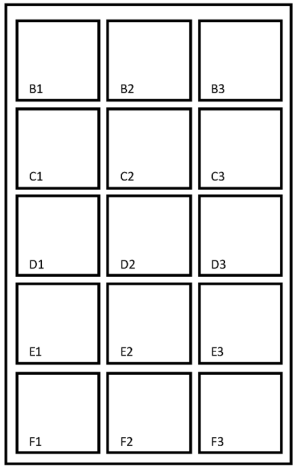
Output File Name: _____.txt

Time of Fluid Application: _____ hh:mm:ss

Time of Fluid Failure: _____ hh:mm:ss

Calculated Failure In Minutes: _____ minutes

Last Average Rate: _____ g/dm^2/h



Refractive Index Measurements
(Standard 15cm line)

Position C2: _____ °Brix *Additional brix measurements should be indicated directly on diagram in respective locations.*

Comments: _____

Figure 1: Simulated Snow Endurance Time Data Form

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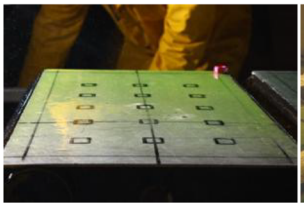
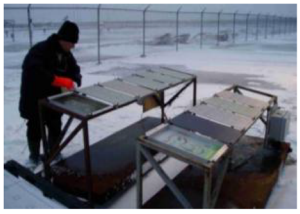
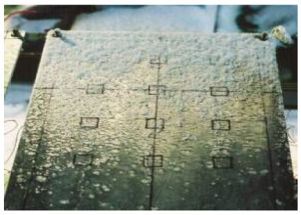
APPENDIX C

METHODOLOGY FOR ENDURANCE TIME TESTING OF TYPE II, III, AND IV FLUIDS WINTER 2018-19

METHODOLOGY FOR ENDURANCE TIME TESTING OF TYPE II, III, AND IV FLUIDS

Winter 2018-19



Prepared by

APS Aviation Inc.

These tests were made possible with the guidance, participation, and contribution of Transport Canada and the Federal Aviation Administration.

July 2019
Version 1.0
Report No. M-2018-19

METHODOLOGY FOR ENDURANCE TIME TESTING OF TYPE II, III, AND IV FLUIDS

Winter 2018-19

Prepared by:

Benjamin Bernier, B.Sc.
Junior Project Leader

July 5, 2019
Date

Reviewed by:

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Director, Aviation Services

July 5, 2019
Date

These tests were made possible with the guidance, participation, and contribution of Transport Canada and the Federal Aviation Administration.

July 2019
Version 1.0
Report No. M-2018-19

SUMMARY

This report documents the key aspects of the testing and analysis methodologies employed by APS Aviation Inc. (APS) to carry out endurance time testing with Type II, III, and IV fluids in the winter of 2018-19.

The testing and analysis methodologies used are based on the protocols provided in Aerospace Recommended Practice (ARP) 5485. This report includes detailed information on:

- Test Sites;
- Test Equipment;
- Test Procedures;
- Test Conditions (precipitation rate limits, ambient temperatures, freezing precipitation droplet sizes); and
- Analysis Methodologies.

This report is intended to be used as a companion document to the reports written to document the individual performance of each Type II, III, and IV fluid tested in the winter of 2018-19. The data, analysis, and results provided in those reports are a function of the test and analysis methodologies described in this report and therefore should be used in conjunction with the information contained herein.

TABLE OF CONTENTS

1. INTRODUCTION 1

2. TEST SITES 2

2.1 Natural Snow, Natural Frost and Artificial Snow 2
2.2 Freezing Precipitation 3

3. TEST EQUIPMENT 6

3.1 Calibration 6
3.2 Environmental Chamber Equipment 6
3.3 Test Surface Structures 6
3.3.1 Flat Plates 6
3.3.2 Cold-Soak Boxes 6
3.3.3 Frosticator Plates 8
3.3.4 Artificial Snow Machine Test Plate 8
3.4 Test Surface Materials 8
3.5 Test Stands 8
3.6 Collection Pans 8
3.7 NRC Sprayer Assembly 10
3.8 Fluids 10

4. TEST PROCEDURES 15

4.1 Test Procedure – Natural Snow Tests 15
4.2 Test Procedure – Natural Frost Tests 15
4.3 Test Procedure – Artificial Snow Tests 15
4.4 Test Procedure – Simulated Precipitation Tests 16
4.5 End Condition Definitions 16
4.6 Precipitation Rate Measurement Procedures 16
4.6.1 Simulated Precipitation Conditions 16
4.6.2 Natural Precipitation Conditions 17

5. TEST CONDITIONS 20

5.1 Precipitation Rate Limits 20
5.1.1 Freezing Fog 21
5.1.2 Freezing Drizzle 22
5.1.3 Light Freezing Rain 22
5.1.4 Rain on a Cold-Soaked Surface 22
5.1.5 Snow 22
5.2 Ambient Temperatures in Type II/III/IV Endurance Time Testing 22
5.3 Freezing Precipitation Droplet Sizes 23
5.4 Summary of Freezing Precipitation Test Conditions 24

6. ANALYSIS METHODOLOGIES 26

6.1 Freezing Precipitation Data 26
6.2 Natural Snow Data 26
6.3 Natural Frost Data 27
6.4 Artificial Snow Data 28
6.5 Rounding and Capping Protocols 28
6.5.1 Rounding Protocols 28
6.5.2 Capping Protocols 28

6.6 Regression Example 29
6.7 Lowest and Highest Usable Precipitation Rates in Snow 30
6.7.1 Temperatures of -14°C and Above 30
6.7.2 Temperatures Below -14°C 31

LIST OF FIGURES, TABLES AND PHOTOS

Figures

Figure 2.1: APS Test Site at Montréal-Pierre-Elliott-Trudeau International Airport 2
Figure 3.1: Standard Test Plate Schematic 7
Figure 3.2: Cold-Soaked Box Schematic 7
Figure 3.3: Test Stand Setup Schematic 9
Figure 3.4: Schematic of Outdoor Precipitation Measurement Pan 9
Figure 4.1: Calculation of Outdoor Precipitation Rate 19
Figure 5.1: Precipitation Rate Limits Used in Endurance Time Testing 21
Figure 6.1: Regression Method on Log-Log Chart – Type IV Neat, Freezing Rain 29
Figure 6.2: Regression Method on Standard Chart – Type IV Neat, Freezing Rain 30

Tables

Table 5.1: Definition of Weather Phenomenon 20
Table 5.2: Theoretical and Experimental MVDs 25
Table 5.3: Summary of Freezing Precipitation Test Conditions 25
Table 6.1: Factors Used in LUPR/HUPR Calculations 32
Table 6.2: LUPR/HUPR Factor Ratings 33

Photos

Photo 2.1: APS Test Site - View from Test Pad 4
Photo 2.2: APS Test Site - View from Trailer 4
Photo 2.3: Outdoor View of NRC Climatic Engineering Facility 5
Photo 2.4: Inside View of NRC Climatic Engineering Facility 5
Photo 3.1: Test Plates Mounted on Stand 11
Photo 3.2: Cold-Soak / Leading Edge Thermal Equivalent Box 11
Photo 3.3: Frost Plate with Insulated Backing 12
Photo 3.4: Standard Plate Setup for Testing with Artificial Snow Machine 12
Photo 3.5: Collection Pans Used Indoors at the NRC 13
Photo 3.6: Sprayer Assembly 13
Photo 3.7: Sprayer Assembly in Use 14
Photo 3.8: Sprayer Nozzle 14

GLOSSARY

APS	APS Aviation Inc.
ARP	Aerospace Recommended Practice
CEF	Climatic Engineering Facility
FAA	Federal Aviation Administration
HOT	Holdover Time
HUPR	Highest Usable Precipitation Rate
ISO	International Organization for Standardization
LOUT	Lowest Operational Use Temperature
LUPR	Lowest Usable Precipitation Rate
MVD	Median Volume Diameter
NRC	National Research Council Canada
TC	Transport Canada

1. INTRODUCTION

This report has been created with the support of the fluid manufacturers, Transport Canada (TC), and the Federal Aviation Administration (FAA).

Aircraft ground de/anti-icing has been the subject of concentrated industry attention in recent years due to the occurrence of several fatal icing-related aircraft accidents. Notably, attention has been placed on the enhancement of anti-icing fluids in order to provide an extended period of protection against further contamination following initial deicing. This emphasis has led to the development of fluid-specific de/anti-icing fluid holdover time (HOT) tables for Type II, Type III, and Type IV fluids. These tables, accepted by regulatory authorities, are used by aircraft operators for departure planning in adverse winter conditions. Specifically, they provide the duration of time that fluids provide protection against ice formation under specific weather conditions.

New anti-icing formulations continue to be developed by leading manufacturers with the specific objective of prolonging fluid holdover times without compromising the aerodynamic features of the airfoil. The purpose of the endurance time testing program is to measure the endurance times of these new fluids and develop fluid-specific HOT tables that provide guidance for their use.

Endurance time tests, conducted in natural and simulated precipitation, are used to develop HOT values for new fluids. These tests are carried out according to SAE Aerospace Recommended Practice (ARP) 5485, which provides the test protocols for measuring endurance times of Type II, III, and IV fluids.

This report documents the key aspects of the testing and analysis methodologies employed by APS Aviation Inc. (APS) to carry out endurance time testing with Type II, III, and IV fluids in the winter of 2018-19. It includes information on:

1) Chapter 2 – Test Sites;
2) Chapter 3 – Test Equipment;
3) Chapter 4 – Test Procedures;
4) Chapter 5 – Test Conditions (precipitation rate limits, ambient temperatures, freezing precipitation droplet sizes); and
5) Chapter 6 – Analysis Methodologies.

This report is intended to be used as a companion document to the reports on individual fluid performance. The data, analysis and results provided in those reports are a function of the test and analysis methodologies described in this report and therefore should be used in conjunction with the information contained herein.

2. TEST SITES

This section documents the test sites where APS conducted endurance time testing with Type II, III, and IV fluids during the winter of 2018-19.

2.1 Natural Snow, Natural Frost and Artificial Snow

Natural snow, natural frost, and artificial snow testing is typically and predominantly performed at the APS test site located at the Montréal Pierre-Elliott-Trudeau International Airport. The test site is located near Environment Canada's Meteorological Services of Canada automated weather observation station, as shown in Figure 2.1 on a plan view of the airport.

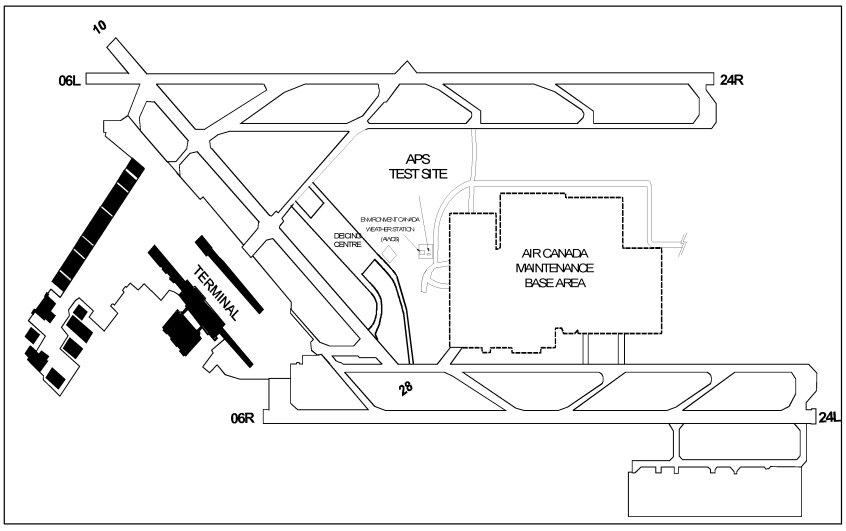


Figure 2.1: APS Test Site at Montréal-Pierre-Elliott-Trudeau International Airport

The APS test site consists of two trailers and three outdoor locations for test stands. One of the trailers is equipped with a refrigeration unit to enable indoor testing at controlled temperatures; artificial snow testing is typically conducted inside this trailer. In winter 2018-19, all artificial snow testing was conducted at PMG Technologies in Blainville, Quebec. This was primarily due to limitations on the achievable temperature of the refrigerated trailer at the APS test site. Photo 2.1 and Photo 2.2 show the test site as seen from the test pads and main trailer, respectively.

In winter 2018-19, additional natural snow testing was conducted using mobile test sites in Edmunston, New Brunswick; Alma, Quebec and Saint-Jérôme, Quebec. Additional natural frost testing was conducted using a mobile test site in Beaconsfield, Quebec.

2.2 Freezing Precipitation

Tests under conditions of freezing fog, rain on cold-soaked surface, freezing drizzle, and light freezing rain were conducted indoors at the National Research Council Canada (NRC) Climatic Engineering Facility (CEF), where precipitation was artificially produced.

Photo 2.3 provides an outdoor view of the facility giving a general indication of its size (30 m by 5.4 m, height 8 m). The facility was originally designed for the testing of locomotives; Photo 2.4 provides an interior view of the CEF set up for endurance time testing. The lowest temperature achievable in the CEF is -46°C.

Photo 2.1: APS Test Site - View from Test Pad



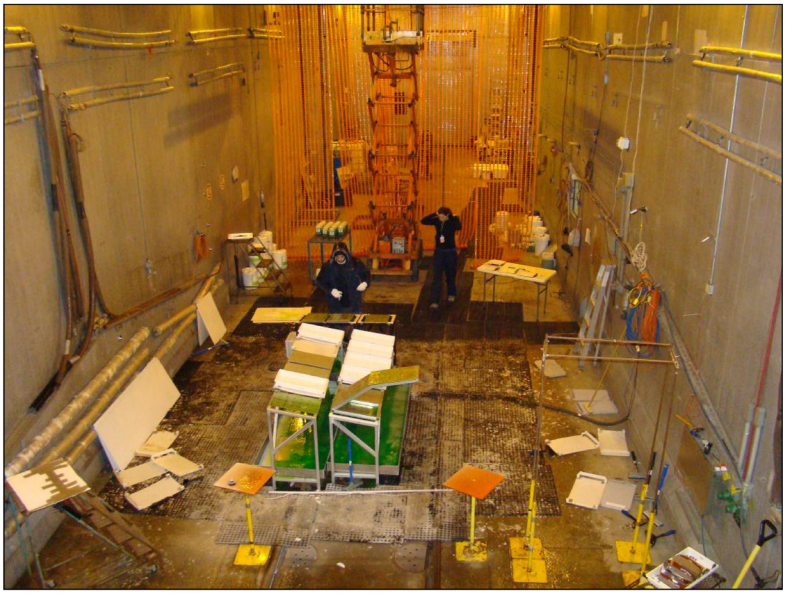
Photo 2.2: APS Test Site - View from Trailer



Photo 2.3: Outdoor View of NRC Climatic Engineering Facility



Photo 2.4: Inside View of NRC Climatic Engineering Facility



3. TEST EQUIPMENT

The key equipment used in endurance time testing is described in this section, as are the calibration procedures APS follows for ensuring the accuracy of its test equipment.

3.1 Calibration

APS measurement instruments and test equipment are calibrated and/or verified on an annual basis. This calibration is carried out according to a calibration plan based upon approved International Organization for Standardization (ISO) 9001:2008 standards, and developed internally by APS.

3.2 Environmental Chamber Equipment

The general environmental chamber equipment used during tests (including air temperature sensor, data acquisition system, temperature control equipment, etc.) was as stipulated in the requirements set out in ARP5485.

3.3 Test Surface Structures

3.3.1 Flat Plates

The majority of endurance time testing is carried out on standard flat plates. A schematic of a standard flat plate is provided in Figure 3.1. It depicts the size and surface markings of a standard flat plate. Three parallel lines are positioned at 2.5 cm (1″), 15 cm (6″), and 30 cm (12″) from the top of the plate. The plates are marked with 15 crosshairs, which are used in determining when end conditions (see Subsection 4.5) are achieved. Photo 3.1, taken outdoors at the APS test site, shows six test plates mounted on a test stand.

3.3.2 Cold-Soak Boxes

Figure 3.2 shows a schematic of the sealed boxes used for tests simulating a cold-soaked wing. The top of the box consists of a flat plate identical to the standard flat plate. An insulated box shaped reservoir is welded to the bottom of the plate. Photo 3.2 shows a picture of a sealed box, which is referred to as a cold-soaked box when filled for simulated rain on cold-soaked wing tests.

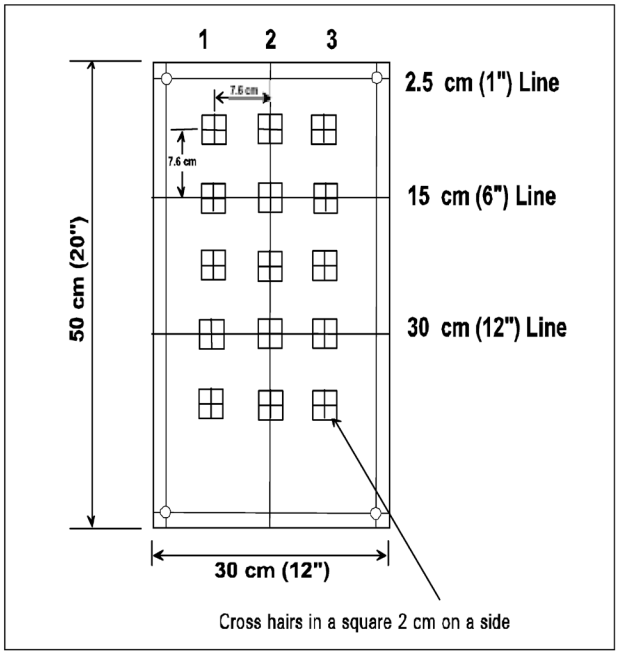


Figure 3.1: Standard Test Plate Schematic

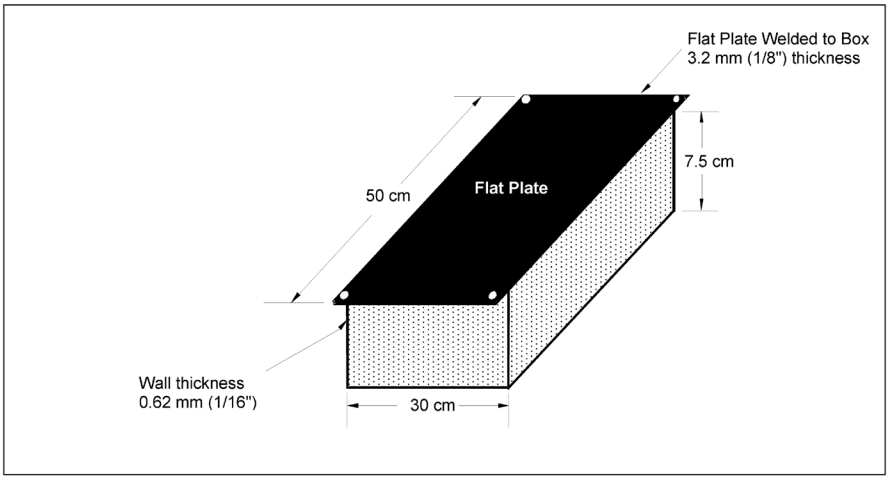


Figure 3.2: Cold-Soaked Box Schematic

3.3.3 Frosticator Plates

In natural frost, tests are conducted on frosticator plates, which are the current standard test surface used in frost holdover time testing. The frosticator plates were constructed by attaching a Styrofoam insulation backing to the back of the test surface (either aluminum or composite). The insulation prevents heat exchange via the underside of the flat plate and allows for effective radiative cooling during active frost conditions. Photo 3.3 shows a white-painted aluminum frosticator plate.

3.3.4 Artificial Snow Machine Test Plate

In artificial snow, tests are conducted on a standard flat plate that has been mounted onto a specialized scale. This setup is shown in Photo 3.4.

3.4 Test Surface Materials

Testing of Type II, III, and IV fluids is carried out exclusively on aluminum surfaces. The aluminum used is 0.32 cm thick Alclad 2024 T3 aluminum.

3.5 Test Stands

Figure 3.3 shows a schematic of the test platform used for HOT testing. For natural snow tests, six test plates are normally mounted on the test stand, which has a working surface inclined at 10° to the horizontal. During normal winter operations two six-position stands are used in combination. Each plate represents a flat plate test. For simulated freezing precipitation tests at the NRC, 12 plates are mounted on 2 six-position stands. Photo 3.1 shows the test stands set up for testing.

3.6 Collection Pans

Figure 3.4 shows a schematic of the collection pan used for precipitation rate measurement in outdoor testing. It is the same size as a standard flat plate and is used to make precipitation rate measurements during outdoor tests. Photo 3.5 shows the collection pans used for measuring precipitation rates indoors at the NRC.

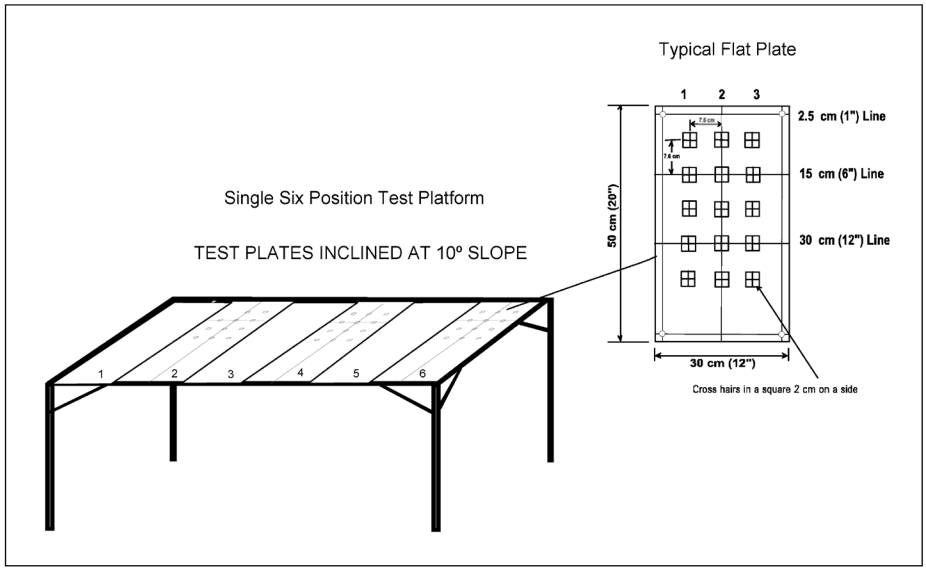


Figure 3.3: Test Stand Setup Schematic

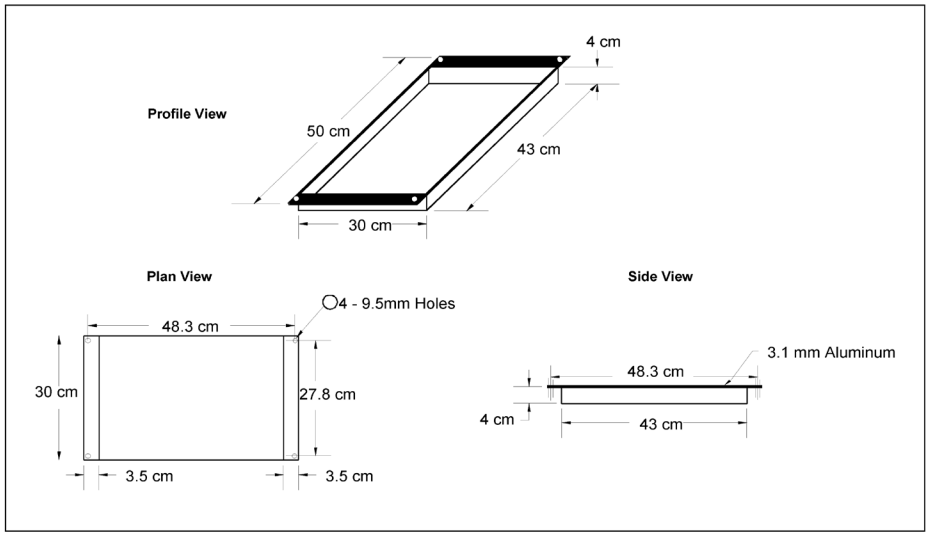


Figure 3.4: Schematic of Outdoor Precipitation Measurement Pan

3.7 NRC Sprayer Assembly

NRC developed an improved sprayer assembly, shown in Photo 3.6 and Photo 3.7, in 1997-98. The improved sprayer provides a larger scan area and improved spray uniformity over the test bed area. The scanner consists of a horizontal main shaft supported by two bearings. The actual spray head assembly is shaft-mounted on a rotating scanner, so that one scan covers a lateral running strip of the test bed area. A stepper motor is synchronized to index the relative angle of the spray head between scans along an axis perpendicular to the scan axis. This provides two axes of rotation, essentially an x-y plane; one along each axis. Each scan is consecutively indexed in order to complete the precipitation coverage of the test bed area. This defines one cycle of the spray unit. The scan rate, index angle, and the number of scans per cycle are adjusted, along with the fluid delivery pressures (water and air) to obtain appropriate droplet sizes and precipitation rates. The spray nozzle is shown in Photo 3.8.

3.8 Fluids

In most cases, testing was carried out with Type II, III, and IV fluids in the standard Type II, III, and IV fluid dilutions: neat, 75/25, and 50/50. Diluted fluids were prepared by the manufacturer; APS does not prepare diluted samples for endurance time testing of new fluids.

Photo 3.1: Test Plates Mounted on Stand

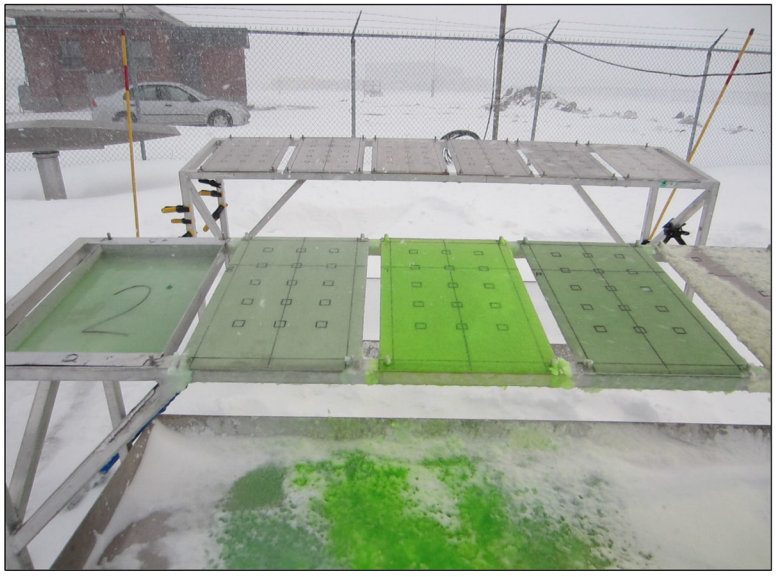


Photo 3.2: Cold-Soak / Leading Edge Thermal Equivalent Box

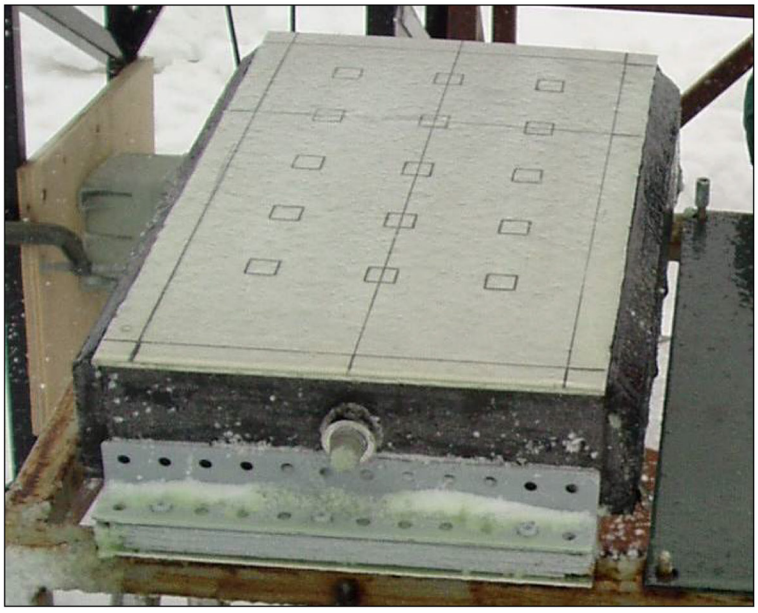


Photo 3.3: Frost Plate with Insulated Backing



Photo 3.4: Standard Plate Setup for Testing with Artificial Snow Machine

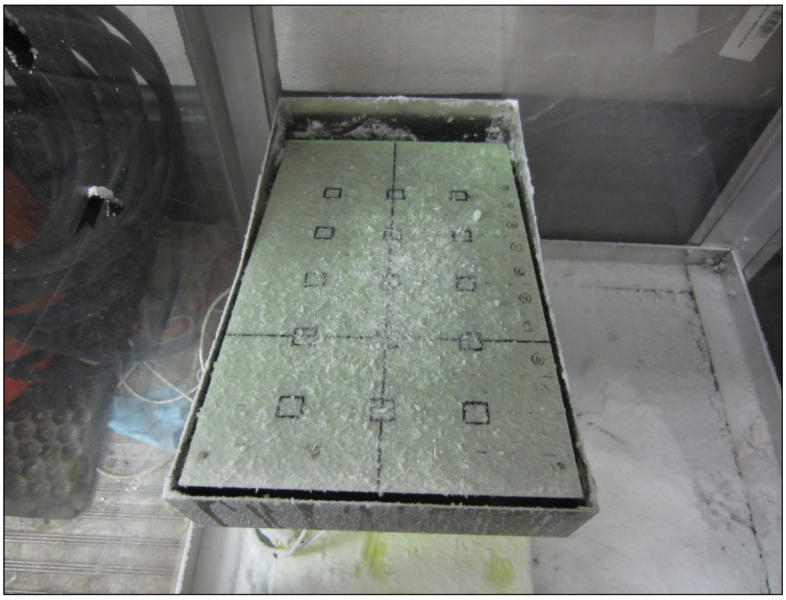


Photo 3.5: Collection Pans Used Indoors at the NRC



Photo 3.6: Sprayer Assembly



Photo 3.7: Sprayer Assembly in Use

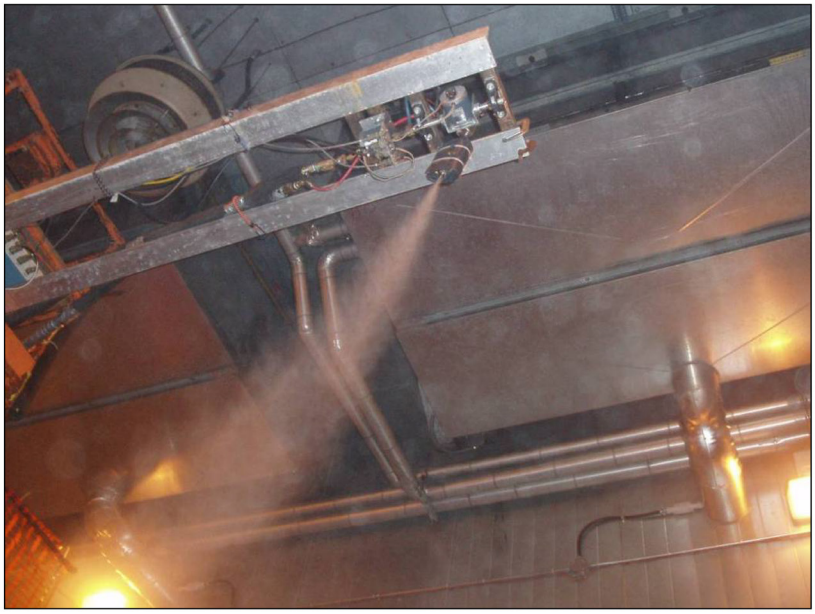
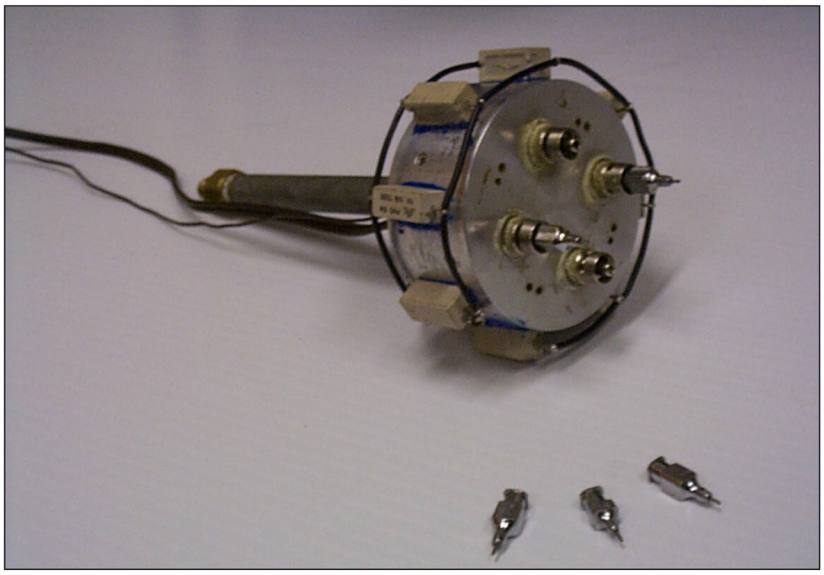


Photo 3.8: Sprayer Nozzle



4. TEST PROCEDURES

ARP5485 provides the standard procedure for endurance time testing of Type II, III, and IV fluids under natural and simulated precipitation conditions.

The procedure generally consists of pouring de/anti-icing fluids onto clean flat plates exposed to various winter precipitation conditions, and recording the elapsed time for the test to reach the defined end condition (see Subsection 4.5), when a specified degree of freezing occurs. The following subsections provide summaries of the test procedures followed for natural snow, natural frost, artificial snow, and simulated freezing precipitation testing.

4.1 Test Procedure – Natural Snow Tests

APS developed a specific procedure for Type II, III, and IV fluid testing in natural snow based on the requirements outlined in ARP5485. Key details of the procedure include:

- Tests are conducted on standard flat plates (see Subsection 3.3.1);
- Fluid is applied at ambient temperature; and
- 1 L of fluid is hand-poured on the test surface.

4.2 Test Procedure – Natural Frost Tests

APS developed a specific procedure for Type II/III/IV testing in natural frost. Key details of the procedure include:

- Tests are conducted on frosticator plates (see Subsection 3.3.3);
- Fluid is applied at ambient temperature; and
- 1 L of fluid is hand-poured on the test surface.

4.3 Test Procedure – Artificial Snow Tests

APS developed a specific procedure for testing in artificial snow based on the requirements outlined in ARP5485. Key details of the procedure include:

- Tests are conducted on a standard plate mounted on the snow machine scale (see Subsection 3.3.4);
- Fluid is applied at ambient temperature; and
- 1 L of fluid is hand-poured on the test surface.

4.4 Test Procedure – Simulated Precipitation Tests

APS developed a specific procedure for Type II/III/IV testing in simulated precipitation based on the requirements outlined in ARP5485. Key details of the procedure include:

- Freezing fog, freezing drizzle, and light freezing rain tests are conducted on standard flat plates (see Subsection 3.3.1);
- Rain on cold-soaked surface tests are conducted on filled cold-soaked boxes (see Subsection 3.3.2);
- Fluid is applied at ambient temperature; and
- 1 L of fluid is hand-poured on the test surface.

4.5 End Condition Definitions

Failure is called when 30 percent (1/3) of the plate or 5 cross-hairs are covered with frozen contamination. Appearance of this frozen contamination includes, but is not limited to:

a) Ice front;
b) Ice sheet;
c) Slush, in clusters or as a front;
d) Disseminated fine ice crystals;
e) Frost on surface;
f) Clear ice pieces partially or totally imbedded in fluid; and
g) Snow bridges on top of the fluid.

4.6 Precipitation Rate Measurement Procedures

The procedures for measuring and determining precipitation rates during simulated precipitation and natural precipitation conditions are provided below.

4.6.1 Simulated Precipitation Conditions

Prior to the start of the rate collection period, the proper needles and nozzles are installed in the spray unit and both the air and water pressures are adjusted. Water spray calibration is performed by placing catch pans on the test stand, each pan

marked with a number identifying the collection location on the test stand, and exposing the pans to a predetermined precipitation collection period.

The pans are weighed prior to exposure to precipitation and the weights are recorded in a customized Excel spreadsheet by using the print function on the digital weigh scale. Prior to the start of the precipitation catch period, the exact time (hh:mm:ss) is recorded using a pre-programmed time macro in the Excel spreadsheet. The pans are re-weighed following this collection period and the precipitation rates over the area of the test stand are examined. If the rates are unacceptable, re-calibration of the water spray is necessary. If the rates are deemed to be acceptable, the pans are weighed and placed on the stand for a second collection period. After the second collection period has expired, the pans are again re-weighed and the rates computed.

Once two rates have been collected at each test location, the catch rates of the first and second collection are compared. If the average catch rate for any location is deemed to be acceptable for the test condition, then the pouring of fluids may begin at this location.

Rates are continuously monitored at a minimum of two locations during a test in order to ensure there are no significant rate fluctuations. Pans will be placed at these locations and be re-weighed at fixed intervals (15 minutes, typically) during the course of a test. If a rate fluctuation occurs, the test is stopped.

Following the failure of a test plate, a rate collection pan is weighed and placed at the plate location for a predetermined time interval. It is then re-weighed and placed again on the stand to collect a minimum of two additional rates at this location.

The rate of precipitation for any location on the stand is calculated by averaging the two rates collected prior to the test and the two rates collected following the test.

4.6.2 Natural Precipitation Conditions

Two rate collection pans per test stand are typically used to determine precipitation rates in natural conditions. Prior to the rate collection period, both pans are marked (upper and lower), and the inner bottom and sides of each pan are wetted with Type IV fluid to prevent blowing snow from escaping the pan. The wetted pans are then weighed to the nearest gram. The start time of the rate collection period is recorded (h/min/sec) using a customized Excel spreadsheet in which the weight is also recorded by pressing the print function on the digital weigh scale.

The pans are positioned in locations 6 and 7 and allowed to collect precipitation for 10-minute intervals in normal conditions and 5-minute intervals in periods of high

precipitation rates and high winds. In frost the collection interval is half hour to one hour depending on the frost accretion intensity.

Prior to removal of the plate pans from the test stand for re-weighing, any accumulated precipitation on the lips and outer sides of each plate pan is carefully removed. The plate pans are then carried to the rate station for re-weighing. Upon entering the trailer, the exact time is noted. The new weights of the plate pans are recorded and the pans are brought back outside. This procedure is continued until the final plate on the test stand fails.

The rate for any HOT test in natural snow or frost is obtained by computing the time-weighted average of the rates collected in the upper and lower pans over the duration of the particular test.

An example of the rate calculation method for tests in natural conditions is displayed in Figure 4.1. Typically, two collections pans are used for each test. The start and end times of the test shown in Figure 4.1 are 10:15 and 10:45, respectively. Precipitation rates for one pan were collected at three periods during this test, indicated by t1, t2, and t3 (minutes). The calculated rates for each collection period are indicated by R1, R2, and R3 (g/dm²/h).

In order to calculate the average rate for this pan, the following formula is then used:

$$\frac{(R_1 \times t_1 + R_2 \times t_2 + R_3 \times t_3)}{t_1 + t_2 + t_3}$$

In the example shown in Figure 4.1, the rate is calculated as follows:

$$\frac{(25 \times 10 + 22 \times 8 + 34 \times 5)}{10 + 8 + 5}$$

The calculated average rate for this pan is 25.9 g/dm²/h. The average rate for the other collection pan is calculated in similar fashion, and the average of the two rates is then taken.

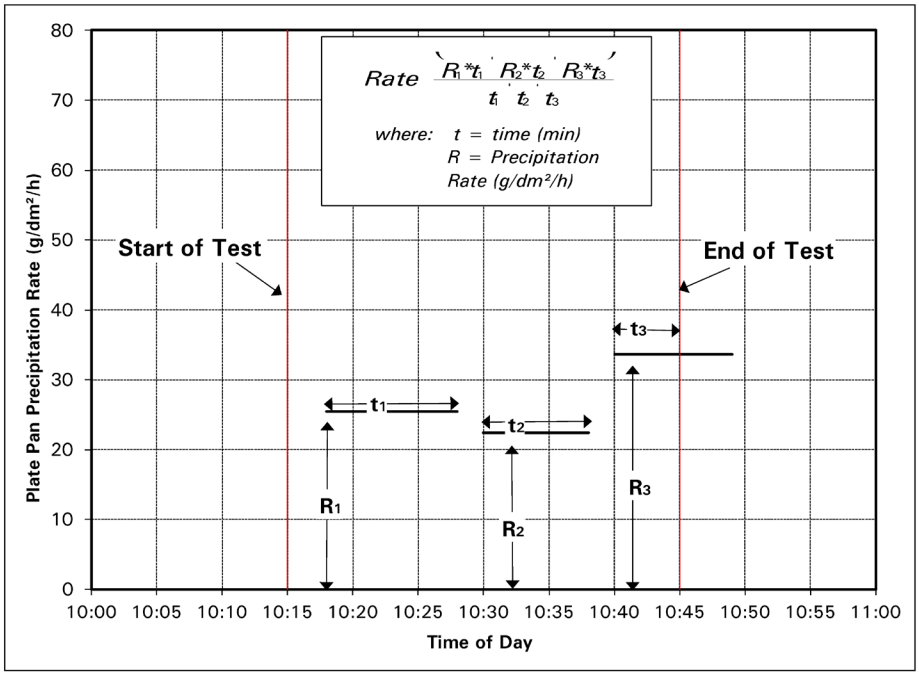


Figure 4.1: Calculation of Outdoor Precipitation Rate

5. TEST CONDITIONS

The conditions under which endurance time testing is conducted with Type II, III, and IV fluids are outlined in this section. Details are provided for precipitation rates, ambient temperatures, and droplet sizes.

5.1 Precipitation Rate Limits

Upper and lower precipitation rate limits are an important part of the test methodology for measuring fluid endurance times. Table 5.1 provides the meteorologically accepted definitions of weather phenomenon / precipitation types. It also includes the criteria used to determine precipitation intensity.

Table 5.1: Definition of Weather Phenomenon

Weather Phenomenon*	Definition*	Intensity Criteria**
FROST (No METAR code) **Note:** No Intensity is assigned to FROST.	Ice crystals that form from ice-saturated air at temperatures below 0°C (32°F) by direct sublimation on the ground or other exposed objects.	
FREEZING FOG (FZFG) **Note:** No Intensity is assigned to FRZ FOG	A suspension of numerous minute water droplets which freezes upon impact with ground or other exposed objects, generally reducing the horizontal	
SNOW (SN)	Precipitation of ice crystals, most of which are branched, star-shaped, or mixed with unbranched crystals. At temperatures higher than about -5°C	
FRZING DRIZZLE (FZDZ)	Fairly uniform precipitation composed exclusively of fine drops [diameter less than 0.5 mm (0.02 in.)] very close together which freezes upon impact with	
FREEZING RAIN (FZRA)	Precipitation of liquid water particles which freezes upon impact with the ground or other exposed objects, either in the form of drops of more than 0.5	
RAIN (RA)	Precipitation of liquid water particles either in the form of drops of more than 0.5 mm (0.02 in.) diameter or of smaller widely scattered drops.	
SNOW PELLETS (GS) and/or SMALL HAIL	Precipitation of white and opaque grains of ice. These grains are spherical or sometimes conical; their diameter	
SNOW GRAINS (SG)	Precipitation of very small white and opaque grains of ice. These grains are fairly flat or elongated; their diameter is	
HAIL (GR)	Precipitation of small balls or pieces of ice with a diame-	
ICE PELLETS (PE)	Precipitation of transparent (sleet or grains of ice), or translucent (small hail) pellets of ice, which are spherical or irregular, and which have a diameter of 5 mm (0.2 in.)	

Snow(SN),Pellets(GS),Grains(SG)

Estimated Intensity	Horizontal Visibility (statute mile)	Liquid Equivalent Snow (SN) Intensity***	Ice Pellets (PE) Definition and Horizontal Visibility
Light (-)	If visibility is: **≥ 5/8 mi** (≥ 1.0 km)	**Trace to 0.05 in/hr** (≤ 1.0 mm/hr or 10 gr/dm²/hr)	Scattered pellets on the ground. Visibility not affected.
Moderate	If visibility is: **< 5/8 to 5/16 mi** (< 1.0 to 0.5 km)	**> 0.05 to 0.10 in/hr** (> 1.0 to 2.5 mm/hr) (> 10.0 to 25.0 gr/dm²/hr)	Slow accumulation on the ground. Visibility reduced to less than 7 mi.
Heavy (+)	If visibility is: **< 5/16 mi** (< 0.5 km)	**More than 0.10 in/hr** (> 2.5 mm/hr or 25 gr/dm²/hr)	Rapid accumulation on the ground. Visibility reduced to less than 3 mi.

Note: Horizontal visibility is only an estimation of snow and freezing drizzle intensity. Measurements and observations have

	Drizzle Intensity (FZDZ)
Light(-)	Trace to 0.01 in/hr (0.254 mm/hr or 2.54 gr/dm²/hr)
Moderate	From 0.01 to 0.02 in/hr (2.54 to 5.08 gr/dm²/hr)
Heavy(+)	More than 0.02 in/hr (> 5.08 gr/dm²/hr) **Note:** Drizzle > 0.04 in/hr is usually in the form of rain.

	Rain (RA), Freezing Rain (FZRA), Ice Pellets (PE)
Measured Intensity Light (-) Estimated Intensity	Up to 0.10 in/hr (2.5 mm/hr or 25 gr/dm²/hr) Maximum 0.01 inch in 6 minutes From scattered drops that, regardless of duration, do not completely wet an
Measured Intensity Moderate Estimated Intensity	0.11 in to 0.30 in/hr (7.6 mm/hr or 76 gr/dm²/hr) More than 0.01 to 0.03 inch in 6 minutes Individual drops are not clearly identifiable; spray is observable just above
Measured Intensity Heavy (+) Estimated Intensity	More than 0.30 in/hr (7.6 mm/hr or 76 gr/dm²/hr) More than 0.03 inch in 6 minutes Rain seemingly falls in sheets; individual drops are not identifiable; heavy

* From World Meteorological Organization Guide to Meteorological Instruments and Methods of Observation (1983)
** From American Meteorological Society, Glossary of Meteorology WSOH #7 MANOBS (3/94)
*** NCAR/SAE Proposed Definition for Liquid Equivalent Snowfall Intensity

1) gr/dm² = 0.01 cm = 0.1 mm = 0.0039 in
2) in = 2.54 cm = 25.4 mm = 254 gm/dm²

Compiled by Jeff Colc and Roy Rasmussen of NCAR/RAP Sept 8, 1999
(Updated for METAR codes)

Table 5.1 was compiled by the National Centre for Atmospheric Research (NCAR) from the *World Meteorological Organization Guide to Meteorological Instruments and Methods of Observation* (1983) and from the *American Meteorological Society, Glossary of Meteorology WSOH # 7 Manual of Surface Weather Observations (MANOBS*) (3/94).

The precipitation rate limits established for Type II/III/IV endurance time testing are provided in ARP5485 and represented graphically in Figure 5.1. Subsections 5.1.1 to 5.1.5 provide detailed definitions and explanations of the precipitation types and rate boundaries used in Type II/III/IV endurance time testing. It should be noted that in many cases these limits are not the same as the meteorologically accepted definitions provided in Table 5.1.

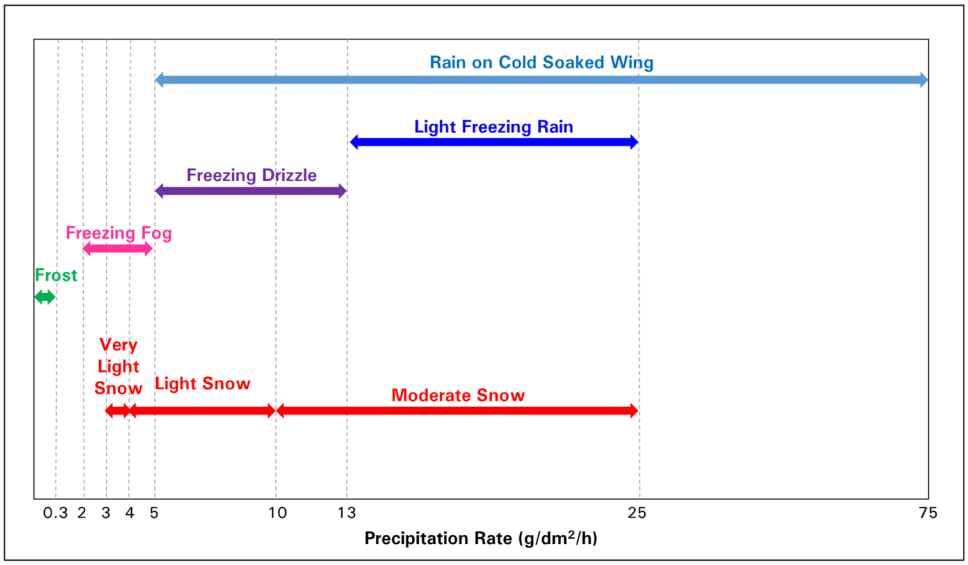


Figure 5.1: Precipitation Rate Limits Used in Endurance Time Testing

5.1.1 Freezing Fog

The precipitation rate limits for endurance time testing in freezing fog were set in 1997 at rates of 2 and 5 g/dm^2/h. These limits were determined with input from NRC meteorologists, who helped define an important parameter in the study of fog referred to as the *Liquid Water Content* (LWC). This quantity, expressed in density terms as the mass of water in grams contained in one cubic meter of air, can generally assume values in the range of 0.2 to 0.6 g/m^3.

5.1.2 Freezing Drizzle

The precipitation rate limits for endurance time testing in freezing drizzle are 5 and 13 g/dm^2/h. The upper limit in this range was adopted based on discussions with meteorological experts and aircraft operators on the SAE G-12 HOT Committee. This range corresponds to heavy drizzle and has been chosen to provide aircraft operators with a greater margin of safety.

5.1.3 Light Freezing Rain

The precipitation rate limits for endurance time testing in light freezing rain are 13 and 25 g/dm^2/h. This range corresponds to the category of light freezing rain and is the only freezing rain category considered, as operations in periods of moderate or heavy freezing rain are deemed unsafe.

5.1.4 Rain on a Cold-Soaked Surface

The precipitation rate limits for rain on cold-soaked surface are 5 and 75 g/dm^2/h. This range encompasses drizzle (5 to 13 g/dm^2/h), light rain (13 to 25 g/dm^2/h), and moderate rain (25 to 75 g/dm^2/h).

5.1.5 Snow

The precipitation rate limits used to determine holdover times for Type II/III/IV fluids in snow are 3, 4, 10, and 25 g/dm²/h. These rate limits encompass very light, light, and moderate snow.

5.2 Ambient Temperatures in Type II/III/IV Endurance Time Testing

Holdover times are provided for six temperature bands in Type II, III, and IV HOT tables. These bands cover temperatures from the fluid's lowest operational use temperature (LOUT) and warmer.

For Type II/IV fluids the temperature bands are:

- -3°C and above (rain on cold-soaked surface limited to +1°C);
- Below -3°C to -8°C;
- Below -8°C to -14°C (freezing drizzle/light freezing limited to -10°C);
- Below -14°C to -18°C;
- Below -18°C to -25°C; and
- Below -25°C to LOUT (for fluids with LOUTs below -25°C).

For Type III fluids the temperature bands are:

- -3°C and above (rain on cold-soaked surface limited to +1°C);
- Below -3°C to -10°C; and
- Below -10°C to LOUT.

For Type III fluids with extremely low LOUTs (below -29.5°C), the third temperature band may be limited to -25°C and a fourth temperature band (below -25°C to LOUT) may be added.

In natural snow and natural frost testing, endurance time testing is carried out under a range of temperatures. In simulated freezing precipitation and artificial snow testing, endurance time testing is typically conducted at the lower limit of each temperature band. At this time, testing is not conducted at -8°C. The temperatures at which testing is conducted for each condition are listed below:

- Freezing Fog: -3°C, -10°C (Type III) / -14°C (Type II/IV), -25°C, LOUT (if LOUT <-29.5°C);
- Freezing Drizzle: -3°C and -10°C;
- Light Freezing Rain: -3°C and -10°C;
- Rain on Cold-Soaked Surface: +1°C; and
- Artificial Snow: -3°C, -10°C (Type III) / -18°C (Type II/IV), -25°C, LOUT (if LOUT <-29.5°C).

5.3 Freezing Precipitation Droplet Sizes

Research has shown that median volume diameter (MVD) of rain droplets is related to rate of precipitation as follows:

- MVD = (precipitation rate/10) $^{0.23}$, where MVD is in mm and rate of precipitation is in g/dm²/h

The theoretical MVDs for rain at various rates of precipitation were determined based on this equation. These values are listed in Table 5.2 beside the experimental MVDs for each precipitation condition.

To determine whether droplets produced at the NRC resembled droplets from natural precipitation, a test was conducted during natural light freezing rain conditions in 1997-98 at the APS test site. The droplet sizes were compared to those obtained in simulated light freezing rain at the NRC. The results of these tests are shown below.

a) *For the outdoor test:*

Location:	Montreal International Airport
Precipitation:	Natural Light Freezing Rain
Precipitation Rate:	20 g/dm²/h
Calibrated MVD:	1.0 mm

b) *For the indoor test:*

Location:	National Research Council CEF
Precipitation:	Simulated Light Freezing Rain
Precipitation Rate:	25 g/dm²/h
Calibrated MVD:	1.0 mm

The MVD for both natural and simulated light freezing rain was 1 mm, indicating that the NRC produced droplets simulate natural precipitation.

As a result of this testing, the MVDs for freezing precipitation testing were established as follows:

- Freezing Fog, high precipitation rate (5 g/dm²/h): 30 μm
- Freezing Fog, low precipitation rate (2 g/dm²/h): 30 μm
- Freezing Drizzle, high precipitation rate (13 g/dm²/h): 350 μm
- Freezing Drizzle, low precipitation rate (5 g/dm²/h): 250 μm
- Light Freezing Rain, high precipitation rate (25 g/dm²/h): 1,000 μm
- Light Freezing Rain, low precipitation rate (13 g/dm²/h): 1,000 μm
- Rain on Cold-Soaked Surface, low precipitation rate (5 g/dm²/h): 250 μm
- Rain on Cold-Soaked Surface, high precipitation rate (75 g/dm²/h): 1,400 μm

5.4 Summary of Freezing Precipitation Test Conditions

The precipitation types/rates, ambient temperatures and droplet sizes for freezing precipitation testing with Type II/III/IV fluids were described in the previous subsections. In summary, freezing precipitation tests are carried out under each of the 16 weather conditions listed in Table 5.3.

Table 5.2: Theoretical and Experimental MVDs

Precipitation Condition	Experimental MVD (mm)	Theoretical MVD (mm)
Moderate Rain (High rate: 75 g/dm²/h)	1.4	1.6
Light Rain (Low rate: 13 g/dm²/h)	1.0	< 1.1
Light Rain (High rate: 25 g/dm²/h)	1.0	1.2
Drizzle (Low rate: 5 g/dm²/h)	0.25	< 0.5
Drizzle (High rate: 13 g/dm²/h)	0.35	< 0.5
Fog		< 0.1

Table 5.3: Summary of Freezing Precipitation Test Conditions

Precipitation Type	Ambient Temperature	Precipitation Rate (Droplet Size)
Freezing Fog	-3°C	2 g/dm²/h (30 μm)
		5 g/dm²/h (30 μm)
	-14°C (Type II/IV) -10°C (Type III)	2 g/dm²/h (30 μm)
		5 g/dm²/h (30 μm)
	-25°C	2 g/dm²/h (30 μm)
		5 g/dm²/h (30 μm)
	LOUT (if < -29°C)	2 g/dm²/h (30 μm)
		5 g/dm²/h (30 μm)
Freezing Drizzle	-3°C	5 g/dm²/h (250 μm)
		13 g/dm²/h (350 μm)
	-10°C	5 g/dm²/h (250 μm)
		13 g/dm²/h (350 μm)
Light Freezing Rain	-3°C	13 g/dm²/h (1,000 μm)
		25 g/dm²/h (1,000 μm)
	-10°C	13 g/dm²/h (1,000 μm)
		25 g/dm²/h (1,000 μm)
Rain on Cold-Soaked Surface	+1°C	5 g/dm²/h (250 μm)
		75 g/dm²/h (1,400 μm)

6. ANALYSIS METHODOLOGIES

A multi-variable regression procedure is used to derive fluid-specific holdover times for Type II/III/IV fluids. The procedure is based on the refinement of an equation for a curve which best represents the test data, and then solving that equation at the upper and lower limits established for the precipitation type. These precipitation rate limits, set by the SAE G-12 HOT Committee and detailed in ARP5485, were described in Subsection 5.1. This approach was developed in the winter of 1996-97 (see TC report, TP 13131E) and has since been used to derive fluid holdover times. There are some differences in the way the methodology is applied to freezing precipitation and natural snow data.

6.1 Freezing Precipitation Data

For each related freezing precipitation HOT table cell, four tests are conducted at the most restrictive (lowest) temperature in the temperature range for that cell: two tests at the low precipitation rate limit and two tests at the high precipitation rate limit (limits are detailed in Subsection 5.1). An exception to this is the "Below -3°C to -8°C" cell for Type II/IV fluids. No testing is conducted in this temperature range; this cell is instead populated with the same holdover times as the "Below -8°C to -14°C" cell.

The equation used to treat freezing precipitation data is:

- $t = 10^{l}R^{a}$, where

  t = Time (minutes)
  R = Rate of precipitation (g/dm²/h)
  l, a = coefficients determined from the regression.

The upper and lower HOT values for each cell are determined from the points at which the best-fit curve intersects the lower and upper precipitation limits, respectively. The calculated holdover times derived from this analysis are subject to the rounding and capping rules detailed in Subsection 6.4.

6.2 Natural Snow Data

As outside air temperature and precipitation rate cannot be controlled under natural test conditions, natural snow tests are carried out at a variety of temperatures and precipitation rates. An attempt is made to gather data under all temperatures and precipitation rates encompassed by the HOT tables.

The general form of the regression equation is modified for natural snow to incorporate the variable of temperature and also to prevent taking the log of a negative number as natural snow can occur at temperatures approaching 2°C. The equation used to treat natural snow data is:

- $t = 10^{l} R^{a} (2\text{-}T)^{b}$, where

  t = Time (minutes)
  R = Rate of precipitation (g/dm²/h)
  l, a, b = coefficients determined from the regression.

The upper and lower HOT values for each cell are determined from the points at which the best-fit curve intersects the lower and upper precipitation limits, using the most restrictive (lowest) temperature for that cell. The calculated holdover times derived from this analysis are subject to the rounding and capping rules detailed in Subsection 6.4.

6.3 Natural Frost Data

Regression analysis is not used in the determination of frost holdover times. The current Type II/III/IV generic frost holdover times were determined based on several years of testing using all fluids which were commercially available at the time. A "minimum values" analysis methodology was used to determine appropriate holdover times from the test data.

The purpose of natural frost testing with new fluids is to verify the fluids can be used with the generic frost holdover times. The analysis methodology is to compare the frost test data collected with the new fluid to the current generic holdover times. If the test data provides holdover times equal to or greater than the generic holdover times then the generic holdover times have been validated for the new fluid.

As outside air temperature and precipitation rate can not be controlled under natural test conditions, natural frost tests are carried out at a variety of temperatures and precipitation rates.

For a given Type II/III/IV fluid, a minimum of two data points (with acceptable results) per dilution are required to consider the generic active frost holdover times validated. The desired data targets are six tests for a neat dilution, four tests for a 75/25 dilution, and two tests for a 50/50 dilution. If these desired data targets are not achieved for a given fluid in the year it is initially submitted for holdover time testing, samples of the fluid will be retained and additional active frost tests will be run the following year. Samples are not to be retained for testing longer than one additional year.

6.4 Artificial Snow Data

Type II and Type IV fluids submitted for endurance time testing in the winter of 2018-19 underwent testing in artificial snow at -18°C and -25°C. The purpose of the testing was to verify the fluids can be used with the generic very cold snow holdover times.

The analysis methodology used to complete this verification was to compare the test data collected to a historical database of similar data. If the test data provided endurance times similar to those in the historical data set, then the generic holdover times were considered validated for the new fluid.

6.5 Rounding and Capping Protocols

Regression-generated holdover times are subject to the rounding and capping protocols detailed below.

6.5.1 Rounding Protocols

All holdover times are rounded to the nearest whole "5" minute, i.e. 55.1 to 57.4 minutes is rounded down to 55 minutes; 57.5 to 59.9 minutes is rounded up to 60 minutes. The only exceptions are:

- In cases where the regression-generated holdover times for Type II/IV fluids are below 10 minutes, the numbers are rounded down to the nearest whole minute as a precautionary measure (e.g. 9.6 minutes is rounded down to 9 minutes); and
- In cases where the regression-generated holdover times for Type III fluids are below 20 minutes, the numbers are rounded down to the nearest whole minute as a precautionary measure (e.g. 19.6 minutes is rounded down to 19 minutes).

6.5.2 Capping Protocols

All holdover time values are capped at maximum values. The caps differ by precipitation type, and in the case of snow, by regulator. The caps are as follows:

- Freezing Fog holdover time values are capped at 4 hours;
- Freezing Drizzle, Light Freezing Rain, Rain on Cold-Soaked Wing holdover times are capped at 2 hours; and
- Snow holdover times are capped at 2 hours by TC and 3 hours by the FAA.

6.6 Regression Example

Sample plots of **Log t** versus **Log R** are shown in Figure 6.1. The plots contain data for one Neat Type IV fluid, in one temperature range (-10°C), in light freezing rain conditions. The best-fit regression line is superimposed onto the plot and was obtained from the analysis using the lowest temperature in the temperature range from which the data were chosen.

The same data plotted on a linear scale (failure time **t** versus precipitation rate **R**) are shown in Figure 6.2. The curve, generated from the power law form of the equation using the coefficients determined from the fit, is superimposed onto the plot. The HOT range is determined from the intersections of the curve with the precipitation rate limits defined for light freezing rain.

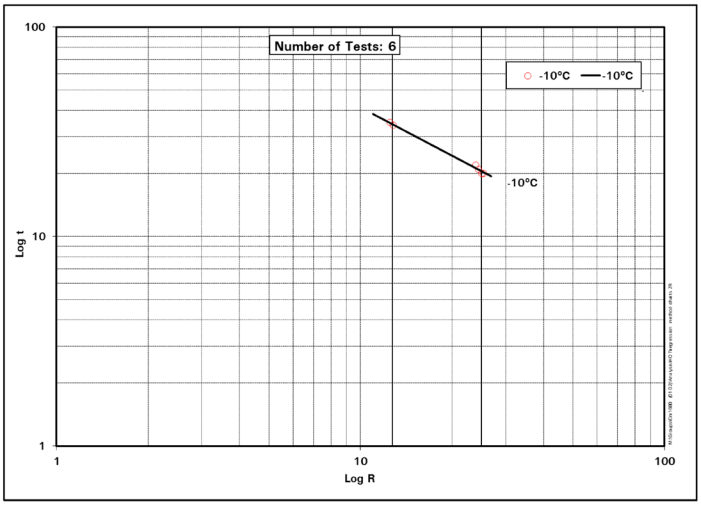


Figure 6.1: Regression Method on Log-Log Chart – Type IV Neat, Freezing Rain

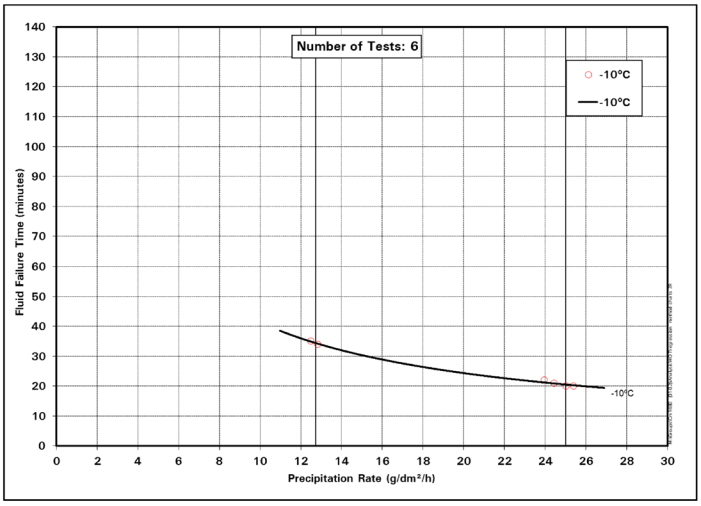


Figure 6.2: Regression Method on Standard Chart – Type IV Neat, Freezing Rain

The holdover times for this fluid at -10°C are 20 minutes at 13 g/dm^2/h and 35 minutes at 25 g/dm^2/h, establishing the HOT range for this particular fluid in the light freezing rain, neat fluid, below -3 to -10°C cell. This illustrates the general approach used in the determination of a fluid HOT range for any given cell in the HOT table.

6.7 Lowest and Highest Usable Precipitation Rates in Snow

A detailed analysis methodology was developed to determine if a snow data set is sufficient to determine holdover times for light and very light snow. Specifically, the analysis determines the lowest usable precipitation rate (LUPR) and also the highest usable precipitation rate (HUPR), which are the lowest and highest rates, respectively, at which the data set is considered robust.

6.7.1 Temperatures of -14°C and Above

A three-factor weighted analysis methodology is used to determine the LUPR and HUPR values for a snow data set at temperatures of -14°C and above. Table 6.1 lists the three factors and their weightings. Each data set is given a rating of 0, 10, 20, 30, or 40 for each factor. The factor rating system is shown in Table 6.2.

The ratings are multiplied by the factor weighting to determine a final score for a specific precipitation rate. LUPR scores are calculated for each precipitation rate between 3 and 10 g/dm²/h. HUPR scores are calculated for 25 and 50 g/dm²/h and rates in multiples of 5 in between (25, 30, 35, 40, 45, 50).

The scores are compared to the minimum acceptance score, which is 26. The LUPR is the lowest precipitation rate at which a data set has a passing score; the HUPR is the highest precipitation rate at which a data set has a passing score.

6.7.2 Temperatures Below -14°C

The methodology described above for determining LUPR values at -14°C and above is also used for determining LUPR values below -14°C.

Moderate snow occurs rarely and heavy snow occurs very rarely at temperatures below -14°C. It is therefore not feasible to collect sufficient natural snow data to support use of the regression curve at high precipitation rates. At this time, regulators have elected to allow use of regression coefficients for temperatures below -14°C up to a rate of 25 g/dm²/h. This is the default HUPR for all fluids below -14°C.

Table 6.1: Factors Used in LUPR/HUPR Calculations

Factor	Description – LUPR	Description – HUPR	Weight
1. Data Points with Precipitation Rates near the Precipitation Rate being Examined	• Number of data points with precipitation rates ≤ 0.5 g/dm²/h above the precipitation rate being examined	• Number of data points with precipitation rates ≥ 10 g/dm²/h below the precipitation rate being examined	30%
2. Data Points in High or Low Precipitation Rate Categories	• Number of data points with precipitation rates ≤ 10 g/dm²/h	• Number of data points with precipitation rates ≥ 20 g/dm²/h	50%
3. Negative Scatter of High or Low Precipitation Rate Data Points	• Difference between endurance time predicted by regression curve and measured endurance time calculated as a percentage • Scatter is set to 0% for data points with positive scatter (i.e. predicted endurance time < measured endurance time) • Average scatter is calculated for all data points ≤ 10 g/dm²/h	• Difference between endurance time predicted by regression curve and measured endurance time calculated as a percentage • Scatter is set to 0% for data points with positive scatter (i.e. predicted endurance time < measured endurance time) • Average scatter is calculated for all data points ≥ 25 g/dm²/h	20%

Table 6.2: LUPR/HUPR Factor Ratings

Factor #1: Data Points with Precipitation Rates near the Precipitation Rate being Examined		
Rating	**LUPR**	**HUPR**
Rating = 40	≥3 data points ≤ precipitation rate +0.5	≥5 data points ≥ precipitation rate -10
Rating = 30	2 data points ≤ precipitation rate +0.5	4 data points ≥ precipitation rate -10
Rating = 20	1 data point ≤ precipitation rate +0.5	3 data points ≥ precipitation rate -10
Rating = 10	n/a	2 data points ≥ precipitation rate -10
Rating = 0	0 data points ≤ precipitation rate +0.5	<2 data points ≥ precipitation rate -10

Factor #2: Data Points at High or Low Precipitation Rate Categories		
Rating	**LUPR**	**HUPR**
Rating = 40	≥8 data points ≤10 g/dm²/h	≥5 data points >20 g/dm²/h
Rating = 30	6-7 data points ≤10 g/dm²/h	4 data points >20 g/dm²/h
Rating = 20	4-5 data points ≤10 g/dm²/h	3 data points >20 g/dm²/h
Rating = 10	2-3 data points ≤10 g/dm²/h	2 data points >20 g/dm²/h
Rating = 0	<2 data points ≤10 g/dm²/h	<2 data points >20 g/dm²/h

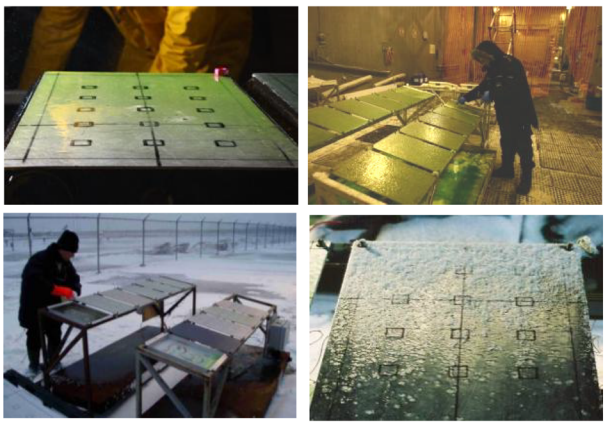
Factor #3: Negative Scatter of High or Low Precipitation Rate Data Points		
Rating	**LUPR**	**HUPR**
Rating = 40	≥-10%	≥-10%
Rating = 30	-11 to -15%	-11 to -15%
Rating = 20	-16 to -20%	-16 to -20%
Rating = 10	n/a	n/a
Rating = 0	<-20%	<-20%

APPENDIX D

AIRCRAFT GROUND ANTI-ICING FLUID ENDURANCE TIME TEST RESULTS – ROMCHIM ADD-PROTECT TYPE II (TYPE II)

AIRCRAFT GROUND ANTI-ICING FLUID ENDURANCE TIME TEST RESULTS

ROMCHIM ADD-PROTECT TYPE II (Type II)



Prepared for

ROMCHIM PROTECT SRL

by

APS Aviation Inc.

These tests were made possible with the guidance, participation and contribution of Transport Canada and the Federal Aviation Administration.

July 2019
Version 1.0
Report No. R-AP2 2018-19

AIRCRAFT GROUND ANTI-ICING FLUID ENDURANCE TIME TEST RESULTS

ROMCHIM ADD-PROTECT TYPE II (Type II)

Prepared for

ROMCHIM PROTECT SRL

Prepared by:



Benjamin Bernier, B.Sc.
Junior Project Leader

July 09, 2019
Date

Reviewed by:



John D'Avirro, Eng., PBDM
Director, Aviation Services

July 09, 2019
Date

These tests were made possible with the guidance, participation and contribution of Transport Canada and the Federal Aviation Administration.

July 2019
Version 1.0
Report No. R-AP2 2018-19

FLUID IDENTIFICATION AND CHARACTERISTICS

Manufacturer:	ROMCHIM PROTECT SRL	
Fluid Test Name:	ADD-PROTECT TYPE II	
Fluid Commercial Name:	ADD-PROTECT TYPE II	
Fluid Type / Base / Colour:	Type II / Propylene Glycol / Yellow	
Batch #:	1440	
Date of Receipt:	December 13, 2018	
Brix (Measured):	Neat fluid:	36.0°
	75/25 dilution:	28.5°
	50/50 dilution:	20.25°
Freeze Point (Stated):	Neat fluid:	-35.0°C
	75/25 dilution:	-21.0°C
	50/50 dilution:	-10.0°C
Aerodynamic LOUT (AMIL):	Neat fluid:	-31.5°C
	75/25 dilution:	-15.0°C
	50/50 dilution:	-9.5°C

Viscosity:

Manufacturer Method	**Stated**	**Measured**
Neat fluid[1]:	3,800 cP	4,000 cP
75/25 dilution[1]:	9,500 cP	7,700 cP
50/50 dilution[1]:	15,900 cP	14,500 cP

AS 9968 Method	**Stated**	**Measured**
Neat fluid[1]:	3,800 cP	4,000 cP
75/25 dilution[1]:	9,500 cP	7,700 cP
50/50 dilution[1]:	15,900 cP	14,500 cP

WSET (from AMIL):	Neat fluid:	41 minutes 27 seconds
	75/25 dilution:	26 minutes 3 seconds
	50/50 dilution:	9 minutes 33 seconds

[1] Spindle LV1 (with guard leg), 600 mL low form beaker, 575 mL of fluid, 20°C, 0.3 rpm, for 10.0 minutes

SUMMARY

The primary objective of this project was to measure the endurance time performance of **ROMCHIM PROTECT SRL ADD-PROTECT TYPE II** over the entire range of conditions encompassed by the Holdover Time (HOT) tables. This report contains the results of these measurements and was completed with the support of the fluid manufacturer, Transport Canada (TC), and the Federal Aviation Administration (FAA).

Tests were carried out according to the protocol provided in Aerospace Recommended Practice (ARP) 5485. The test procedure consisted of pouring fluids onto clean aluminum test surfaces inclined at 10°; the onset of failure was recorded as a function of time in natural and simulated precipitation.

Tests were performed at the APS Aviation Inc. (APS) test facility at Montréal-Pierre-Elliott-Trudeau International Airport and the National Research Council Canada (NRC) Climatic Engineering Facility (CEF) in Ottawa.

De/anti-icing fluid endurance times were derived from the data collected using multi-variable regression analysis. This resulted in the generation of the fluid-specific holdover times shown below. These holdover times will be published by regulators for use in the winter 2019-20 operating season.

ROMCHIM ADD-PROTECT TYPE II Type II Fluid Holdover Times

Outside Air Temperature (°C)	Type IV Fluid Concentration Neat Fluid/ Water (Vol %/Vol %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)							
		Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets*			Freezing Drizzle	Light Freezing Rain	Rain on Cold Soaked Wing	Other
			Very Light	Light	Moderate				
-3 and above	100/0	1:40-3:30	1:55-2:25	1:00-1:55	0:30-1:00	0:40-1:35	0:25-0:45	0:09-0:50	
	75/25	0:40-1:10	1:00-1:10	0:30-1:00	0:15-0:30	0:25-0:40	0:15-0:25	0:05-0:25	
	50/50	0:20-0:35	0:30-0:35	0:15-0:30	0:09-0:15	0:10-0:30	0:08-0:10	CAUTION: No holdover time guidelines exist	
below -3 to -8	100/0	0:30-0:45	1:20-1:40	0:40-1:20	0:20-0:40	0:25-0:50	0:20-0:30		
	75/25	0:30-0:55	0:40-0:50	0:25-0:40	0:10-0:25	0:20-0:30	0:15-0:20		
below -8 to -14	100/0	0:30-0:45	1:05-1:20	0:35-1:05	0:15-0:35	0:25-0:50	0:20-0:30		
	75/25	0:30-0:55	0:35-0:40	0:20-0:35	0:09-0:20	0:20-0:30	0:15-0:20		
below -14 to -18	100/0	0:15-0:25	0:20-0:30	0:07-0:20	0:02-0:07				
below -18 to -25	100/0	0:15-0:25	0:09-0:15	0:03-0:09	0:01-0:03				
below -25 to -28	100/0	0:15-0:25	0:05-0:07	0:01-0:05	0:00-0:01				

**FAA values shown, Transport Canada will publish only the lower values for very light snow and caps all snow HOTs at two hours*

TABLE OF CONTENTS

1. INTRODUCTION 1

2. METHODOLOGY 2

3. DESCRIPTION OF DATA 3

3.1 Natural and Artificial Snow Tests 3
3.2 Freezing Precipitation Tests 3
3.3 Natural Frost Tests 4
3.4 Fluid Thickness Tests 4
3.5 Test Logs 4

4. RESULTS AND DISCUSSION 11

4.1 Results 11
4.1.1 Endurance Time Tests – Natural Snow and Freezing Precipitation 11
4.1.2 Endurance Time Tests – Natural Frost 11
4.1.3 Fluid Thickness Tests 11
4.2 Discussion 22
4.2.1 Holdover Time Table 22
4.2.2 Holdover Times in Snow at Temperatures Below -14°C 22
4.2.3 Holdover Times in Frost 22
4.2.4 Fluid Viscosity 22
4.2.5 Lowest Operational Use Temperatures (LOUTs) 23
4.2.6 Lowest and Highest Usable Precipitation Rates in Snow 23
4.2.7 Publication of Holdover Times 24

ANNEX: Methodology for Endurance Time Testing of Type II, III, and IV Fluids – Winter 2018-19

LIST OF FIGURES AND TABLES

Figures

Figure 4.1: Type II 100/0 – Natural Snow 12
Figure 4.2: Type II 75/25 – Natural Snow 12
Figure 4.3: Type II 50/50 – Natural Snow 13
Figure 4.4: Type II 100/0 – Artificial Snow at -18°C with Historical Results 13
Figure 4.5: Type II 100/0 – Artificial Snow at -25°C with Historical Results 14
Figure 4.6: Type II 100/0 – Freezing Drizzle 14
Figure 4.7: Type II 75/25 – Freezing Drizzle 15
Figure 4.8: Type II 50/50 – Freezing Drizzle 15
Figure 4.9: Type II 100/0 – Light Freezing Rain 16
Figure 4.10: Type II 75/25 – Light Freezing Rain 16
Figure 4.11: Type II 50/50 – Light Freezing Rain 17
Figure 4.12: Type II 100/0 – Freezing Fog 17
Figure 4.13: Type II 75/25 – Freezing Fog 18
Figure 4.14: Type II 50/50 – Freezing Fog 18
Figure 4.15: Type II 100/0 – Rain on Cold-Soaked Surface 19
Figure 4.16: Type II 75/25 – Rain on Cold-Soaked Surface 19
Figure 4.17: Fluid Thickness Profiles of ROMCHIM ADD-PROTECT TYPE II 21
Figure 4.18: Final Fluid Thickness of ROMCHIM ADD-PROTECT TYPE II 21

Tables

Table 3.1: Summary of Tests Performed (Snow) 5
Table 3.2: Summary of Tests Performed (Freezing Precipitation) 8
Table 3.3: Summary of Tests Performed (Natural Frost) 10
Table 4.1: Regression Equation Coefficients for ROMCHIM ADD-PROTECT TYPE II 20
Table 4.2: Fluid Specific Holdover Time Guidelines – ROMCHIM ADD-PROTECT TYPE II (TC Format) 25
Table 4.3: Fluid Specific Holdover Time Guidelines – ROMCHIM ADD-PROTECT TYPE II (FAA Format) 26
Table 4.4: LUPR Statistics – ROMCHIM ADD-PROTECT TYPE II 27
Table 4.5: HUPR Statistics – ROMCHIM ADD-PROTECT TYPE II 28

GLOSSARY

APS	APS Aviation Inc.
ARP	Aerospace Recommended Practice
CEF	Climatic Engineering Facility
EG	Ethylene Glycol
FAA	Federal Aviation Administration
HOT	Holdover Time
HUPR	Highest Usable Precipitation Rate
LOUT	Lowest Operational Use Temperature
LOWV	Lowest On-Wing Viscosity
LUPR	Lowest Usable Precipitation Rate
NRC	National Research Council Canada
PG	Propylene Glycol
TC	Transport Canada

1. INTRODUCTION

This report has been created with the support of the fluid manufacturer, Transport Canada (TC), and the Federal Aviation Administration (FAA).

Aircraft ground de/anti-icing has been the subject of concentrated industry attention in recent years due to the occurrence of several fatal icing-related aircraft accidents. Notably, attention has been placed on the enhancement of anti-icing fluids in order to provide an extended period of protection against further contamination following initial deicing. This emphasis has led to the development of fluid-specific de/anti-icing fluid holdover time (HOT) tables for Type II, Type III and Type IV fluids. These tables, accepted by regulatory authorities, are used by aircraft operators for departure planning in adverse winter conditions. Specifically, they provide the duration of time that qualified fluids provide protection against ice formation under specific weather conditions.

New anti-icing formulations continue to be developed by leading manufacturers with the specific objective of prolonging fluid holdover times without compromising the aerodynamic features of the airfoil. The purpose of the endurance time testing program is to measure the endurance times of these new fluids and develop fluid-specific HOT tables that provide guidance for their use.

Flat plate tests, conducted in natural and simulated precipitation, are used to develop HOT values for new fluids. These tests are carried out according to SAE Aerospace Recommended Practice (ARP) 5485, which provides the test protocols for measuring endurance times of Type II, III, and IV fluids. Along with its counterpart for measuring endurance times of Type I fluids ARP5945, ARP5485 has evolved into a refined procedure for measuring the duration of de/anti-icing fluid protection against ice formation.

The current data analysis protocol for developing HOT values from endurance time data was developed in 1996-97 and uses multi-variable regression to obtain HOT values. HOT values are derived for the majority of cells in Type II/III/IV HOT tables using this protocol and are used to create a fluid-specific HOT table for each Type II/III/IV fluid tested.

This report provides a detailed account of the endurance time testing conducted by APS Aviation Inc. (APS) with **ROMCHIM PROTECT SRL ADD-PROTECT TYPE II**, a new Type II fluid. It describes the test methodology used, endurance time data collected, and analysis completed to derive fluid-specific holdover times for the fluid.

2. METHODOLOGY

Tests were carried out according to SAE ARP5485, which provides the procedure and requirements for endurance time testing with Type II, III, and IV fluids under natural and simulated conditions.

The test methodology for endurance time testing carried out in the winter of 2018-19 is documented in detail in the report *"Methodology for Endurance Time Testing of Type II, III, and IV Fluids – Winter 2018-19."* A copy of this report is provided as an annex to this document.

The methodology report summarizes the key aspects of the test methodology, including some aspects included in ARP5485 and some aspects which are not included in ARP54855. It includes sections on:

a) Test Sites;
b) Test Equipment;
c) Test Procedures;
d) Precipitation Rates used in Type I, II, III, and IV Endurance Time Testing;
e) Ambient Temperatures used in Type I, II, III, and IV Endurance Time Testing;
f) Freezing Precipitation Droplet Sizes; and
g) Analysis Methodologies.

The data, analysis and results provided in this report are a function of the test and analysis methodologies described in the methodology report. They should only be used in conjunction with the methodologies described therein.

3. DESCRIPTION OF DATA

This section provides a summary of the number of tests conducted. Breakdowns are provided for the number of tests performed by test type, precipitation type, fluid dilution and test temperature.

3.1 Natural and Artificial Snow Tests

Tests were conducted in natural snow conditions at the APS test site and at several mobile test sites (refer to the report annex for details). Artificial snow tests were conducted at PMG Technologies in Blainville, QC. The breakdown of tests conducted is summarized below by fluid dilution and temperature.

Fluid Dilution	Natural Snow				Artificial Snow	
	≥ -3°C	< -3 to -8°C	< -8 to -14°C	<-14°C	-18°C	-25°C
Neat	5	16	10	2	8	8
75/25	5	19	10	2	0	0
50/50	7	9	0	0	0	0

3.2 Freezing Precipitation Tests

Tests were conducted in freezing drizzle, light freezing rain, freezing fog and rain on cold-soaked surface conditions at the National Research Council Canada (NRC) Climatic Engineering Facility (CEF). The number of tests conducted is summarized below by precipitation type, fluid dilution and test temperature.

Fluid Dilution	Freezing Drizzle		Light Freezing Rain		Freezing Fog			Cold Soak
	-3°C	-10°C	-3°C	-10°C	-3°C	-14°C	-25°C	+1°C
Neat	4	4	4	4	4	4	4	4
75/25	4	4	4	4	4	4	0	4
50/50	4	0	4	0	4	0	0	0

3.3 Natural Frost Tests

Tests were conducted in natural frost at the APS test site. The breakdown of tests conducted is summarized below by fluid dilution and temperature.

Fluid Dilution	Natural Frost			
	≥-1°C	<-1 to -3°C	<-3 to -10°C	<-10°C
Neat	0	0	1	3
75/25	1	0	1	3
50/50	1	0	0	0

3.4 Fluid Thickness Tests

Fluid thickness tests were conducted to measure the film thickness profiles of the fluid under dry conditions. Two tests were performed for each dilution. For each test, 1 litre of fluid was poured onto a flat plate mounted on a test stand inclined by 10°. Thickness measurements were taken at the 15-cm (6") line at select time intervals over a 30-minute period. Tests were conducted at -3°C.

3.5 Test Logs

Details of each test conducted are provided in the test logs included as Table 3.1 (snow), Table 3.2 (freezing precipitation), and Table 3.3 (frost).

Table 3.1: Summary of Tests Performed (Snow)

Test No.	Date	Snow Type	Fluid Name	Fluid Dilution	Test Temp. (°C)	Icing Intensity (g/dm²/h)	Endurance Time (min)
2	28-Dec-18	Natural Snow	ADD-PROTECT TYPE II	100%	-7.8	4.6	88.4
5	28-Dec-18	Natural Snow	ADD-PROTECT TYPE II	75%	-7.9	2.7	76.9
6	28-Dec-18	Natural Snow	ADD-PROTECT TYPE II	100%	-6.1	37.0	18.2
7	28-Dec-18	Natural Snow	ADD-PROTECT TYPE II	75%	-6.1	33.8	12.8
11	7-Jan-19	Natural Snow	ADD-PROTECT TYPE II	100%	-11.2	14.6	22.0
12	7-Jan-19	Natural Snow	ADD-PROTECT TYPE II	75%	-11.2	12.4	14.5
18	8-Jan-19	Natural Snow	ADD-PROTECT TYPE II	100%	-10.2	34.4	14.0
19	8-Jan-19	Natural Snow	ADD-PROTECT TYPE II	75%	-10.2	37.6	8.5
28	8-Jan-19	Natural Snow	ADD-PROTECT TYPE II	100%	-8.5	15.2	35.0
29	8-Jan-19	Natural Snow	ADD-PROTECT TYPE II	75%	-8.4	14.4	19.8
33	8-Jan-19	Natural Snow	ADD-PROTECT TYPE II	100%	-4.7	9.1	88.1
34	8-Jan-19	Natural Snow	ADD-PROTECT TYPE II	75%	-5.1	10.7	29.3
40	8-Jan-19	Natural Snow	ADD-PROTECT TYPE II	50%	-4.1	7.7	18.8
45	18-Jan-19	Natural Snow	ADD-PROTECT TYPE II	100%	-15.4	1.1	86.4
51	18-Jan-19	Natural Snow	ADD-PROTECT TYPE II	75%	-15.5	0.9	74.1
57	18-Jan-19	Natural Snow	ADD-PROTECT TYPE II	100%	-13.7	2.0	124.0
58	18-Jan-19	Natural Snow	ADD-PROTECT TYPE II	75%	-13.8	2.1	58.5
63	29-Jan-19	Natural Snow	ADD-PROTECT TYPE II	100%	-14.8	5.1	49.3
64	29-Jan-19	Natural Snow	ADD-PROTECT TYPE II	75%	-15.1	4.7	28.8
69	29-Jan-19	Natural Snow	ADD-PROTECT TYPE II	100%	-10.5	4.9	41.3
70	29-Jan-19	Natural Snow	ADD-PROTECT TYPE II	75%	-10.4	4.0	28.7
77	2-Feb-19	Natural Snow	ADD-PROTECT TYPE II	100%	-9.2	3.7	98.4
78	2-Feb-19	Natural Snow	ADD-PROTECT TYPE II	75%	-9.3	3.6	43.2
80	2-Feb-19	Natural Snow	ADD-PROTECT TYPE II	100%	-8.5	7.9	66.8
81	2-Feb-19	Natural Snow	ADD-PROTECT TYPE II	75%	-8.6	7.1	29.9
87	2-Feb-19	Natural Snow	ADD-PROTECT TYPE II	100%	-7.6	8.2	70.6
88	2-Feb-19	Natural Snow	ADD-PROTECT TYPE II	75%	-7.9	9.5	22.8
92	12-Feb-19	Natural Snow	ADD-PROTECT TYPE II	100%	-11.9	7.8	26.2
93	12-Feb-19	Natural Snow	ADD-PROTECT TYPE II	75%	-11.9	7.3	19.3
100	12-Feb-19	Natural Snow	ADD-PROTECT TYPE II	100%	-10.2	16.2	36.6
101	12-Feb-19	Natural Snow	ADD-PROTECT TYPE II	75%	-10.7	13.6	20.4
107	12-Feb-19	Natural Snow	ADD-PROTECT TYPE II	100%	-8.5	23.9	23.5
108	12-Feb-19	Natural Snow	ADD-PROTECT TYPE II	75%	-8.5	26.0	10.4
114	12-Feb-19	Natural Snow	ADD-PROTECT TYPE II	100%	-6.5	31.1	28.5
115	12-Feb-19	Natural Snow	ADD-PROTECT TYPE II	75%	-6.5	32.7	10.8
121	13-Feb-19	Natural Snow	ADD-PROTECT TYPE II	100%	-7.1	30.6	16.4
122	13-Feb-19	Natural Snow	ADD-PROTECT TYPE II	75%	-7.1	28.4	10.9

Table 3.1: Summary of Tests Performed (Snow) (cont'd)

Test No.	Date	Snow Type	Fluid Name	Fluid Dilution	Test Temp. (°C)	Icing Intensity (g/dm²/h)	Endurance Time (min)
128	13-Feb-19	Natural Snow	ADD-PROTECT TYPE II	100%	-7.5	54.2	12.0
129	13-Feb-19	Natural Snow	ADD-PROTECT TYPE II	75%	-7.5	53.7	7.2
132	13-Feb-19	Natural Snow	ADD-PROTECT TYPE II	100%	-7.3	63.6	9.4
133	13-Feb-19	Natural Snow	ADD-PROTECT TYPE II	75%	-7.3	64.0	5.9
138	13-Feb-19	Natural Snow	ADD-PROTECT TYPE II	100%	-7.0	31.6	18.7
139	13-Feb-19	Natural Snow	ADD-PROTECT TYPE II	75%	-7.0	32.2	9.0
151	15-Feb-19	Natural Snow	ADD-PROTECT TYPE II	75%	-3.9	10.2	28.8
152	15-Feb-19	Natural Snow	ADD-PROTECT TYPE II	50%	-4.8	10.3	13.8
154	15-Feb-19	Natural Snow	ADD-PROTECT TYPE II	50%	-3.0	10.1	13.0
155	21-Feb-19	Natural Snow	ADD-PROTECT TYPE II	100%	-5.5	23.8	20.1
156	21-Feb-19	Natural Snow	ADD-PROTECT TYPE II	75%	-5.5	24.8	9.4
168	21-Feb-19	Natural Snow	ADD-PROTECT TYPE II	100%	-6.3	50.3	11.8
169	21-Feb-19	Natural Snow	ADD-PROTECT TYPE II	75%	-6.2	49.5	7.5
173	21-Feb-19	Natural Snow	ADD-PROTECT TYPE II	100%	-7.3	27.4	17.4
174	21-Feb-19	Natural Snow	ADD-PROTECT TYPE II	75%	-7.3	24.7	11.9
180	21-Feb-19	Natural Snow	ADD-PROTECT TYPE II	100%	-7.1	8.2	67.7
181	21-Feb-19	Natural Snow	ADD-PROTECT TYPE II	75%	-7.1	7.0	34.2
197	3-Mar-19	Natural Snow	ADD-PROTECT TYPE II	75%	-3.3	2.4	75.1
198	3-Mar-19	Natural Snow	ADD-PROTECT TYPE II	50%	-3.1	3.0	27.4
200	3-Mar-19	Natural Snow	ADD-PROTECT TYPE II	50%	-3.6	1.9	41.8
204	3-Mar-19	Natural Snow	ADD-PROTECT TYPE II	75%	-4.1	1.1	135.1
214	10-Mar-19	Natural Snow	ADD-PROTECT TYPE II	100%	-1.8	38.6	19.8
215	10-Mar-19	Natural Snow	ADD-PROTECT TYPE II	75%	-1.8	36.8	12.8
216	10-Mar-19	Natural Snow	ADD-PROTECT TYPE II	50%	-1.8	36.6	8.3
223	10-Mar-19	Natural Snow	ADD-PROTECT TYPE II	100%	-1.8	38.5	21.9
224	10-Mar-19	Natural Snow	ADD-PROTECT TYPE II	75%	-1.8	36.9	13.4
225	10-Mar-19	Natural Snow	ADD-PROTECT TYPE II	50%	-1.8	40.5	5.6
232	10-Mar-19	Natural Snow	ADD-PROTECT TYPE II	100%	-1.3	37.1	20.4
233	10-Mar-19	Natural Snow	ADD-PROTECT TYPE II	75%	-1.3	32.6	14.1
234	10-Mar-19	Natural Snow	ADD-PROTECT TYPE II	50%	-1.3	26.1	8.7
236	10-Mar-19	Natural Snow	ADD-PROTECT TYPE II	50%	0.7	7.6	32.7
243	10-Mar-19	Natural Snow	ADD-PROTECT TYPE II	100%	-8.0	63.6	8.6
244	10-Mar-19	Natural Snow	ADD-PROTECT TYPE II	75%	-8.0	63.6	7.4
252	10-Mar-19	Natural Snow	ADD-PROTECT TYPE II	100%	-7.3	35.0	25.1
253	10-Mar-19	Natural Snow	ADD-PROTECT TYPE II	75%	-7.3	41.2	14.3
261	10-Mar-19	Natural Snow	ADD-PROTECT TYPE II	100%	-1.9	18.4	54.4

Table 3.1: Summary of Tests Performed (Snow) (cont'd)

Test No.	Date	Snow Type	Fluid Name	Fluid Dilution	Test Temp. (°C)	Icing Intensity (g/dm²/h)	Endurance Time (min)
262	10-Mar-19	Natural Snow	ADD-PROTECT TYPE II	75%	-2.0	20.2	32.7
263	10-Mar-19	Natural Snow	ADD-PROTECT TYPE II	50%	-2.0	21.6	17.7
270	10-Mar-19	Natural Snow	ADD-PROTECT TYPE II	100%	0.2	37.3	28.9
271	10-Mar-19	Natural Snow	ADD-PROTECT TYPE II	75%	0.2	38.3	20.6
272	10-Mar-19	Natural Snow	ADD-PROTECT TYPE II	50%	0.2	44.4	8.9
274	30-Mar-19	Natural Snow	ADD-PROTECT TYPE II	50%	-4.4	17.1	15.4
276	30-Mar-19	Natural Snow	ADD-PROTECT TYPE II	50%	-4.4	20.7	10.8
282	30-Mar-19	Natural Snow	ADD-PROTECT TYPE II	100%	-4.2	26.3	30.5
283	30-Mar-19	Natural Snow	ADD-PROTECT TYPE II	75%	-4.2	24.8	16.6
285	30-Mar-19	Natural Snow	ADD-PROTECT TYPE II	50%	-4.2	28.0	7.2
287	30-Mar-19	Natural Snow	ADD-PROTECT TYPE II	50%	-4.3	23.7	10.8
289	30-Mar-19	Natural Snow	ADD-PROTECT TYPE II	50%	-4.5	12.3	18.9
AS9	23-Apr-19	Artificial Snow	ADD-PROTECT TYPE II	100%	-18.0	3.1	50.6
AS9R	26-Apr-19	Artificial Snow	ADD-PROTECT TYPE II	100%	-18.0	3.0	58.9
AS10	26-Apr-19	Artificial Snow	ADD-PROTECT TYPE II	100%	-18.0	4.1	28.0
AS10R	26-Apr-19	Artificial Snow	ADD-PROTECT TYPE II	100%	-18.0	4.0	34.5
AS11	26-Apr-19	Artificial Snow	ADD-PROTECT TYPE II	100%	-18.0	10.2	14.4
AS11R	26-Apr-19	Artificial Snow	ADD-PROTECT TYPE II	100%	-18.0	10.1	16.1
AS12	24-Apr-19	Artificial Snow	ADD-PROTECT TYPE II	100%	-18.0	25.1	7.4
AS12R	26-Apr-19	Artificial Snow	ADD-PROTECT TYPE II	100%	-18.0	25.4	8.5
AS13	15-Apr-19	Artificial Snow	ADD-PROTECT TYPE II	100%	-25.0	3.0	44.3
AS14	17-Apr-19	Artificial Snow	ADD-PROTECT TYPE II	100%	-25.0	4.0	26.7
AS14R	22-Apr-19	Artificial Snow	ADD-PROTECT TYPE II	100%	-25.0	4.0	24.4
AS15	5-Apr-19	Artificial Snow	ADD-PROTECT TYPE II	100%	-25.0	10.3	7.6
AS15R	8-Apr-19	Artificial Snow	ADD-PROTECT TYPE II	100%	-25.0	10.0	11.6
AS15R2	22-Apr-19	Artificial Snow	ADD-PROTECT TYPE II	100%	-25.0	10.0	11.4
AS16	15-Apr-19	Artificial Snow	ADD-PROTECT TYPE II	100%	-25.0	25.0	7.8
AS16R	22-Apr-19	Artificial Snow	ADD-PROTECT TYPE II	100%	-25.0	25.9	8.9

Table 3.2: Summary of Tests Performed (Freezing Precipitation)

Test No.	Date	Precipitation Type	Fluid Name	Fluid Dilution	Test Temp. (°C)	Icing Intensity (g/dm²/h)	Endurance Time (min)
1	11-Apr-19	Cold-Soaked Box	ADD-PROTECT TYPE II	100%	1.0	4.8	47.5
2	11-Apr-19	Cold-Soaked Box	ADD-PROTECT TYPE II	100%	1.0	5.1	50.9
3	11-Apr-19	Cold-Soaked Box	ADD-PROTECT TYPE II	75%	1.0	4.8	25.9
4	11-Apr-19	Cold-Soaked Box	ADD-PROTECT TYPE II	75%	1.0	5.2	24.0
15	11-Apr-19	Cold-Soaked Box	ADD-PROTECT TYPE II	100%	1.3	77.7	9.0
16	11-Apr-19	Cold-Soaked Box	ADD-PROTECT TYPE II	100%	1.3	77.7	9.1
17	11-Apr-19	Cold-Soaked Box	ADD-PROTECT TYPE II	75%	1.4	77.3	5.7
18	11-Apr-19	Cold-Soaked Box	ADD-PROTECT TYPE II	75%	1.4	74.9	6.0
29	3-Apr-19	Freezing Drizzle	ADD-PROTECT TYPE II	100%	-3.1	5.2	87.5
30	3-Apr-19	Freezing Drizzle	ADD-PROTECT TYPE II	100%	-3.1	5.3	93.3
31	3-Apr-19	Freezing Drizzle	ADD-PROTECT TYPE II	75%	-3.1	5.3	39.0
32	3-Apr-19	Freezing Drizzle	ADD-PROTECT TYPE II	75%	-3.1	5.3	37.8
33	3-Apr-19	Freezing Drizzle	ADD-PROTECT TYPE II	50%	-3.1	5.1	25.2
34	3-Apr-19	Freezing Drizzle	ADD-PROTECT TYPE II	50%	-3.1	5.4	30.5
47	3-Apr-19	Freezing Drizzle	ADD-PROTECT TYPE II	100%	-3.2	13.3	37.0
48	3-Apr-19	Freezing Drizzle	ADD-PROTECT TYPE II	100%	-3.2	13.4	39.4
49	3-Apr-19	Freezing Drizzle	ADD-PROTECT TYPE II	75%	-3.3	13.3	20.9
50	3-Apr-19	Freezing Drizzle	ADD-PROTECT TYPE II	75%	-3.3	13.4	23.7
51	3-Apr-19	Freezing Drizzle	ADD-PROTECT TYPE II	50%	-3.1	13.5	12.9
52	3-Apr-19	Freezing Drizzle	ADD-PROTECT TYPE II	50%	-3.1	13.1	10.9
65	4-Apr-19	Freezing Drizzle	ADD-PROTECT TYPE II	100%	-10.2	5.3	47.7
66	4-Apr-19	Freezing Drizzle	ADD-PROTECT TYPE II	100%	-10.2	5.1	53.2
67	4-Apr-19	Freezing Drizzle	ADD-PROTECT TYPE II	75%	-10.1	4.9	32.0
68	4-Apr-19	Freezing Drizzle	ADD-PROTECT TYPE II	75%	-10.1	4.9	31.7
79	4-Apr-19	Freezing Drizzle	ADD-PROTECT TYPE II	100%	-10.2	13.0	24.6
80	4-Apr-19	Freezing Drizzle	ADD-PROTECT TYPE II	100%	-10.2	13.2	24.7
81	4-Apr-19	Freezing Drizzle	ADD-PROTECT TYPE II	75%	-10.2	13.2	19.2
82	4-Apr-19	Freezing Drizzle	ADD-PROTECT TYPE II	75%	-10.2	13.3	17.4
93	10-Apr-19	Freezing Fog	ADD-PROTECT TYPE II	100%	-3.2	2.1	189.3
94	10-Apr-19	Freezing Fog	ADD-PROTECT TYPE II	100%	-3.2	2.3	202.8
95	10-Apr-19	Freezing Fog	ADD-PROTECT TYPE II	75%	-3.0	2.0	67.0
96	10-Apr-19	Freezing Fog	ADD-PROTECT TYPE II	75%	-3.0	1.8	79.0
97	10-Apr-19	Freezing Fog	ADD-PROTECT TYPE II	50%	-3.1	2.0	39.8
98	10-Apr-19	Freezing Fog	ADD-PROTECT TYPE II	50%	-3.1	1.8	34.7
111	10-Apr-19	Freezing Fog	ADD-PROTECT TYPE II	100%	-3.1	4.9	108.8
112	10-Apr-19	Freezing Fog	ADD-PROTECT TYPE II	100%	-3.1	5.3	87.9
113	10-Apr-19	Freezing Fog	ADD-PROTECT TYPE II	75%	-3.1	5.1	43.4

Table 3.2: Summary of Tests Performed (Freezing Precipitation) (cont'd)

Test No.	Date	Precipitation Type	Fluid Name	Fluid Dilution	Test Temp. (°C)	Icing Intensity (g/dm²/h)	Endurance Time (min)
114	10-Apr-19	Freezing Fog	ADD-PROTECT TYPE II	75%	-3.1	5.1	36.1
115	10-Apr-19	Freezing Fog	ADD-PROTECT TYPE II	50%	-3.0	5.0	21.9
116	10-Apr-19	Freezing Fog	ADD-PROTECT TYPE II	50%	-3.0	4.9	18.6
129	9-Apr-19	Freezing Fog	ADD-PROTECT TYPE II	100%	-14.1	2.0	47.3
130	9-Apr-19	Freezing Fog	ADD-PROTECT TYPE II	100%	-14.1	2.1	44.5
131	9-Apr-19	Freezing Fog	ADD-PROTECT TYPE II	75%	-14.1	2.0	52.9
132	9-Apr-19	Freezing Fog	ADD-PROTECT TYPE II	75%	-14.1	2.1	51.9
143	9-Apr-19	Freezing Fog	ADD-PROTECT TYPE II	100%	-14.0	4.7	27.3
144	9-Apr-19	Freezing Fog	ADD-PROTECT TYPE II	100%	-13.9	4.9	29.0
145	9-Apr-19	Freezing Fog	ADD-PROTECT TYPE II	75%	-14.2	4.7	29.9
146	9-Apr-19	Freezing Fog	ADD-PROTECT TYPE II	75%	-14.2	4.9	30.2
167	8-Apr-19	Freezing Fog	ADD-PROTECT TYPE II	100%	-24.9	4.8	15.5
168	8-Apr-19	Freezing Fog	ADD-PROTECT TYPE II	100%	-24.9	4.9	15.3
181	5-Apr-19	Light Freezing Rain	ADD-PROTECT TYPE II	100%	-2.9	13.2	43.4
182	5-Apr-19	Light Freezing Rain	ADD-PROTECT TYPE II	100%	-2.9	12.8	41.9
183	5-Apr-19	Light Freezing Rain	ADD-PROTECT TYPE II	75%	-2.8	13.4	24.1
184	5-Apr-19	Light Freezing Rain	ADD-PROTECT TYPE II	75%	-2.8	13.3	20.7
185	5-Apr-19	Light Freezing Rain	ADD-PROTECT TYPE II	50%	-2.8	13.4	11.5
186	5-Apr-19	Light Freezing Rain	ADD-PROTECT TYPE II	50%	-2.8	12.9	12.0
199	5-Apr-19	Light Freezing Rain	ADD-PROTECT TYPE II	100%	-3.0	25.5	25.7
200	5-Apr-19	Light Freezing Rain	ADD-PROTECT TYPE II	100%	-3.0	25.6	25.1
201	5-Apr-19	Light Freezing Rain	ADD-PROTECT TYPE II	75%	-3.1	25.4	14.7
202	5-Apr-19	Light Freezing Rain	ADD-PROTECT TYPE II	75%	-3.1	25.2	14.4
203	5-Apr-19	Light Freezing Rain	ADD-PROTECT TYPE II	50%	-3.1	24.9	8.2
204	5-Apr-19	Light Freezing Rain	ADD-PROTECT TYPE II	50%	-3.1	25.4	7.7
217	4-Apr-19	Light Freezing Rain	ADD-PROTECT TYPE II	100%	-9.6	13.2	28.1
218	4-Apr-19	Light Freezing Rain	ADD-PROTECT TYPE II	100%	-9.6	13.2	28.1
219	4-Apr-19	Light Freezing Rain	ADD-PROTECT TYPE II	75%	-9.5	13.2	18.2
220	4-Apr-19	Light Freezing Rain	ADD-PROTECT TYPE II	75%	-9.5	13.2	17.9
231	5-Apr-19	Light Freezing Rain	ADD-PROTECT TYPE II	100%	-10.0	25.8	19.1
232	5-Apr-19	Light Freezing Rain	ADD-PROTECT TYPE II	100%	-10.0	25.9	19.2
233	5-Apr-19	Light Freezing Rain	ADD-PROTECT TYPE II	75%	-9.9	24.6	12.5
234	5-Apr-19	Light Freezing Rain	ADD-PROTECT TYPE II	75%	-9.9	24.7	13.0
157R	8-Apr-19	Freezing Fog	ADD-PROTECT TYPE II	100%	-25.0	2.0	24.9
158R	8-Apr-19	Freezing Fog	ADD-PROTECT TYPE II	100%	-25.0	2.2	25.1

Table 3.3: Summary of Tests Performed (Natural Frost)

Test No.	Date	Precip. Type	Fluid Name	Fluid Dilution	Test Duration (min.)	Average Rate (g/dm²/h)	Temp (°C)	Wind Speed (km/h)	Average RH (%)	Comments
7	11-Feb-19	Natural Frost	ADD-PROTECT TYPE II	75%	67	0.02	-12.2	7	57	Did Not Fail
11	17-Feb-19	Natural Frost	ADD-PROTECT TYPE II	100%	426	0.05	-14.0	9	73	Did Not Fail
14	17-Feb-19	Natural Frost	ADD-PROTECT TYPE II	75%	374	0.05	-14.4	8	74	Did Not Fail
21	19-Feb-19	Natural Frost	ADD-PROTECT TYPE II	100%	307	0.06	-16.3	5	78	
25	19-Feb-19	Natural Frost	ADD-PROTECT TYPE II	75%	184	0.05	-15.7	5	76	
26	28-Feb-19	Natural Frost	ADD-PROTECT TYPE II	100%	503	0.05	-14.1	6	67	
33	18-Mar-19	Natural Frost	ADD-PROTECT TYPE II	100%	546	0.06	-8.4	5	68	Did Not Fail
37	18-Mar-19	Natural Frost	ADD-PROTECT TYPE II	75%	267	0.09	-7.2	5	68	
40	16-Apr-19	Natural Frost	ADD-PROTECT TYPE II	75%	308	0.10	0.7	6	72	Did Not Fail
43	16-Apr-19	Natural Frost	ADD-PROTECT TYPE II	50%	306	0.10	0.7	6	72	Did Not Fail

4. RESULTS AND DISCUSSION

The methods used to evaluate the test data are provided in the report "*Methodology for Endurance Time Testing of Type II, III, and IV Fluids – Winter 2018-19,*" which is provided as an annex to this report. The results of the data analyses and a discussion of the findings are presented in this section.

4.1 Results

The results of the endurance time and thickness tests are described in this section.

4.1.1 Endurance Time Tests – Natural Snow and Freezing Precipitation

Figures 4.1 to 4.16 present the endurance time data collected in natural snow, artificial snow, and freezing precipitation (freezing drizzle, light freezing rain, freezing fog, and rain on cold-soaked surface).

These figures show the effect of temperature, precipitation type and precipitation rate on fluid endurance time in the conditions encompassed by the Type II HOT guidelines. The figures include the current Type II generic holdover times for comparative purposes.

Multi-variable regression analysis was performed on these data sets as described in the annex. Table 4.1 provides the outputs from the multi-variable regression analyses. These outputs were used to derive fluid-specific holdover times for all conditions encompassed by Type IV fluid-specific HOT tables. One exception is the snow cells in temperature bands colder than -14°C (see Subsection 4.2.2).

4.1.2 Endurance Time Tests – Natural Frost

The natural frost data was presented in Table 3.3. The test durations were compared to the Type II generic holdover times. Tests that were not completed (due to active frost ending before fluid failure could occur) surpassed the generic holdover times.

Two data points failed to meet the existing Type II generic holdover times. Additional natural frost tests will be completed in winter 2019-20 with retained samples of ROMCHIM ADD-PROTECT TYPE II. The data collected will be analyzed again once additional data collection is complete.

4.1.3 Fluid Thickness Tests

Figure 4.17 shows the fluid thickness test data. As described in Subsection 3.4, two tests were conducted at an ambient temperature of -3°C. The final fluid thicknesses are displayed in Figure 4.18.

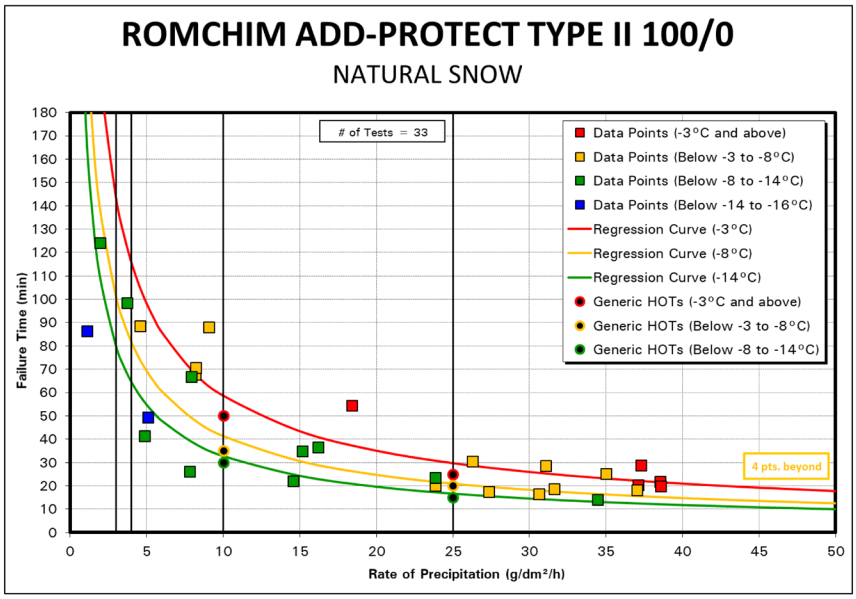


Figure 4.1: Type II 100/0 – Natural Snow

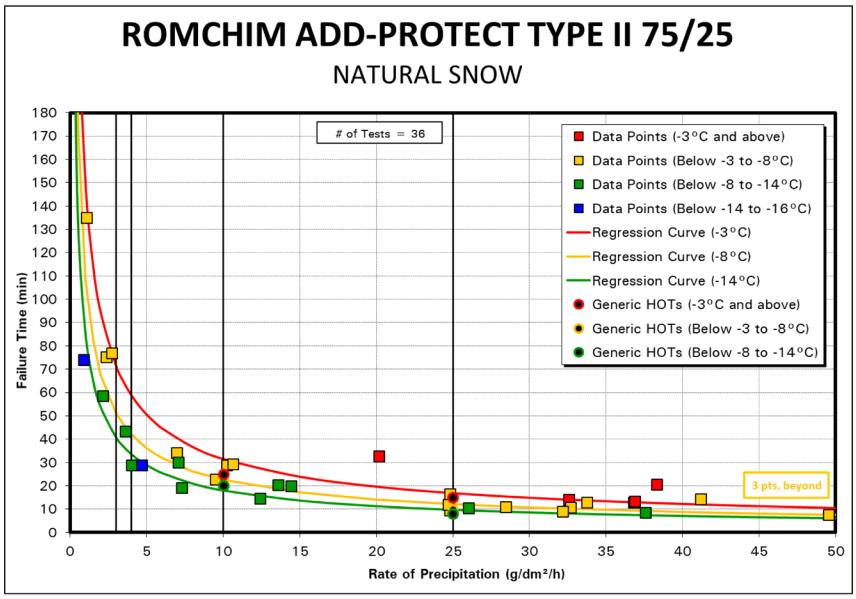


Figure 4.2: Type II 75/25 – Natural Snow

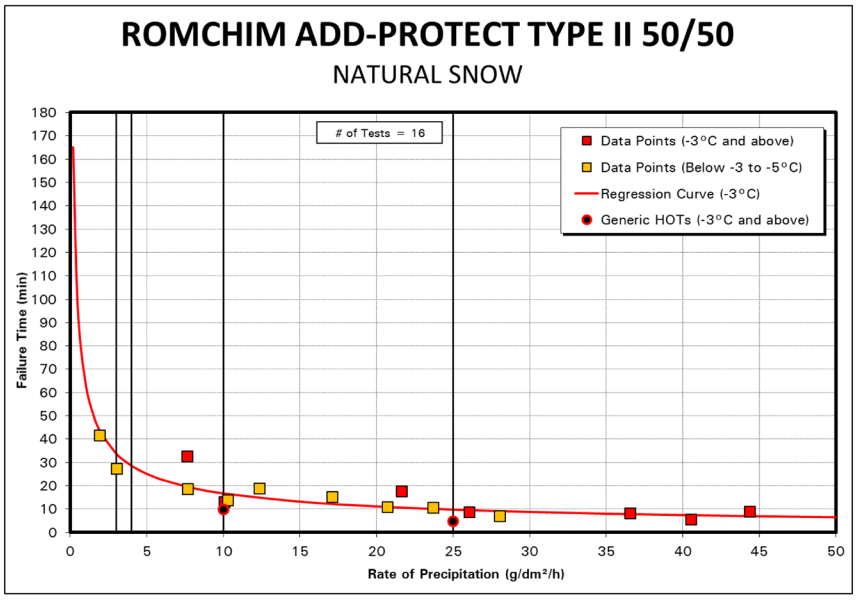


Figure 4.3: Type II 50/50 – Natural Snow

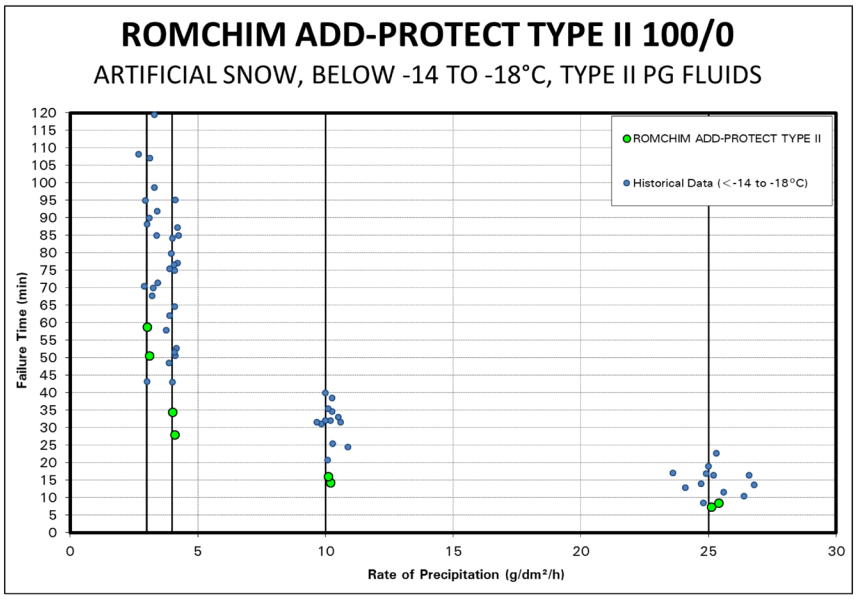


Figure 4.4: Type II 100/0 – Artificial Snow at -18°C with Historical Results

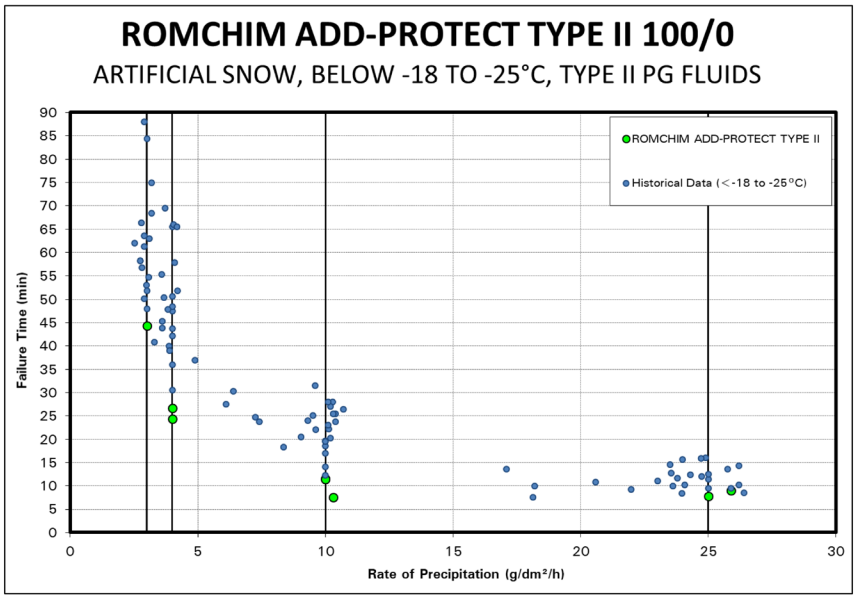


Figure 4.5: Type II 100/0 – Artificial Snow at -25°C with Historical Results

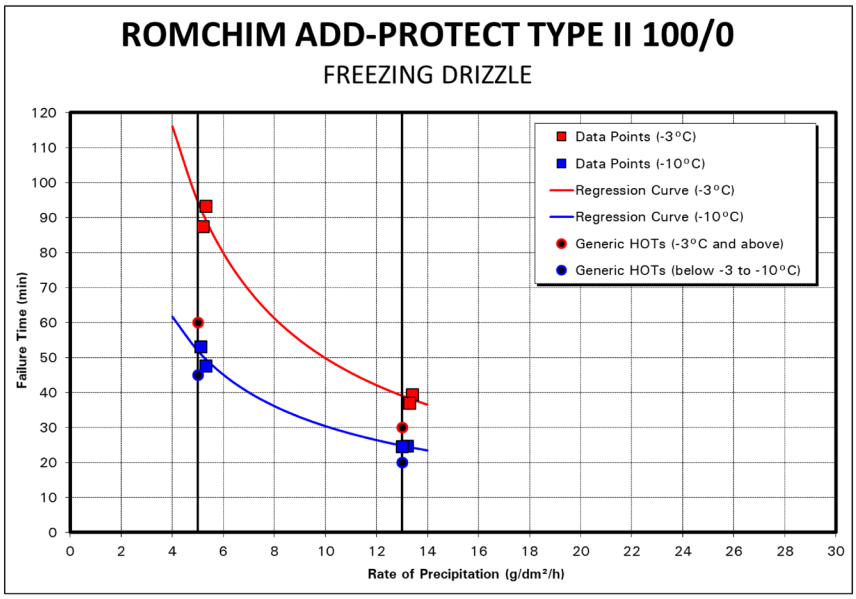


Figure 4.6: Type II 100/0 – Freezing Drizzle

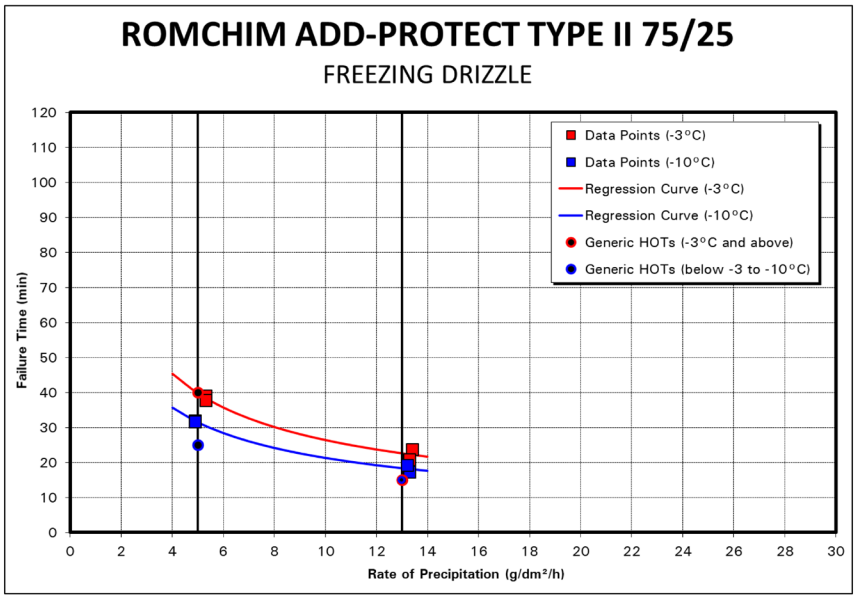


Figure 4.7: Type II 75/25 – Freezing Drizzle

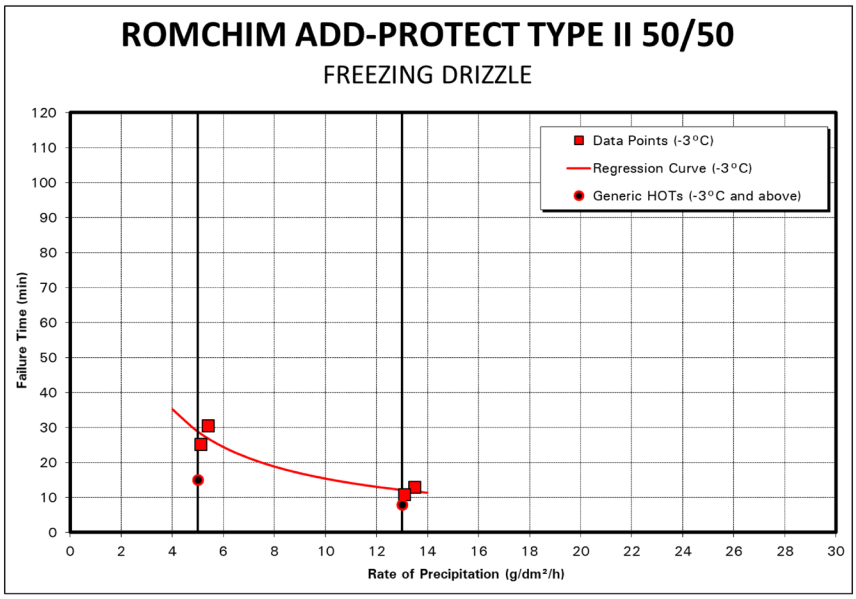


Figure 4.8: Type II 50/50 – Freezing Drizzle

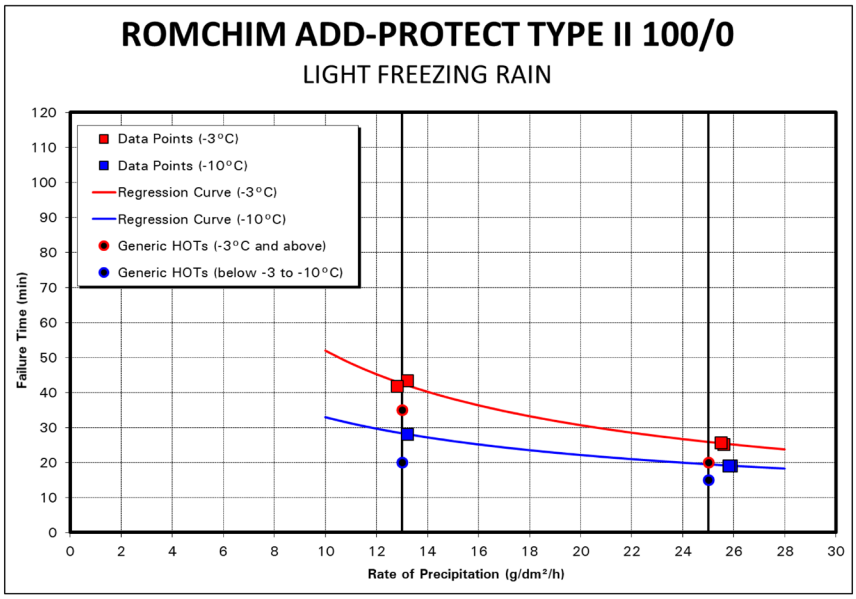


Figure 4.9: Type II 100/0 – Light Freezing Rain

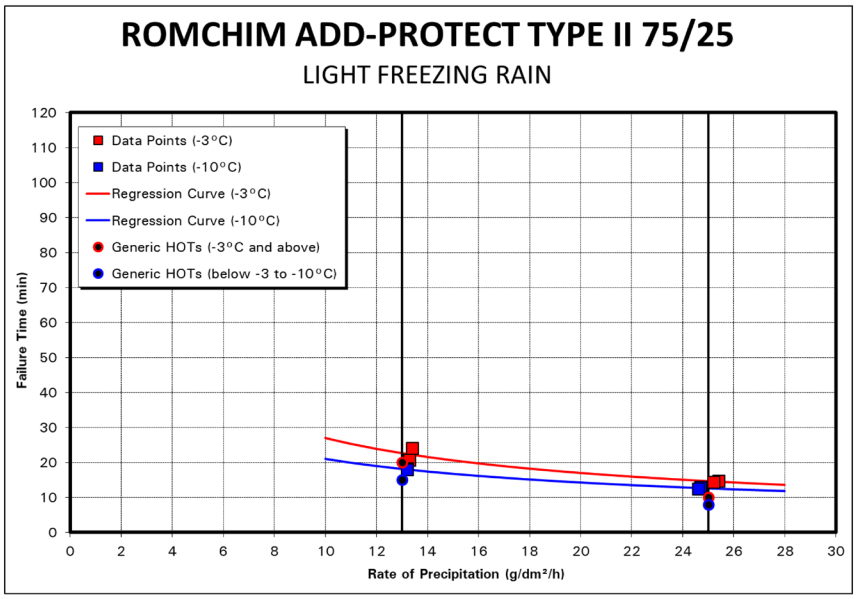


Figure 4.10: Type II 75/25 – Light Freezing Rain

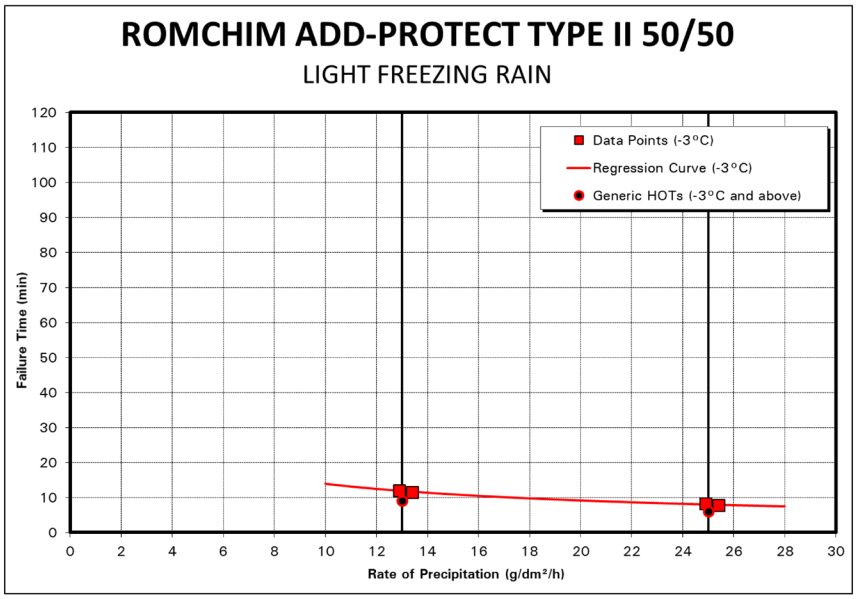


Figure 4.11: Type II 50/50 – Light Freezing Rain

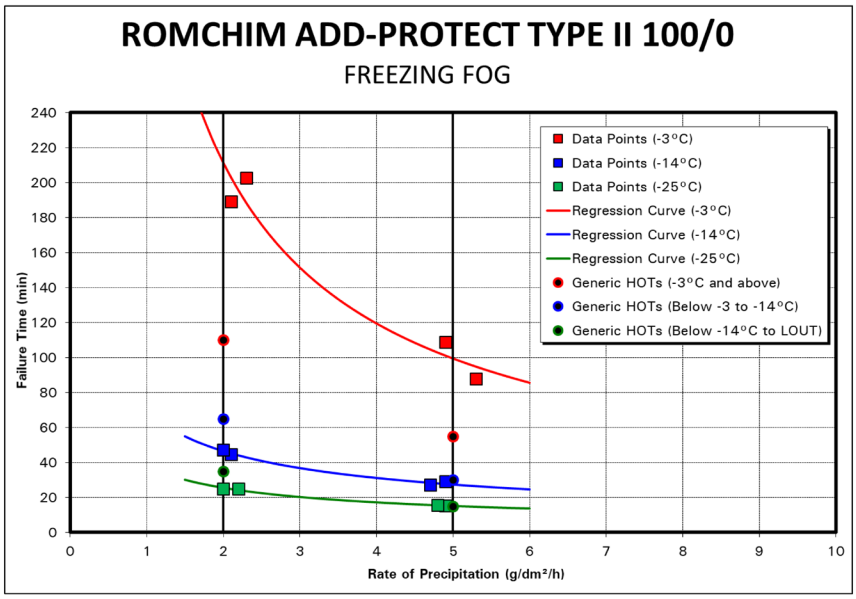


Figure 4.12: Type II 100/0 – Freezing Fog

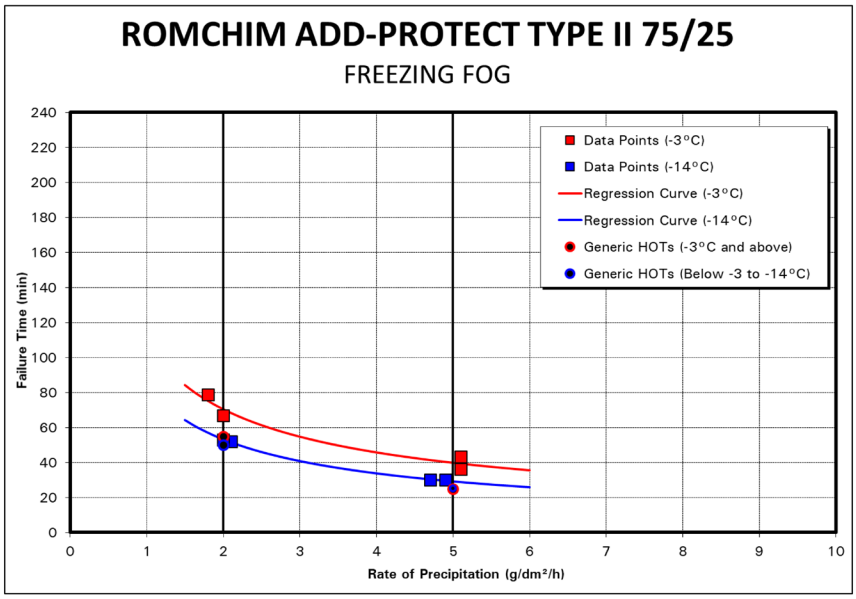


Figure 4.13: Type II 75/25 – Freezing Fog

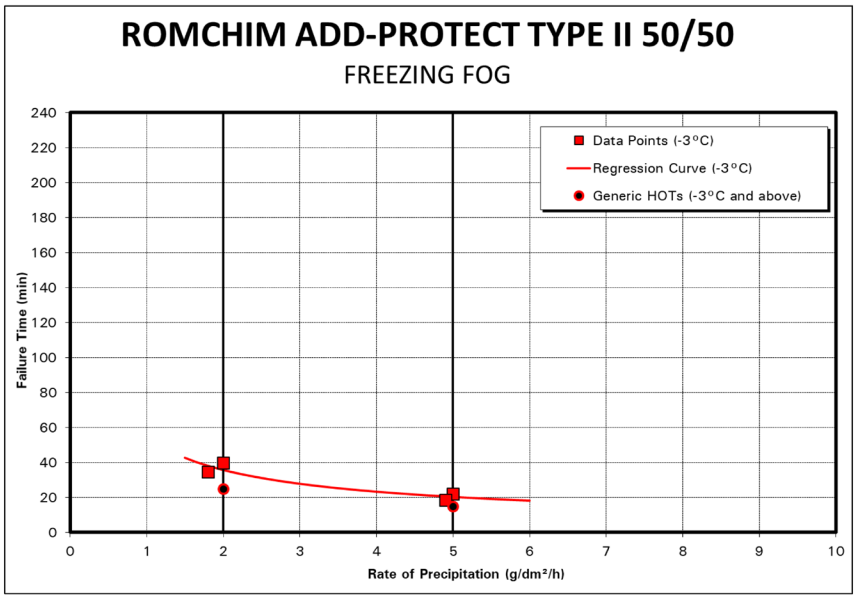


Figure 4.14: Type II 50/50 – Freezing Fog

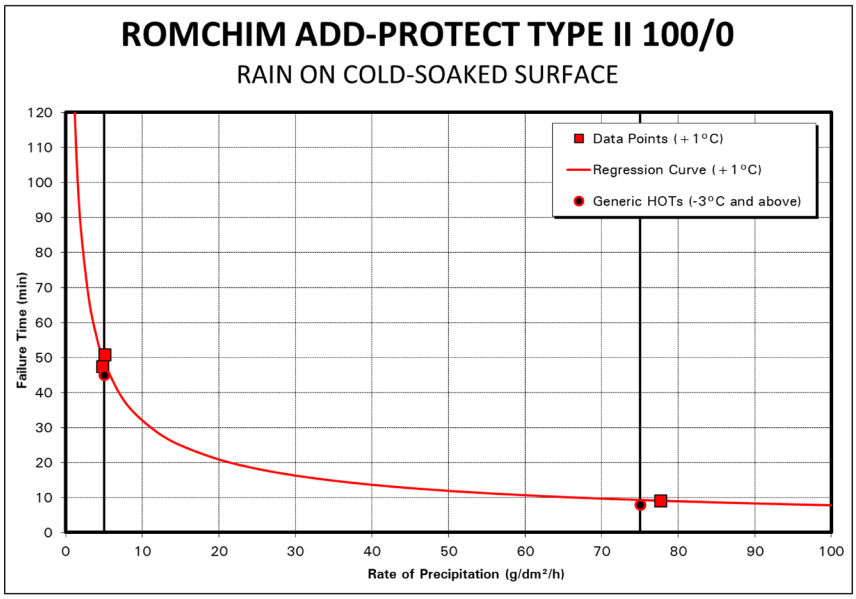


Figure 4.15: Type II 100/0 – Rain on Cold-Soaked Surface

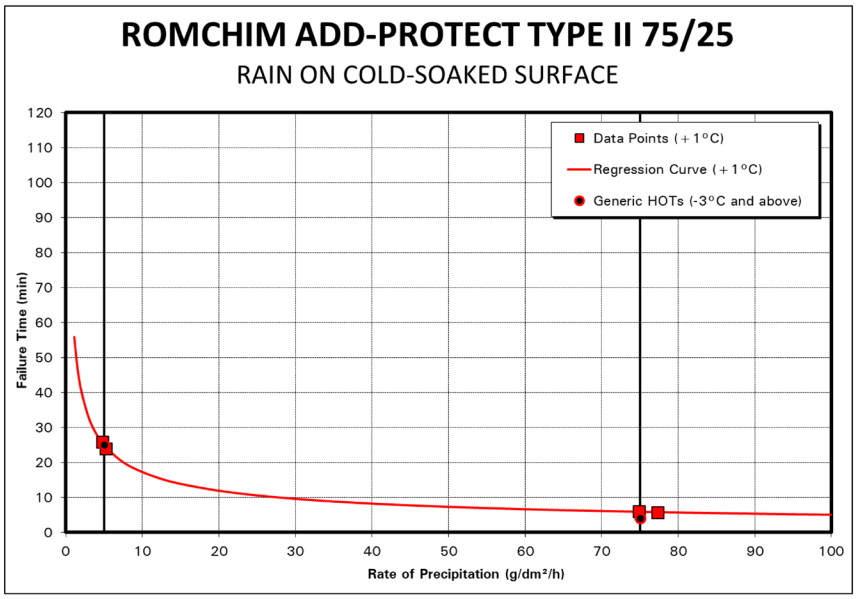


Figure 4.16: Type II 75/25 – Rain on Cold-Soaked Surface

Table 4.1: Regression Equation Coefficients for ROMCHIM ADD-PROTECT TYPE II

Natural Snow

Fluid	Dil	Temp.	R^2	Intercept (I)	Coeff. Rate (A)	Coeff. Tem (B)	Total Pts.
ROMCHIM ADD-PROTECT TYPE II	100%	≥ -14°C	86%	2.8637	-0.7431	-0.5033	33
ROMCHIM ADD-PROTECT TYPE II	75%	≥ -14°C	94%	2.5210	-0.6815	-0.4862	36
ROMCHIM ADD-PROTECT TYPE II	50%	≥ -14°C	84%	1.9864	-0.5840	-0.2529	16

General Equation $t = 10^{I} R^{A} (2\text{-}T)^{B}$

Simulated Freezing Fog

Fluid	Dil	Temp.	R^2	Intercept (I)	Coeff. Rate (A)	Total Pts.
ROMCHIM ADD-PROTECT TYPE II	100%	-3°C	96%	2.5740	-0.8251	4
ROMCHIM ADD-PROTECT TYPE II	75%	-3°C	94%	2.0354	-0.6203	4
ROMCHIM ADD-PROTECT TYPE II	50%	-3°C	91%	1.7404	-0.6221	4
ROMCHIM ADD-PROTECT TYPE II	100%	-14°C	98%	1.8401	-0.5735	4
ROMCHIM ADD-PROTECT TYPE II	75%	-14°C	100%	1.9219	-0.6509	4
ROMCHIM ADD-PROTECT TYPE II	100%	-25°C	99%	1.5810	-0.5714	4

General Equation $t = 10^{I} R^{A}$

Simulated Freezing Drizzle

Fluid	Dil	Temp.	R^2	Intercept (I)	Coeff. Rate (A)	Total Pts.
ROMCHIM ADD-PROTECT TYPE II	100%	-3°C	99%	2.6191	-0.9213	4
ROMCHIM ADD-PROTECT TYPE II	75%	-3°C	97%	2.0120	-0.5901	4
ROMCHIM ADD-PROTECT TYPE II	50%	-3°C	93%	2.0897	-0.9018	4
ROMCHIM ADD-PROTECT TYPE II	100%	-10°C	99%	2.2574	-0.7754	4
ROMCHIM ADD-PROTECT TYPE II	75%	-10°C	99%	1.8894	-0.5596	4

General Equation $t = 10^{I} R^{A}$

Simulated Light Freezing Rain

Fluid	Dil	Temp.	R^2	Intercept (I)	Coeff. Rate (A)	Total Pts.
ROMCHIM ADD-PROTECT TYPE II	100%	-3°C	99%	2.4792	-0.7630	4
ROMCHIM ADD-PROTECT TYPE II	75%	-3°C	94%	2.1011	-0.6689	4
ROMCHIM ADD-PROTECT TYPE II	50%	-3°C	99%	1.7429	-0.6010	4
ROMCHIM ADD-PROTECT TYPE II	100%	-10°C	100%	2.0901	-0.5723	4
ROMCHIM ADD-PROTECT TYPE II	75%	-10°C	99%	1.8836	-0.5597	4

General Equation $t = 10^{I} R^{A}$

Simulated Rain on Cold-Soaked Wing

Fluid	Dil	Temp.	R^2	Intercept (I)	Coeff. Rate (A)	Total Pts.
ROMCHIM ADD-PROTECT TYPE II	100%	+1°C	100%	2.1185	-0.6149	4
ROMCHIM ADD-PROTECT TYPE II	75%	+1°C	100%	1.7686	-0.5325	4

General Equation $t = 10^{I} R^{A}$

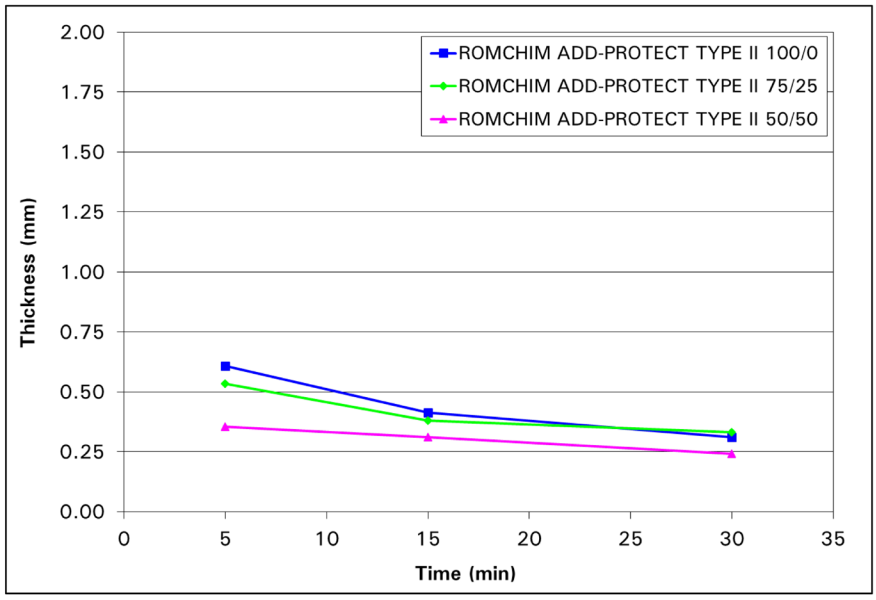


Figure 4.17: Fluid Thickness Profiles of ROMCHIM ADD-PROTECT TYPE II

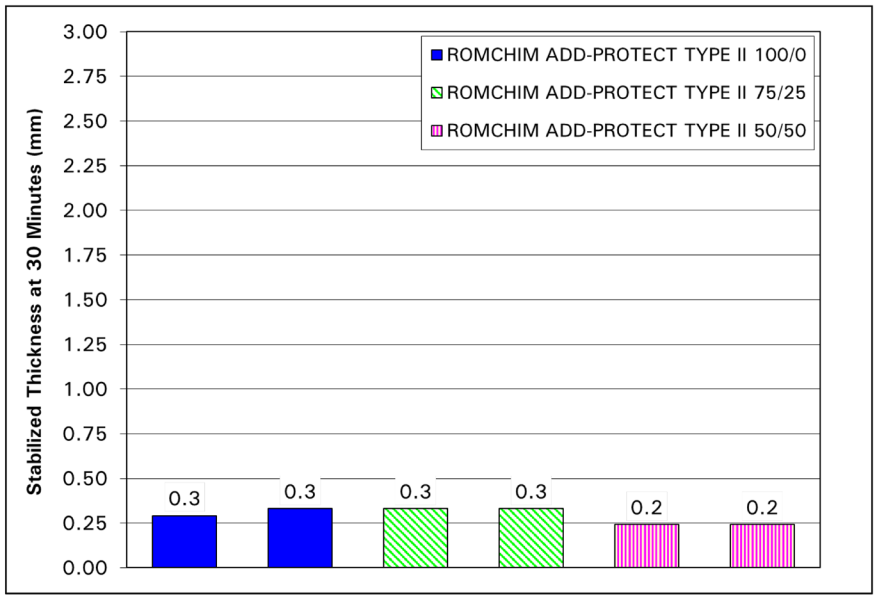


Figure 4.18: Final Fluid Thickness of ROMCHIM ADD-PROTECT TYPE II

4.2 Discussion

4.2.1 Holdover Time Table

The holdover times described in Subsection 4.1 were used to populate a fluid-specific HOT table for ROMCHIM ADD-PROTECT TYPE II. The HOT table is shown in both the TC format (Table 4.2) and FAA format (Table 4.3) at the end of this chapter.

4.2.2 Holdover Times in Snow at Temperatures Below -14°C

Due to the cost associated with collecting endurance time data in very cold snow conditions, all Type II/IV fluids that have not undergone (optional) supplemental fluid-specific testing in very cold snow are given generic HOT values for snow at temperatures below -14°C. These generic values were determined analytically in the winter of 2018-19, and are based on limited fluid-specific natural snow data and an analysis of relative fluid performance.

The generic values differ for Type II and Type IV fluids and for ethylene glycol (EG) and propylene glycol (PG) based fluids. Accordingly, ROMCHIM ADD-PROTECT TYPE II has been given Type II PG-specific generic values in the "Below -14°C to -18°C," "Below -18°C to -25°C," and "Below -25°C to lowest operational use temperature (LOUT)" snow cells.

4.2.3 Holdover Times in Frost

It should be noted that frost holdover times are not included in the fluid-specific HOT tables. This is due to a decision made by TC and the FAA in May 2009 to move frost holdover times from the generic and fluid-specific HOT tables to a separate frost HOT table. Accordingly, frost holdover times have not been included in the ROMCHIM ADD-PROTECT TYPE II fluid-specific HOT table.

4.2.4 Fluid Viscosity

The viscosities of the fluid samples used in this testing were measured using both the AS9968 method and the manufacturer's designated method. The APS measured viscosities appear at the beginning of this document and will be published as the lowest on-wing viscosity (LOWV) values for the fluid. In order for the fluid-specific holdover times provided in this document to be valid, operators must ensure that the viscosity of the fluid being used is equal or greater than the published LOWV.

4.2.5 Lowest Operational Use Temperatures (LOUTs)

The LOUT for Type II/III/IV fluids is determined by the higher of:

a) The lowest temperature at which the fluid meets the aerodynamic acceptance test for a given aircraft type; and

b) The actual freezing point of the fluid plus its freezing point buffer of 7°C (13°F).

The aerodynamic acceptance and freezing point information for this fluid is provided at the beginning of this document. The LOUTs for ROMCHIM ADD-PROTECT TYPE II are:

- 100/0: -28°C (-18°F);
- 75/25: -14°C (7°F); and
- 50/50: -3°C (27°F).

4.2.6 Lowest and Highest Usable Precipitation Rates in Snow

The lowest usable precipitation rates (LUPRs) and highest usable precipitation rates (HUPRs) for ROMCHIM ADD-PROTECT TYPE II were determined by analysing the natural snow data sets using the analysis methodology described in the report "*Methodology for Endurance Time Testing of Type II, III, and IV Fluids – Winter 2018-19*," which is provided as an annex to this report. The resulting statistics are shown in Table 4.4 (LUPR statistics) and 4.5 (HUPR statistics).

The analysis determined the LUPRs for ROMCHIM ADD-PROTECT TYPE II are:

- 100/0 = 3 g/dm²/h;
- 75/25 = 3 g/dm²/h; and
- 50/50 = 3 g/dm²/h.

The analysis determined the HUPRs for ROMCHIM ADD-PROTECT TYPE II are:

- 100/0 = 50 g/dm²/h;
- 75/25 = 50 g/dm²/h; and
- 50/50 = 50 g/dm²/h.

4.2.7 Publication of Holdover Times

As ROMCHIM PROTECT SRL intends to commercialize ADD-PROTECT TYPE II, TC and FAA will publish its fluid-specific HOT table in their 2019-20 HOT Guidelines. The guidelines will also include the LOWV and LOUT information; the regression and LUPR/HUPR data will be published in the related TC and FAA Regression Information documents.

Table 4.2: Fluid Specific Holdover Time Guidelines – ROMCHIM ADD-PROTECT TYPE II (TC Format)

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	1:40 - 3:30	1:55	1:00 - 1:55	0:30 - 1:00	0:40 - 1:35	0:25 - 0:45	0:09 - 0:50	
	75/25	0:40 - 1:10	1:00	0:30 - 1:00	0:15 - 0:30	0:25 - 0:40	0:15 - 0:25	0:05 - 0:25	
	50/50	0:20 - 0:35	0:30	0:15 - 0:30	0:09 - 0:15	0:10 - 0:30	0:08 - 0:10		
below -3 to -8°C (below 27 to 18°F)	100/0	0:30 - 0:45	1:20	0:40 - 1:20	0:20 - 0:40	0:25 - 0:50	0:20 - 0:30		
	75/25	0:30 - 0:55	0:40	0:25 - 0:40	0:10 - 0:25	0:20 - 0:30	0:15 - 0:20		
below -8 to -14°C (below 18 to 7°F)	100/0	0:30 - 0:45	1:05	0:35 - 1:05	0:15 - 0:35	0:25 - 0:50[7]	0:20 - 0:30[7]		
	75/25	0:30 - 0:55	0:35	0:20 - 0:35	0:09 - 0:20	0:20 - 0:30[7]	0:15 - 0:20[7]		
below -14 to -18°C (below 7 to 0°F)	100/0	0:15 - 0:25	0:20	0:07 - 0:20	0:02 - 0:07				
below -18 to -25°C (below 0 to -13°F)	100/0	0:15 - 0:25	0:09	0:03 - 0:09	0:01 - 0:03				
below -25 to -28°C (below -13 to -18°F)	100/0	0:15 - 0:25	0:05	0:01 - 0:05	0:00 - 0:01				

CAUTION: No holdover time guidelines exist

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

Table 4.3: Fluid Specific Holdover Time Guidelines – ROMCHIM ADD-PROTECT TYPE II (FAA Format)

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	1:40 - 3:30	1:55 - 2:25	1:00 - 1:55	0:30 - 1:00	0:40 - 1:35	0:25 - 0:45	0:09 - 0:50	
	75/25	0:40 - 1:10	1:00 - 1:10	0:30 - 1:00	0:15 - 0:30	0:25 - 0:40	0:15 - 0:25	0:05 - 0:25	
	50/50	0:20 - 0:35	0:30 - 0:35	0:15 - 0:30	0:09 - 0:15	0:10 - 0:30	0:08 - 0:10	CAUTION: No holdover time guidelines exist	
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:30 - 0:45	1:20 - 1:40	0:40 - 1:20	0:20 - 0:40	0:25 - 0:50	0:20 - 0:30		
	75/25	0:30 - 0:55	0:40 - 0:50	0:25 - 0:40	0:10 - 0:25	0:20 - 0:30	0:15 - 0:20		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:30 - 0:45	1:05 - 1:20	0:35 - 1:05	0:15 - 0:35	0:25 - 0:50[7]	0:20 - 0:30[7]		
	75/25	0:30 - 0:55	0:35 - 0:40	0:20 - 0:35	0:09 - 0:20	0:20 - 0:30[7]	0:15 - 0:20[7]		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:15 - 0:25	0:20 - 0:30	0:07 - 0:20	0:02 - 0:07				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:15 - 0:25	0:09 - 0:15	0:03 - 0:09	0:01 - 0:03				
below -25 to -28 °C (below -13 to -18 °F)	100/0	0:15 - 0:25	0:05 - 0:07	0:01 - 0:05	0:00 - 0:01				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

Table 4.4: LUPR Statistics – ROMCHIM ADD-PROTECT TYPE II

Data Measure	100/0		75/25		50/50	
	Stat	Rating	Stat	Rating	Stat	Rating
Data Points <10.0	11	40	12	40	4	20
Data Points <=9.5	11	40	12	40	4	40
Data Points <=8.5	10	40	11	40	4	40
Data Points <=7.5	6	40	11	40	2	30
Data Points <=6.5	6	40	8	40	2	30
Data Points <=5.5	6	40	8	40	2	30
Data Points <=4.5	3	40	7	40	2	30
Data Points <=3.5	2	30	5	40	2	30
Negative Scatter 0-10 g	-11%	30	-6%	40	-5%	40

Rate	100/0		75/25		50/50	
	Score	Pass/Fail	Score	Pass/Fail	Score	Pass/Fail
9 g/dm²/h	38	pass	40	pass	34	pass
8 g/dm²/h	38	pass	40	pass	34	pass
7 g/dm²/h	38	pass	40	pass	29	pass
6 g/dm²/h	38	pass	40	pass	29	pass
5 g/dm²/h	38	pass	40	pass	29	pass
4 g/dm²/h	38	pass	40	pass	29	pass
3 g/dm²/h	33	pass	40	pass	29	pass

LUPR	100/0	75/25	50/50
	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h

Table 4.5: HUPR Statistics – ROMCHIM ADD-PROTECT TYPE II

Data Measure	100/0		75/25		50/50	
	Stat	Rating	Stat	Rating	Stat	Rating
Data Points >20 g	18	40	19	40	8	40
Data Points ≥15 g	21	40	19	40	9	40
Data Points ≥20 g	18	40	19	40	8	40
Data Points ≥25 g	16	40	15	40	5	40
Data Points ≥30 g	14	40	13	40	3	40
Data Points ≥35 g	10	40	9	40	3	40
Data Points ≥40 g	4	40	5	40	2	40
Negative Scatter >25 g	-10%	40	-7%	40	-14%	30

Rate	100/0		75/25		50/50	
	Score	Pass/Fail	Score	Pass/Fail	Score	Pass/Fail
25 g/dm²/h	40	pass	40	pass	38	pass
30 g/dm²/h	40	pass	40	pass	38	pass
35 g/dm²/h	40	pass	40	pass	38	pass
40 g/dm²/h	40	pass	40	pass	38	pass
45 g/dm²/h	40	pass	40	pass	38	pass
50 g/dm²/h	40	pass	40	pass	38	pass

HUPR	100/0	75/25	50/50
	50 g/dm²/h	50 g/dm²/h	50 g/dm²/h

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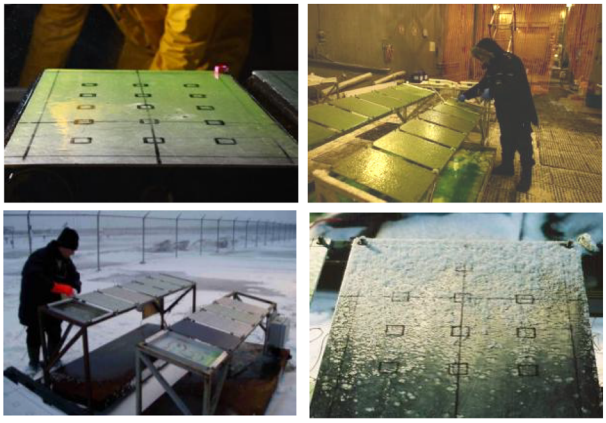
APPENDIX E

AIRCRAFT GROUND ANTI-ICING FLUID ENDURANCE TIME TEST RESULTS – ALLCLEAR CLEARWING EG (TYPE IV)

AIRCRAFT GROUND ANTI-ICING FLUID ENDURANCE TIME TEST RESULTS

AllClear ClearWing EG (Type IV)



Prepared for

AllClear Systems LLC

by

APS Aviation Inc.

These tests were made possible with the guidance, participation, and contribution of Transport Canada and the Federal Aviation Administration.

July 2019
Version 1.1
Report No. A-CWEG 2018-19

AIRCRAFT GROUND ANTI-ICING FLUID ENDURANCE TIME TEST RESULTS

AllClear ClearWing EG (Type IV)

Prepared for

AllClear Systems LLC

Prepared by:



Benjamin Bernier, B.Sc.
Junior Project Leader

July 17, 2019
Date

Reviewed by:



John D'Avirro, Eng., PBDM
Director, Aviation Services

July 17, 2019
Date

These tests were made possible with the guidance, participation, and contribution of Transport Canada and the Federal Aviation Administration.

July 2019
Version 1.1
Report No. A-CWEG 2018-19

FLUID IDENTIFICATION AND CHARACTERISTICS

Manufacturer:	AllClear Systems LLC		
Fluid Test Name:	ClearWing EG		
Fluid Commercial Name:	ClearWing EG		
Fluid Type / Base / Colour:	Type IV / Ethylene Glycol / Green		
Batch #:	120718		
Date of Receipt:	January 7th, 2019		
Brix (Measured):	Neat fluid:	32.25°	
Freeze Point (Stated):	Neat fluid:	-38.0°C	
Aerodynamic LOUT (AMIL):	Neat fluid:	-29.0°C	
Viscosity:	**Manufacturer Method**	**Stated**	**Measured**
	Neat fluid[1]:	28,700 cP	35,500 cP
	AS 9968 Method	**Stated**	**Measured**
	Neat fluid[2]:	13,217 cP	13,360 cP
WSET (from AMIL):	Neat fluid:	120 minutes	

[1] Spindle SC4-31/13R, small sample adapter, 9 mL of fluid, 0°C, 0.3 rpm, for 30.0 minutes
[2] Spindle LV1, 600 mL low form beaker, 575 mL of fluid, 20°C, 0.3 rpm, for 10.0 minutes

SUMMARY

The primary objective of this project was to measure the endurance time performance of **AllClear Systems LLC ClearWing EG** over the entire range of conditions encompassed by the Holdover Time (HOT) tables. This report contains the results of these measurements and was completed with the support of the fluid manufacturer, Transport Canada (TC), and the Federal Aviation Administration (FAA).

Tests were carried out according to the protocol provided in Aerospace Recommended Practice (ARP) 5485. The test procedure consisted of pouring fluids onto clean aluminum test surfaces inclined at 10°; the onset of failure was recorded as a function of time in natural and simulated precipitation.

Tests were performed at the APS Aviation Inc. (APS) test facility at Montréal-Pierre-Elliott-Trudeau International Airport and the National Research Council Canada (NRC) Climatic Engineering Facility (CEF) in Ottawa.

De/anti-icing fluid endurance times were derived from the data collected using multi-variable regression analysis. This resulted in the generation of the fluid-specific holdover times shown below. These holdover times will be published by regulators for use in the winter 2019-20 operating season.

AllClear ClearWing EG Type IV Fluid Holdover Times

Outside Air Temperature (°C)	Type IV Fluid Concentration Neat Fluid/ Water (Vol %/Vol %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)							
		Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets*			Freezing Drizzle	Light Freezing Rain	Rain on Cold Soaked Wing	Other
			Very Light	Light	Moderate				
-3 and above	100/0	1:50-3:15	2:40-3:00	1:20-2:40	0:40-1:20	1:10-1:35	0:30-1:00	0:10-1:30	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A	CAUTION: No holdover time guidelines exist	
below -3 to -8	100/0	1:35-3:45	2:25-3:00	1:10-2:25	0:35-1:10	1:05-1:30	0:30-1:00		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14	100/0	1:35-3:45	2:15-2:45	1:05-2:15	0:30-1:05	1:05-1:30	0:30-1:00		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18	100/0	0:55-2:00	0:50-1:05	0:25-0:50	0:10-0:25				
below -18 to -25	100/0	0:55-2:00	0:40-0:55	0:15-0:40	0:05-0:15				
below -25 to -29	100/0	0:55-2:00	0:25-0:35	0:08-0:25	0:02-0:08				

**FAA values shown, Transport Canada will publish only the lower values for very light snow and caps all snow HOTs at two hours*

TABLE OF CONTENTS

1. INTRODUCTION 1

2. METHODOLOGY 2

3. DESCRIPTION OF DATA 3

3.1 Natural and Artificial Snow Tests 3
3.2 Freezing Precipitation Tests 3
3.3 Natural Frost Tests 4
3.4 Fluid Thickness Tests 4
3.5 Test Logs 4

4. RESULTS AND DISCUSSION 9

4.1 Results 9
4.1.1 Endurance Time Tests – Natural Snow and Freezing Precipitation 9
4.1.2 Endurance Time Tests – Natural Frost 9
4.1.3 Fluid Thickness Tests 9
4.2 Discussion 16
4.2.1 Holdover Time Table 16
4.2.2 Holdover Times in Snow at Temperatures Below -14°C 16
4.2.3 Holdover Times in Frost 16
4.2.4 Fluid Viscosity 16
4.2.5 Lowest Operational Use Temperatures (LOUTs) 17
4.2.6 Lowest and Highest Usable Precipitation Rates in Snow 17
4.2.7 Publication of Holdover Times 17

ANNEX: Methodology for Endurance Time Testing of Type II, III, and IV Fluids – Winter 2018-19

LIST OF FIGURES AND TABLES

Figures

Figure 4.1: Type IV 100/0 – Natural Snow 10
Figure 4.2: Type IV 100/0 – Artificial Snow at -18°C with Historical Results 10
Figure 4.3: Type IV 100/0 – Artificial Snow at -25°C with Historical Results 11
Figure 4.4: Type IV 100/0 – Freezing Drizzle 11
Figure 4.5: Type IV 100/0 – Light Freezing Rain 12
Figure 4.6: Type IV 100/0 – Freezing Fog 12
Figure 4.7: Type IV 100/0 – Rain on Cold-Soaked Surface 13
Figure 4.8: Fluid Thickness Profiles of AllClear ClearWing EG 15
Figure 4.9: Final Fluid Thickness of AllClear ClearWing EG 15

Tables

Table 3.1: Summary of Tests Performed (Snow) 5
Table 3.2: Summary of Tests Performed (Freezing Precipitation) 7
Table 3.3: Summary of Tests Performed (Natural Frost) 8
Table 4.1: Regression Equation Coefficients for AllClear ClearWing EG 14
Table 4.2: Fluid Specific Holdover Time Guidelines – AllClear ClearWing EG (TC Format) 18
Table 4.3: Fluid Specific Holdover Time Guidelines – AllClear ClearWing EG (FAA Format) 19
Table 4.4: LUPR Statistics – AllClear ClearWing EG 20
Table 4.5: HUPR Statistics – AllClear ClearWing EG 21

GLOSSARY

APS	APS Aviation Inc.
ARP	Aerospace Recommended Practice
CEF	Climatic Engineering Facility
EG	Ethylene Glycol
FAA	Federal Aviation Administration
HOT	Holdover Time
HUPR	Highest Usable Precipitation Rate
LOUT	Lowest Operational Use Temperature
LOWV	Lowest On-Wing Viscosity
LUPR	Lowest Usable Precipitation Rate
NRC	National Research Council Canada
PG	Propylene Glycol
TC	Transport Canada

1. INTRODUCTION

This report has been created with the support of the fluid manufacturer, Transport Canada (TC), and the Federal Aviation Administration (FAA).

Aircraft ground de/anti-icing has been the subject of concentrated industry attention in recent years due to the occurrence of several fatal icing-related aircraft accidents. Notably, attention has been placed on the enhancement of anti-icing fluids in order to provide an extended period of protection against further contamination following initial deicing. This emphasis has led to the development of fluid-specific de/anti-icing fluid holdover time (HOT) tables for Type II, Type III, and Type IV fluids. These tables, accepted by regulatory authorities, are used by aircraft operators for departure planning in adverse winter conditions. Specifically, they provide the duration of time that qualified fluids provide protection against ice formation under specific weather conditions.

New anti-icing formulations continue to be developed by leading manufacturers with the specific objective of prolonging fluid holdover times without compromising the aerodynamic features of the airfoil. The purpose of the endurance time testing program is to measure the endurance times of these new fluids and develop fluid-specific HOT tables that provide guidance for their use.

Flat plate tests, conducted in natural and simulated precipitation, are used to develop HOT values for new fluids. These tests are carried out according to SAE Aerospace Recommended Practice (ARP) 5485, which provides the test protocols for measuring endurance times of Type II, III, and IV fluids. Along with its counterpart for measuring endurance times of Type I fluids ARP5945, ARP5485 has evolved into a refined procedure for measuring the duration of de/anti-icing fluid protection against ice formation.

The current data analysis protocol for developing HOT values from endurance time data was developed in 1996-97 and uses multi-variable regression to obtain HOT values. HOT values are derived for the majority of cells in Type II/III/IV HOT tables using this protocol and are used to create a fluid-specific HOT table for each Type II/III/IV fluid tested.

This report provides a detailed account of the endurance time testing conducted by APS Aviation Inc. (APS) with **AllClear ClearWing EG**, a new Type IV fluid. It describes the test methodology used, endurance time data collected, and analysis completed to derive fluid-specific holdover times for the fluid.

2. METHODOLOGY

Tests were carried out according to SAE ARP5485, which provides the procedure and requirements for endurance time testing with Type II, III, and IV fluids under natural and simulated conditions.

The test methodology for endurance time testing carried out in the winter of 2018-19 is documented in detail in the report *"Methodology for Endurance Time Testing of Type II, III, and IV Fluids – Winter 2018-19."* A copy of this report is provided as an annex to this document.

The methodology report summarizes the key aspects of the test methodology, including some aspects included in ARP5485 and some aspects which are not included in ARP5485. It includes sections on:

a) Test Sites;
b) Test Equipment;
c) Test Procedures;
d) Precipitation Rates used in Type I, II, III, and IV Endurance Time Testing;
e) Ambient Temperatures used in Type I, II, III, and IV Endurance Time Testing;
f) Freezing Precipitation Droplet Sizes; and
g) Analysis Methodologies.

The data, analysis, and results provided in this report are a function of the test and analysis methodologies described in the methodology report. They should only be used in conjunction with the methodologies described therein.

3. DESCRIPTION OF DATA

This section provides a summary of the number of tests conducted. Breakdowns are provided for the number of tests performed by test type, precipitation type, fluid dilution, and test temperature.

3.1 Natural and Artificial Snow Tests

Tests were conducted in natural snow conditions at the APS test site and at several mobile test sites (refer to the report annex for details). Artificial snow tests were conducted at PMG Technologies in Blainville, QC. The breakdown of tests conducted is summarized below by fluid dilution and temperature.

Fluid Dilution	Natural Snow				Artificial Snow	
	≥ -3°C	< -3 to -8°C	< -8 to -14°C	<-14°C	-18°C	-25°C
Neat	5	13	11	2	5	4
75/25	N/A	N/A	N/A	N/A	N/A	N/A
50/50	N/A	N/A	N/A	N/A	N/A	N/A

3.2 Freezing Precipitation Tests

Tests were conducted in freezing drizzle, light freezing rain, freezing fog and rain on cold-soaked surface conditions at the National Research Council Canada (NRC) Climatic Engineering Facility (CEF). The number of tests conducted is summarized below by precipitation type, fluid dilution and test temperature.

Fluid Dilution	Freezing Drizzle		Light Freezing Rain		Freezing Fog			Cold Soak
	-3°C	-10°C	-3°C	-10°C	-3°C	-14°C	-25°C	+1°C
Neat	4	4	4	4	4	4	4	4
75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
50/50	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

3.3 Natural Frost Tests

Tests were conducted in natural frost at the APS test site. The breakdown of tests conducted is summarized below by fluid dilution and temperature.

Fluid Dilution	Natural Frost			
	≥-1°C	<-1 to -3°C	<-3 to -10°C	<-10°C
Neat	0	0	1	2
75/25	N/A	N/A	N/A	N/A
50/50	N/A	N/A	N/A	N/A

3.4 Fluid Thickness Tests

Fluid thickness tests were conducted to measure the film thickness profiles of the fluid under dry conditions. Two tests were performed for each dilution. For each test, 1 litre of fluid was poured onto a flat plate mounted on a test stand inclined by 10°. Thickness measurements were taken at the 15-cm (6") line at select time intervals over a 30-minute period. Tests were conducted at -3°C.

3.5 Test Logs

Details of each test conducted are provided in the test logs included as Table 3.1 (snow), Table 3.2 (freezing precipitation), and Table 3.3 (frost).

Table 3.1: Summary of Tests Performed (Snow)

Test No.	Date	Snow Type	Fluid Name	Fluid Dilution	Test Temp. (°C)	Icing Intensity (g/dm²/h)	Endurance Time (min)
14	7-Jan-19	Natural Snow	ClearWing EG	100%	-11.2	21.1	38.5
21	8-Jan-19	Natural Snow	ClearWing EG	100%	-9.2	16.0	56.6
26	8-Jan-19	Natural Snow	ClearWing EG	100%	-8.5	18.3	46.8
32	8-Jan-19	Natural Snow	ClearWing EG	100%	-8.7	25.2	34.1
36	8-Jan-19	Natural Snow	ClearWing EG	100%	-4.7	8.7	84.0
50	18-Jan-19	Natural Snow	ClearWing EG	100%	-14.8	1.7	240.0
53	18-Jan-19	Natural Snow	ClearWing EG	100%	-13.1	2.4	236.3
66	29-Jan-19	Natural Snow	ClearWing EG	100%	-14.5	5.8	84.0
72	29-Jan-19	Natural Snow	ClearWing EG	100%	-10.7	5.6	75.8
74	2-Feb-19	Natural Snow	ClearWing EG	100%	-9.1	4.2	123.2
83	2-Feb-19	Natural Snow	ClearWing EG	100%	-8.5	7.9	60.1
90	2-Feb-19	Natural Snow	ClearWing EG	100%	-7.6	8.2	68.4
95	12-Feb-19	Natural Snow	ClearWing EG	100%	-11.9	12.8	57.0
103	12-Feb-19	Natural Snow	ClearWing EG	100%	-9.9	17.3	59.0
110	12-Feb-19	Natural Snow	ClearWing EG	100%	-8.2	23.3	39.3
117	12-Feb-19	Natural Snow	ClearWing EG	100%	-6.5	31.1	33.3
124	13-Feb-19	Natural Snow	ClearWing EG	100%	-7.1	38.0	25.2
136	13-Feb-19	Natural Snow	ClearWing EG	100%	-7.3	61.8	15.0
141	13-Feb-19	Natural Snow	ClearWing EG	100%	-7.0	31.7	28.4
158	21-Feb-19	Natural Snow	ClearWing EG	100%	-5.7	20.3	41.6
164	21-Feb-19	Natural Snow	ClearWing EG	100%	-6.6	49.6	18.0
176	21-Feb-19	Natural Snow	ClearWing EG	100%	-7.3	35.3	23.8
182	21-Feb-19	Natural Snow	ClearWing EG	100%	-7.2	7.4	137.0
209	10-Mar-19	Natural Snow	ClearWing EG	100%	-1.8	40.0	20.5
218	10-Mar-19	Natural Snow	ClearWing EG	100%	-1.8	39.5	25.1
227	10-Mar-19	Natural Snow	ClearWing EG	100%	-1.3	36.6	25.8
238	10-Mar-19	Natural Snow	ClearWing EG	100%	-8.0	61.3	14.6
247	10-Mar-19	Natural Snow	ClearWing EG	100%	-6.8	28.8	56.0
256	10-Mar-19	Natural Snow	ClearWing EG	100%	-1.9	20.1	64.2
265	10-Mar-19	Natural Snow	ClearWing EG	100%	0.2	37.2	36.0
278	30-Mar-19	Natural Snow	ClearWing EG	100%	-4.2	28.0	42.2
AS33	24-Apr-19	Artificial Snow	ClearWing EG	100%	-18.0	3.2	201.3
AS34	25-Apr-19	Artificial Snow	ClearWing EG	100%	-18.0	4.1	180.0
AS35	26-Apr-19	Artificial Snow	ClearWing EG	100%	-18.0	10.2	67.2
AS35R	26-Apr-19	Artificial Snow	ClearWing EG	100%	-18.0	10.3	72.0
AS36	26-Apr-19	Artificial Snow	ClearWing EG	100%	-18.0	25.4	30.5
AS37	22-Apr-19	Artificial Snow	ClearWing EG	100%	-25.0	3.1	175.0

Table 3.1: Summary of Tests Performed (Snow) (cont'd)

Test No.	Date	Snow Type	Fluid Name	Fluid Dilution	Test Temp. (°C)	Icing Intensity (g/dm²/h)	Endurance Time (min)
AS38	18-Apr-19	Artificial Snow	ClearWing EG	100%	-25.0	4.0	155.3
AS39	5-Apr-19	Artificial Snow	ClearWing EG	100%	-25.0	10.0	38.4
AS40	17-Apr-19	Artificial Snow	ClearWing EG	100%	-25.0	25.3	22.0

Table 3.2: Summary of Tests Performed (Freezing Precipitation)

Test No.	Date	Precipitation Type	Fluid Name	Fluid Dilution	Test Temp. (°C)	Icing Intensity (g/dm²/h)	Endurance Time (min)
11	11-Apr-19	Cold-Soaked Box	ClearWing EG	100%	1.0	4.7	89.9
12	11-Apr-19	Cold-Soaked Box	ClearWing EG	100%	1.0	5.1	91.0
25	11-Apr-19	Cold-Soaked Box	ClearWing EG	100%	1.3	76.6	11.9
26	11-Apr-19	Cold-Soaked Box	ClearWing EG	100%	1.3	75.4	11.7
43	3-Apr-19	Freezing Drizzle	ClearWing EG	100%	-3.1	5.2	98.4
44	3-Apr-19	Freezing Drizzle	ClearWing EG	100%	-3.1	5.3	93.0
61	3-Apr-19	Freezing Drizzle	ClearWing EG	100%	-3.2	13.3	66.3
62	3-Apr-19	Freezing Drizzle	ClearWing EG	100%	-3.1	13.4	68.4
75	4-Apr-19	Freezing Drizzle	ClearWing EG	100%	-10.2	5.2	90.1
76	4-Apr-19	Freezing Drizzle	ClearWing EG	100%	-10.2	5.1	87.9
89	4-Apr-19	Freezing Drizzle	ClearWing EG	100%	-10.2	12.8	64.9
90	4-Apr-19	Freezing Drizzle	ClearWing EG	100%	-10.3	13.0	64.8
107	10-Apr-19	Freezing Fog	ClearWing EG	100%	-3.2	2.1	187.7
108	10-Apr-19	Freezing Fog	ClearWing EG	100%	-3.2	2.2	187.8
125	10-Apr-19	Freezing Fog	ClearWing EG	100%	-3.1	5.0	108.0
126	10-Apr-19	Freezing Fog	ClearWing EG	100%	-3.1	4.9	115.3
139	9-Apr-19	Freezing Fog	ClearWing EG	100%	-14.1	2.1	207.5
140	9-Apr-19	Freezing Fog	ClearWing EG	100%	-14.1	2.1	221.3
153	9-Apr-19	Freezing Fog	ClearWing EG	100%	-14.0	4.7	98.4
154	9-Apr-19	Freezing Fog	ClearWing EG	100%	-14.0	4.6	103.4
163	8-Apr-19	Freezing Fog	ClearWing EG	100%	-25.0	2.3	110.3
164	8-Apr-19	Freezing Fog	ClearWing EG	100%	-25.0	2.1	113.4
173	8-Apr-19	Freezing Fog	ClearWing EG	100%	-25.2	4.7	55.2
174	8-Apr-19	Freezing Fog	ClearWing EG	100%	-25.2	4.7	56.1
195	5-Apr-19	Light Freezing Rain	ClearWing EG	100%	-2.9	13.4	62.8
196	5-Apr-19	Light Freezing Rain	ClearWing EG	100%	-2.9	12.9	58.2
213	5-Apr-19	Light Freezing Rain	ClearWing EG	100%	-3.0	24.9	27.0
214	5-Apr-19	Light Freezing Rain	ClearWing EG	100%	-3.0	25.4	28.7
227	4-Apr-19	Light Freezing Rain	ClearWing EG	100%	-9.8	13.3	58.6
228	4-Apr-19	Light Freezing Rain	ClearWing EG	100%	-9.8	13.1	57.0
241	5-Apr-19	Light Freezing Rain	ClearWing EG	100%	-10.0	24.9	30.3
242	5-Apr-19	Light Freezing Rain	ClearWing EG	100%	-10.0	24.8	31.5

Table 3.3: Summary of Tests Performed (Natural Frost)

Test No.	Date	Precip. Type	Fluid Name	Fluid Dilution	Test Duration (min.)	Average Rate (g/dm²/h)	Temp (°C)	Wind Speed (km/h)	Average RH (%)	Comments
12	Feb-17-19	Natural Frost	ClearWing EG	100%	429	0.05	-14.0	9	73	Did Not Fail
16	Feb-19-19	Natural Frost	ClearWing EG	100%	450	0.07	-16.7	5	80	Did Not Fail
28	Mar-18-19	Natural Frost	ClearWing EG	100%	602	0.06	-8.0	5	66	Did Not Fail

4. RESULTS AND DISCUSSION

The methods used to evaluate the test data are provided in the report "*Methodology for Endurance Time Testing of Type II, III, and IV Fluids – Winter 2018-19,*" which is provided as an annex to this report. The results of the data analyses and a discussion of the findings are presented in this section.

4.1 Results

The results of the endurance time and thickness tests are described in this section.

4.1.1 Endurance Time Tests – Natural Snow and Freezing Precipitation

Figures 4.1 to 4.7 present the endurance time data collected in natural snow, artificial snow, and freezing precipitation (freezing drizzle, light freezing rain, freezing fog and rain on cold-soaked surface).

These figures show the effect of temperature, precipitation type, and precipitation rate on fluid endurance time in the conditions encompassed by the Type IV HOT guidelines. The figures include the current Type IV generic holdover times for comparative purposes.

Multi-variable regression analysis was performed on these data sets as described in the annex. Table 4.1 provides the outputs from the multi-variable regression analyses. These outputs were used to derive fluid-specific holdover times for all conditions encompassed by Type IV fluid-specific HOT tables. One exception is the snow cells in temperature bands colder than -14°C (see Subsection 4.2.2).

4.1.2 Endurance Time Tests – Natural Frost

The natural frost data was presented in Table 3.3. The test durations were compared to the Type IV generic holdover times. Tests that were not completed (due to active frost ending before fluid failure could occur) surpassed the generic holdover times. This analysis indicates the Type IV generic frost holdover times can be considered substantiated for AllClear ClearWing EG.

Additional natural frost tests will be completed in winter 2019-20 with retained samples of AllClear ClearWing EG.

4.1.3 Fluid Thickness Tests

Figure 4.8 shows the fluid thickness test data. As described in Subsection 3.4, two tests were conducted at an ambient temperature of -3°C. The final fluid thicknesses are displayed in Figure 4.9.

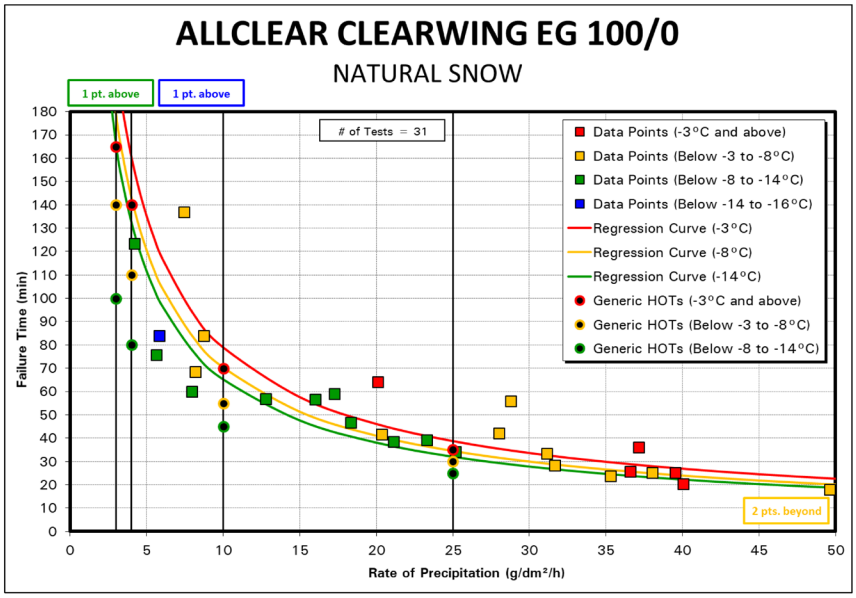


Figure 4.1: Type IV 100/0 – Natural Snow

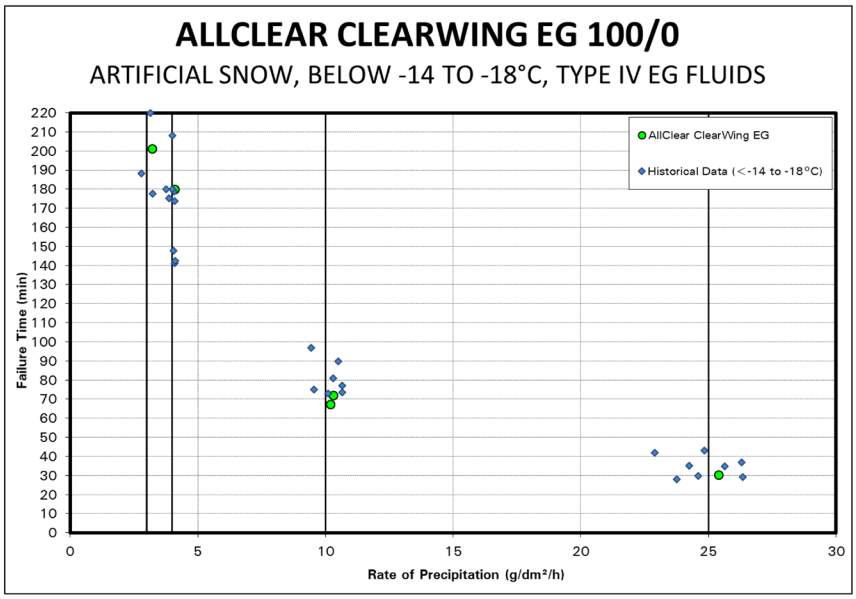


Figure 4.2: Type IV 100/0 – Artificial Snow at -18°C with Historical Results

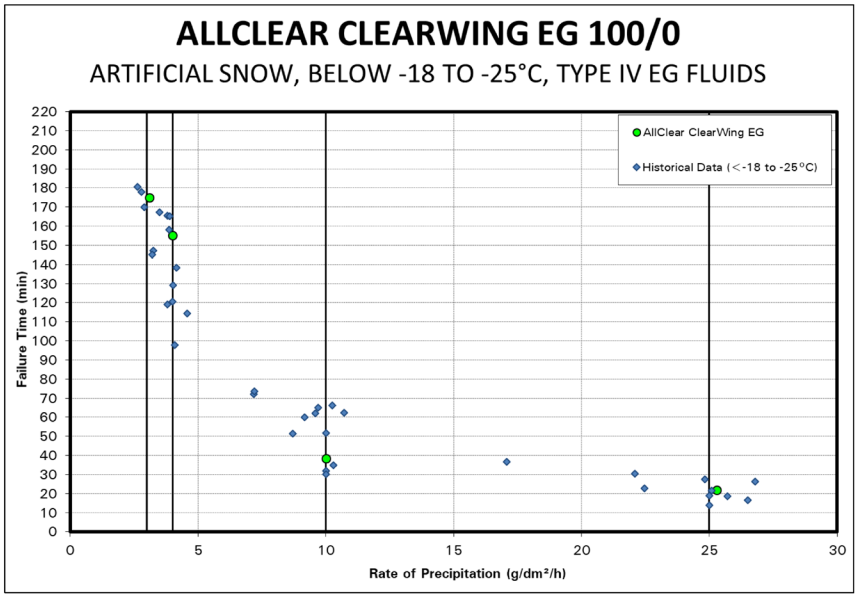


Figure 4.3: Type IV 100/0 – Artificial Snow at -25°C with Historical Results

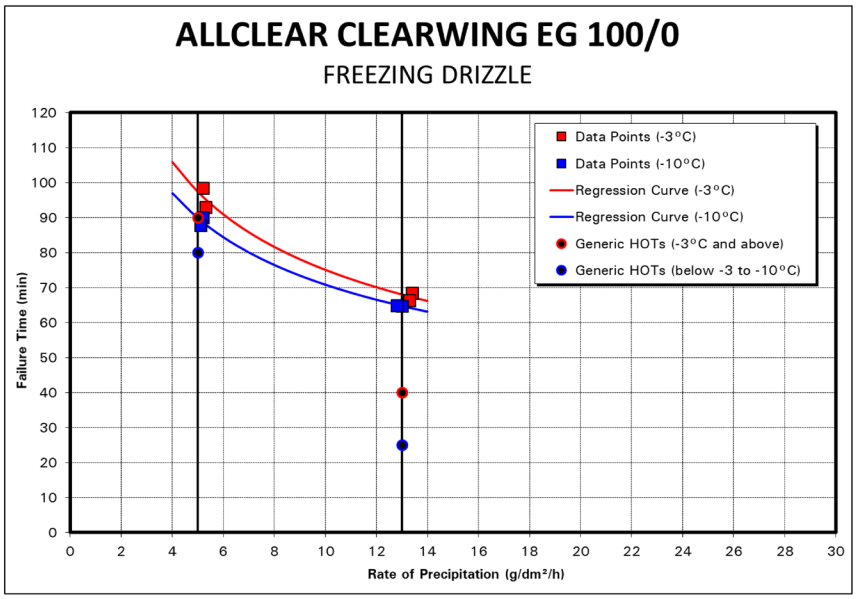


Figure 4.4: Type IV 100/0 – Freezing Drizzle

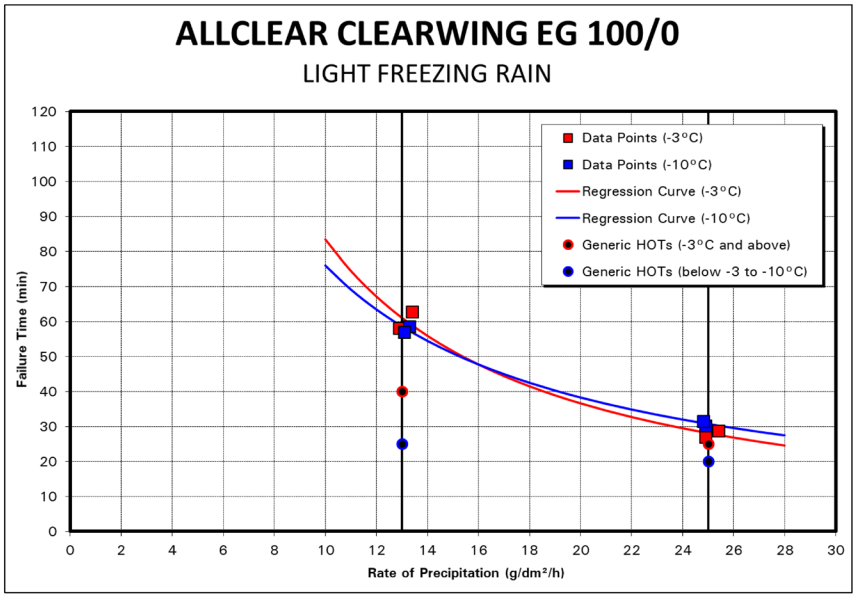


Figure 4.5: Type IV 100/0 – Light Freezing Rain

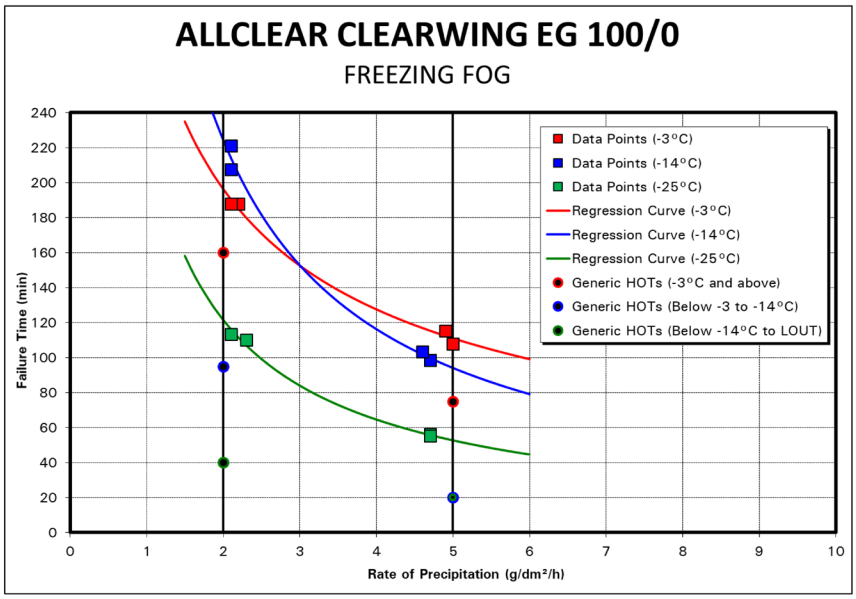


Figure 4.6: Type IV 100/0 – Freezing Fog

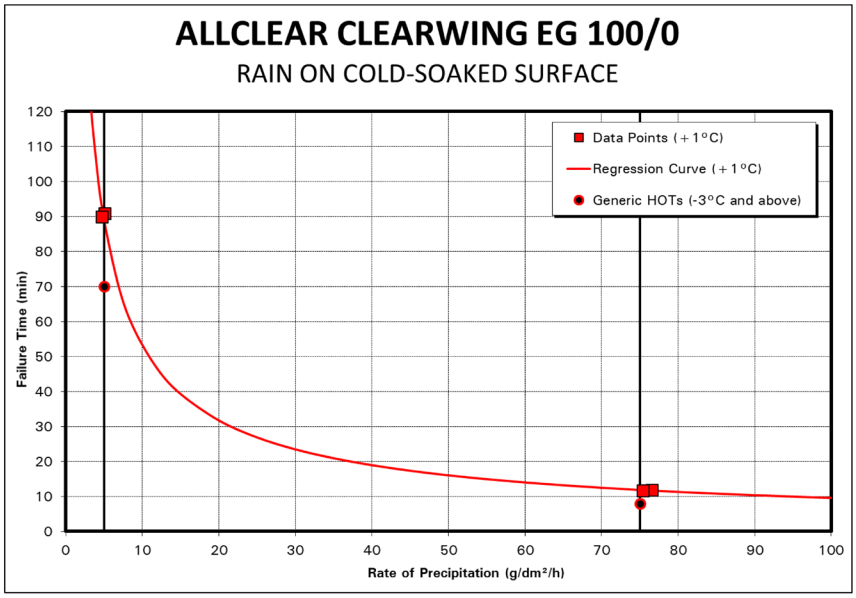


Figure 4.7: Type IV 100/0 – Rain on Cold-Soaked Surface

Table 4.1: Regression Equation Coefficients for AllClear ClearWing EG

Natural Snow

Fluid	Dil	Temp.	R^2	Intercept (I)	Coeff. Rate (A)	Coeff. Tem (B)	Total Pts.
AllClear ClearWing EG	100%	≥ -14°C	91%	2.7895	-0.7766	-0.1648	31

General Equation $t = 10^{I} R^{A} (2\text{-}T)^{B}$

Simulated Freezing Fog

Fluid	Dil	Temp.	R^2	Intercept (I)	Coeff. Rate (A)	Total Pts.
AllClear ClearWing EG	100%	-3°C	99%	2.4808	-0.6236	4
AllClear ClearWing EG	100%	-14°C	100%	2.6368	-0.9489	4
AllClear ClearWing EG	100%	-25°C	100%	2.3601	-0.9134	4

General Equation $t = 10^{I} R^{A}$

Simulated Freezing Drizzle

Fluid	Dil	Temp.	R^2	Intercept (I)	Coeff. Rate (A)	Total Pts.
AllClear ClearWing EG	100%	-3°C	99%	2.2517	-0.3764	4
AllClear ClearWing EG	100%	-10°C	99%	2.1945	-0.3445	4

General Equation $t = 10^{I} R^{A}$

Simulated Light Freezing Rain

Fluid	Dil	Temp.	R^2	Intercept (I)	Coeff. Rate (A)	Total Pts.
AllClear ClearWing EG	100%	-3°C	98%	3.1105	-1.1890	4
AllClear ClearWing EG	100%	-10°C	100%	2.8711	-0.9900	4

General Equation $t = 10^{I} R^{A}$

Simulated Rain on Cold-Soaked Wing

Fluid	Dil	Temp.	R^2	Intercept (I)	Coeff. Rate (A)	Total Pts.
AllClear ClearWing EG	100%	+1°C	100%	2.4690	-0.7435	4

General Equation $t = 10^{I} R^{A}$

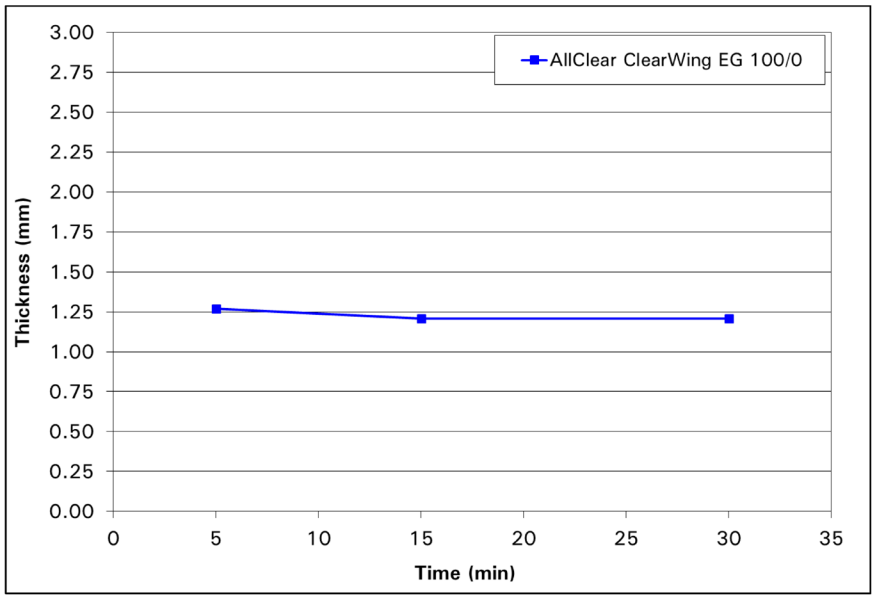


Figure 4.8: Fluid Thickness Profiles of AllClear ClearWing EG

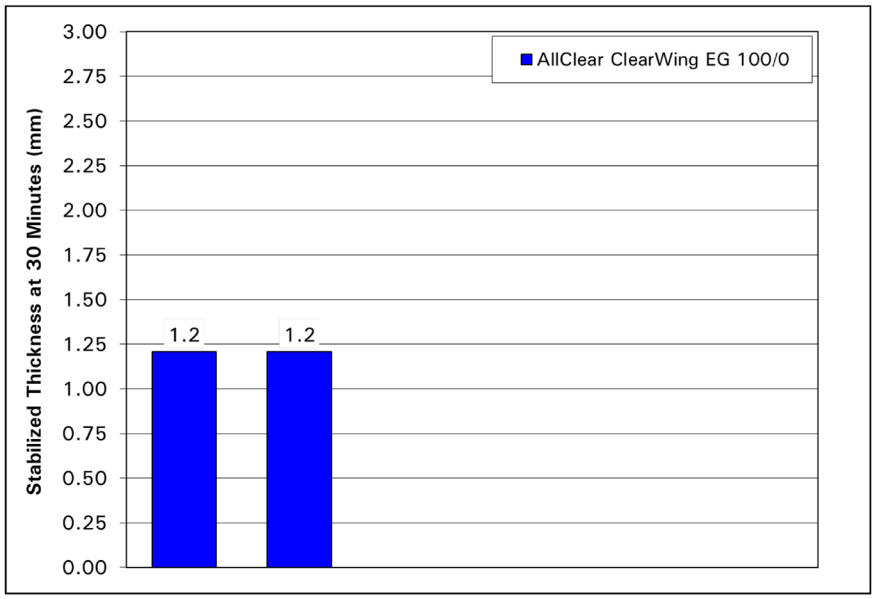


Figure 4.9: Final Fluid Thickness of AllClear ClearWing EG

4.2 Discussion

4.2.1 Holdover Time Table

The holdover times described in Subsection 4.1 were used to populate a fluid-specific HOT table for AllClear ClearWing EG. The HOT table is shown in both the TC format (Table 4.2) and FAA format (Table 4.3) at the end of this chapter.

4.2.2 Holdover Times in Snow at Temperatures Below -14°C

Due to the cost associated with collecting endurance time data in very cold snow conditions, all Type II/IV fluids that have not undergone (optional) supplemental fluid-specific testing in very cold snow are given generic HOT values for snow at temperatures below -14°C. These generic values were determined analytically in the winter of 2018-19, and are based on limited fluid-specific natural snow data and an analysis of relative fluid performance.

The generic values differ for Type II and Type IV fluids and for ethylene glycol (EG) and propylene glycol (PG) based fluids. Accordingly, AllClear ClearWing EG has been given Type IV EG-specific generic values in the "Below -14°C to -18°C," "Below -18°C to -25°C," and "Below -25°C to lowest operational use temperature (LOUT)" snow cells.

4.2.3 Holdover Times in Frost

It should be noted that frost holdover times are not included in the fluid-specific HOT tables. This is due to a decision made by TC and the FAA in May 2009 to move frost holdover times from the generic and fluid-specific HOT tables to a separate frost HOT table. Accordingly, frost holdover times have not been included in the AllClear ClearWing EG fluid-specific HOT table.

4.2.4 Fluid Viscosity

The viscosities of the fluid samples used in this testing were measured using both the AS9968 method and the manufacturer's designated method. The APS measured viscosities appear at the beginning of this document and will be published as the lowest on-wing viscosity (LOWV) values for the fluid. In order for the fluid-specific holdover times provided in this document to be valid, operators must ensure that the viscosity of the fluid being used is equal or greater than the published LOWV.

4.2.5 Lowest Operational Use Temperatures (LOUTs)

The LOUT for Type II/III/IV fluids is determined by the higher of:

a) The lowest temperature at which the fluid meets the aerodynamic acceptance test for a given aircraft type; and

b) The actual freezing point of the fluid plus its freezing point buffer of 7°C (13°F).

This aerodynamic LOUT and fluid freeze point information for this fluid appears at the beginning of this document. The LOUT for AllClear ClearWing EG (100/0) is -29°C (-20°F).

4.2.6 Lowest and Highest Usable Precipitation Rates in Snow

The lowest usable precipitation rates (LUPRs) and highest usable precipitation rates (HUPRs) for AllClear ClearWing EG were determined by analysing the natural snow data sets using the analysis methodology described in the report "*Methodology for Endurance Time Testing of Type II, III, and IV Fluids – Winter 2018-19*," which is provided as an annex to this report. The resulting statistics are shown in Tables 4.4 (LUPR statistics) and 4.5 (HUPR statistics).

The analysis determined that for AllClear ClearWing EG (100/0) at temperatures of -14°C and above, the LUPR is 3 g/dm²/h and the HUPR is 50 g/dm²/h.

4.2.7 Publication of Holdover Times

As AllClear Systems intends to commercialize ClearWing EG, TC and the FAA will publish its fluid-specific HOT table in their 2019-20 HOT Guidelines. The guidelines will also include the LOWV and LOUT information; the regression and LUPR/HUPR data will be published in the related TC and FAA Regression Information documents.

Table 4.2: Fluid Specific Holdover Time Guidelines – AllClear ClearWing EG (TC Format)

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	1:50 - 3:15	2:00	1:20 - 2:00	0:40 - 1:20	1:10 - 1:35	0:30 - 1:00	0:10 - 1:30	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A	CAUTION: No holdover time guidelines exist	
below -3 to -8°C (below 27 to 18°F)	100/0	1:35 - 3:45	2:00	1:10 - 2:00	0:35 - 1:10	1:05 - 1:30	0:30 - 1:00		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14°C (below 18 to 7°F)	100/0	1:35 - 3:45	2:00	1:05 - 2:00	0:30 - 1:05	1:05 - 1:30[7]	0:30 - 1:00[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18°C (below 7 to 0°F)	100/0	0:55 - 2:00	0:50	0:25 - 0:50	0:10 - 0:25				
below -18 to -25°C (below 0 to -13°F)	100/0	0:55 - 2:00	0:40	0:15 - 0:40	0:05 - 0:15				
below -25 to -29°C (below -13 to -20°F)	100/0	0:55 - 2:00	0:25	0:08 - 0:25	0:02 - 0:08				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table 42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

Table 4.3: Fluid Specific Holdover Time Guidelines – AllClear ClearWing EG (FAA Format)

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	1:50 - 3:15	2:40 - 3:00	1:20 - 2:40	0:40 - 1:20	1:10 - 1:35	0:30 - 1:00	0:10 - 1:30	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A	CAUTION: No holdover time guidelines exist	
below -3 to -8 °C (below 27 to 18 °F)	100/0	1:35 - 3:45	2:25 - 3:00	1:10 - 2:25	0:35 - 1:10	1:05 - 1:30	0:30 - 1:00		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14 °C (below 18 to 7 °F)	100/0	1:35 - 3:45	2:15 - 2:45	1:05 - 2:15	0:30 - 1:05	1:05 - 1:30[7]	0:30 - 1:00[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:55 - 2:00	0:50 - 1:05	0:25 - 0:50	0:10 - 0:25				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:55 - 2:00	0:40 - 0:55	0:15 - 0:40	0:05 - 0:15				
below -25 to -29 °C (below -13 to -20 °F)	100/0	0:55 - 2:00	0:25 - 0:35	0:08 - 0:25	0:02 - 0:08				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table 42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

Table 4.4: LUPR Statistics – AllClear ClearWing EG

Data Measure	100/0	
	Stat	Rating
Data Points < = 10.0	9	40
Data Points < = 9.5	9	40
Data Points < = 8.5	8	40
Data Points < = 7.5	6	40
Data Points < = 6.5	5	40
Data Points < = 5.5	3	40
Data Points < = 4.5	3	40
Data Points < = 3.5	2	30
Negative Scatter 0-10 g	-12%	30

Rate	100/0	
	Score	Pass/Fail
9 g/dm²/h	38	pass
8 g/dm²/h	38	pass
7 g/dm²/h	38	pass
6 g/dm²/h	38	pass
5 g/dm²/h	38	pass
4 g/dm²/h	38	pass
3 g/dm²/h	33	pass

LUPR	100/0
	3 g/dm²/h

Table 4.5: HUPR Statistics – AllClear ClearWing EG

Data Measure	100/0	
	Stat	Rating
Data Points >20 g	18	40
Data Points ≥15 g	21	40
Data Points ≥20 g	18	40
Data Points ≥25 g	14	40
Data Points ≥30 g	11	40
Data Points ≥35 g	9	40
Data Points ≥40 g	4	40
Negative Scatter >25 g	-8%	40

Rate	100/0	
	Score	Pass/Fail
25 g/dm²/h	40	pass
30 g/dm²/h	40	pass
35 g/dm²/h	40	pass
40 g/dm²/h	40	pass
45 g/dm²/h	40	pass
50 g/dm²/h	40	pass

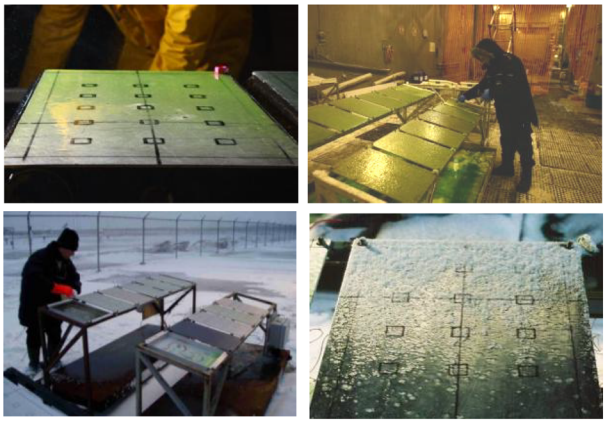
HUPR	100/0
	50 g/dm²/h

APPENDIX F

AIRCRAFT GROUND ANTI-ICING FLUID ENDURANCE TIME TEST RESULTS – CRYOTECH POLAR GUARD XTEND (TYPE IV)

AIRCRAFT GROUND ANTI-ICING FLUID ENDURANCE TIME TEST RESULTS

Cryotech Polar Guard Xtend (Type IV)



Prepared for

Cryotech Deicing Technology

by

APS Aviation Inc.

These tests were made possible with the guidance, participation and contribution of Transport Canada and the Federal Aviation Administration.

July 2019
Version 1.1
Report No. C-PGX 2018-19

AIRCRAFT GROUND ANTI-ICING FLUID ENDURANCE TIME TEST RESULTS

Cryotech Polar Guard Xtend (Type IV)

Prepared for

Cryotech Deicing Technology

Prepared by:

Benjamin Bernier, B.Sc.
Junior Project Leader

July 17, 2019
Date

Reviewed by:

John D'Avirro, Eng., PBDM
Director, Aviation Services

July 17, 2019
Date

These tests were made possible with the guidance, participation and contribution of Transport Canada and the Federal Aviation Administration.

July 2019
Version 1.1
Report No. C-PGX 2018-19

FLUID IDENTIFICATION AND CHARACTERISTICS

Manufacturer:	Cryotech Deicing Technology	
Fluid Test Name:	Developmental Type IV Fluid A 2018	
Fluid Commercial Name:	Cryotech Polar Guard® Xtend	
Fluid Type / Base / Colour:	Type IV / Propylene Glycol / Green	
Batch #:	PGA181205PA	
Date of Receipt:	December 12, 2018	
Brix (Measured):	Neat fluid:	36.0°
	75/25 dilution:	28.5°
	50/50 dilution:	20.0°
Freeze Point (Stated):	Neat fluid:	-38.8°C
	75/25 dilution:	-21.0°C
	50/50 dilution:	-10.6°C
Aerodynamic LOUT (AMIL):	Neat fluid:	-31.0°C
	75/25 dilution:	Not Provided
	50/50 dilution:	Not Provided

Viscosity:	**Manufacturer Method**	**Stated**	**Measured**
	Neat fluid[1]:	8,000 cP	6,000 cP
	75/25 dilution[1]:	1,200 cP	1,000 cP
	50/50 dilution[3]:	24 cP	24 cP
	AS 9968 Method	**Stated**	**Measured**
	Neat fluid[2]:	7,860 cP	6,350 cP
	75/25 dilution[3]:	500 cP	470 cP
	50/50 dilution[3]:	24 cP	24 cP

WSET (from AMIL):	Neat fluid:	83 minutes
	75/25 dilution:	40 minutes 38 seconds
	50/50 dilution:	2 minutes 32 seconds

[1] Spindle SC4-34/13R, small sample adapter, 10 mL of fluid, 20°C, 0.3 rpm, for 10.0 minutes
[2] Spindle LV1 (with guard leg), 600 mL low form beaker, 575 mL of fluid, 20°C, 0.3 rpm, for 10.0 minutes
[3] Spindle LV0, ultra low adapter, 16 mL of fluid, 20°C, 0.3 rpm, for 10.0 minutes

SUMMARY

The primary objective of this project was to measure the endurance time performance of **Cryotech Polar Guard Xtend** over the entire range of conditions encompassed by the Holdover Time (HOT) tables. This report contains the results of these measurements and was completed with the support of the fluid manufacturer, Transport Canada (TC), and the Federal Aviation Administration (FAA).

Tests were carried out according to the protocol provided in Aerospace Recommended Practice (ARP) 5485. The test procedure consisted of pouring fluids onto clean aluminum test surfaces inclined at 10°; the onset of failure was recorded as a function of time in natural and simulated precipitation.

Tests were performed at the APS Aviation Inc. (APS) test facility at Montréal-Pierre-Elliott-Trudeau International Airport and the National Research Council Canada (NRC) Climatic Engineering Facility (CEF) in Ottawa.

De/anti-icing fluid endurance times were derived from the data collected using multi-variable regression analysis. This resulted in the generation of the fluid-specific holdover times shown below. Testing was completed with all dilutions of the fluid, however at the request of the manufacturer only the 100/0 holdover times will be published by regulators. These holdover times will be published by regulators for use in the winter 2019-20 operating season.

Cryotech Polar Guard Xtend Fluid Holdover Times

Outside Air Temperature (°C)	Type IV Fluid Concentration Neat Fluid/ Water (Vol %/Vol %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)							
		Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets*			Freezing Drizzle	Light Freezing Rain	Rain on Cold Soaked Wing	Other
			Very Light	Light	Moderate				
-3 and above	100/0	2:30-4:00	3:00-3:00	2:00-3:00	1:05-2:00	2:00-2:00	1:00-1:50	0:20-1:45	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A		
below -3 to -8	100/0	1:00-1:50	2:50-3:00	1:35-2:50	0:50-1:35	0:35-1:40	0:50-0:55		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14	100/0	1:00-1:50	2:25-2:55	1:20-2:25	0:45-1:20	0:35-1:40	0:50-0:55	CAUTION: No holdover time guidelines exist	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18	100/0	0:25-0:40	0:30-0:45	0:09-0:30	0:02-0:09				
below -18 to -25	100/0	0:25-0:40	0:10-0:20	0:03-0:10	0:01-0:03				
below -25 to -29	100/0	0:25-0:40	0:07-0:10	0:02-0:07	0:00-0:02				

**FAA values shown, Transport Canada will publish only the lower values for very light snow and caps all snow HOTs at two hours*

TABLE OF CONTENTS

1. INTRODUCTION 1

2. METHODOLOGY 2

3. DESCRIPTION OF DATA 3

3.1 Natural and Artificial Snow Tests 3
3.2 Freezing Precipitation Tests 3
3.3 Natural Frost Tests 4
3.4 Fluid Thickness Tests 4
3.5 Test Logs 4

4. RESULTS AND DISCUSSION 11

4.1 Results 11
4.1.1 Endurance Time Tests – Natural Snow and Freezing Precipitation 11
4.1.2 Endurance Time Tests – Natural Frost 11
4.1.3 Fluid Thickness Tests 11
4.2 Discussion 22
4.2.1 Holdover Time Table 22
4.2.2 Holdover Times in Snow at Temperatures Below -14°C 22
4.2.3 Holdover Times in Frost 22
4.2.4 Fluid Viscosity 22
4.2.5 Lowest Operational Use Temperatures (LOUTs) 23
4.2.6 Lowest and Highest Usable Precipitation Rates in Snow 23
4.2.7 Publication of Holdover Times 24

ANNEX: Methodology for Endurance Time Testing of Type II, III, and IV Fluids – Winter 2018-19

LIST OF FIGURES AND TABLES

Figures

Figure 4.1: Type IV 100/0 – Natural Snow 12
Figure 4.2: Type IV 75/25 – Natural Snow 12
Figure 4.3: Type IV 50/50 – Natural Snow 13
Figure 4.4: Type IV 100/0 – Artificial Snow at -18°C with Historical Results 13
Figure 4.5: Type IV 100/0 – Artificial Snow at -25°C with Historical Results 14
Figure 4.6: Type IV 100/0 – Freezing Drizzle 14
Figure 4.7: Type IV 75/25 – Freezing Drizzle 15
Figure 4.8: Type IV 50/50 – Freezing Drizzle 15
Figure 4.9: Type IV 100/0 – Light Freezing Rain 16
Figure 4.10: Type IV 75/25 – Light Freezing Rain 16
Figure 4.11: Type IV 50/50 – Light Freezing Rain 17
Figure 4.12: Type IV 100/0 – Freezing Fog 17
Figure 4.13: Type IV 75/25 – Freezing Fog 18
Figure 4.14: Type IV 50/50 – Freezing Fog 18
Figure 4.15: Type IV 100/0 – Rain on Cold-Soaked Surface 19
Figure 4.16: Type IV 75/25 – Rain on Cold-Soaked Surface 19
Figure 4.17: Fluid Thickness Profiles of Cryotech Polar Guard Xtend 21
Figure 4.18: Final Fluid Thickness of Cryotech Polar Guard Xtend 21

Tables

Table 3.1: Summary of Tests Performed (Snow) 5
Table 3.2: Summary of Tests Performed (Freezing Precipitation) 8
Table 3.3: Summary of Tests Performed (Natural Frost) 10
Table 4.1: Regression Equation Coefficients for Cryotech Polar Guard Xtend 20
Table 4.2: Fluid Specific Holdover Time Guidelines – Cryotech Polar Guard Xtend (TC Format) 25
Table 4.3: Fluid Specific Holdover Time Guidelines – Cryotech Polar Guard Xtend (FAA Format) 26
Table 4.4: LUPR Statistics – Cryotech Polar Guard Xtend 27
Table 4.5: HUPR Statistics – Cryotech Polar Guard Xtend 28

GLOSSARY

APS	APS Aviation Inc.
ARP	Aerospace Recommended Practice
CEF	Climatic Engineering Facility
EG	Ethylene Glycol
FAA	Federal Aviation Administration
HOT	Holdover Time
HUPR	Highest Usable Precipitation Rate
LOUT	Lowest Operational Use Temperature
LOWV	Lowest On-Wing Viscosity
LUPR	Lowest Usable Precipitation Rate
NRC	National Research Council Canada
PG	Propylene Glycol
TC	Transport Canada

1. INTRODUCTION

This report has been created with the support of the fluid manufacturer, Transport Canada (TC), and the Federal Aviation Administration (FAA).

Aircraft ground de/anti-icing has been the subject of concentrated industry attention in recent years due to the occurrence of several fatal icing-related aircraft accidents. Notably, attention has been placed on the enhancement of anti-icing fluids in order to provide an extended period of protection against further contamination following initial deicing. This emphasis has led to the development of fluid-specific de/anti-icing fluid holdover time (HOT) tables for Type II, Type III, and Type IV fluids. These tables, accepted by regulatory authorities, are used by aircraft operators for departure planning in adverse winter conditions. Specifically, they provide the duration of time that qualified fluids provide protection against ice formation under specific weather conditions.

New anti-icing formulations continue to be developed by leading manufacturers with the specific objective of prolonging fluid holdover times without compromising the aerodynamic features of the airfoil. The purpose of the endurance time testing program is to measure the endurance times of these new fluids and develop fluid-specific HOT tables that provide guidance for their use.

Flat plate tests, conducted in natural and simulated precipitation, are used to develop HOT values for new fluids. These tests are carried out according to SAE Aerospace Recommended Practice (ARP) 5485, which provides the test protocols for measuring endurance times of Type II, III, and IV fluids. Along with its counterpart for measuring endurance times of Type I fluids ARP5945, ARP5485 has evolved into a refined procedure for measuring the duration of de/anti-icing fluid protection against ice formation.

The current data analysis protocol for developing HOT values from endurance time data was developed in 1996-97 and uses multi-variable regression to obtain HOT values. HOT values are derived for the majority of cells in Type II/III/IV HOT tables using this protocol and are used to create a fluid-specific HOT table for each Type II/III/IV fluid tested.

This report provides a detailed account of the endurance time testing conducted by APS Aviation Inc. (APS) with **Cryotech Polar Guard® Xtend**. It describes the test methodology used, endurance time data collected, and analysis completed to derive fluid-specific holdover times for the fluid.

2. METHODOLOGY

Tests were carried out according to SAE ARP5485, which provides the procedure and requirements for endurance time testing with Type II, III, and IV fluids under natural and simulated conditions.

The test methodology for endurance time testing carried out in the winter of 2018-19 is documented in detail in the report *"Methodology for Endurance Time Testing of Type II, III, and IV Fluids – Winter 2018-19."* A copy of this report is provided as an annex to this document.

The methodology report summarizes the key aspects of the test methodology, including some aspects included in ARP5485 and some aspects which are not included in ARP5485. It includes sections on:

a) Test Sites;

b) Test Equipment;

c) Test Procedures;

d) Precipitation Rates used in Type I, II, III, and IV Endurance Time Testing;

e) Ambient Temperatures used in Type I, II, III, and IV Endurance Time Testing;

f) Freezing Precipitation Droplet Sizes; and

g) Analysis Methodologies.

The data, analysis, and results provided in this report are a function of the test and analysis methodologies described in the methodology report. They should only be used in conjunction with the methodologies described therein.

3. DESCRIPTION OF DATA

This section provides a summary of the number of tests conducted. Breakdowns are provided for the number of tests performed by test type, precipitation type, fluid dilution, and test temperature.

3.1 Natural and Artificial Snow Tests

Tests were conducted in natural snow conditions at the APS test site and at several mobile test sites (refer to the report annex for details). Artificial snow tests were conducted at PMG Technologies in Blainville, QC. The breakdown of tests conducted is summarized below by fluid dilution and temperature.

Fluid Dilution	Natural Snow				Artificial Snow	
	≥ -3°C	< -3 to -8°C	< -8 to -14°C	<-14°C	-18°C	-25°C
Neat	5	15	9	2	4	4
75/25	5	15	9	2	0	0
50/50	7	9	0	0	0	0

3.2 Freezing Precipitation Tests

Tests were conducted in freezing drizzle, light freezing rain, freezing fog and rain on cold-soaked surface conditions at the National Research Council Canada (NRC) Climatic Engineering Facility (CEF). The number of tests conducted is summarized below by precipitation type, fluid dilution, and test temperature.

Fluid Dilution	Freezing Drizzle		Light Freezing Rain		Freezing Fog			Cold Soak
	-3°C	-10°C	-3°C	-10°C	-3°C	-14°C	-25°C	+1°C
Neat	4	4	4	4	4	4	4	4
75/25	4	4	4	4	4	4	0	4
50/50	4	0	6	0	4	0	0	0

3.3 Natural Frost Tests

Tests were conducted in natural frost at the APS test site. The breakdown of tests conducted is summarized below by fluid dilution and temperature.

Fluid Dilution	Natural Frost			
	≥-1°C	<-1 to -3°C	<-3 to -10°C	<-10°C
Neat	0	0	1	2
75/25	1	0	1	3
50/50	1	0	0	0

3.4 Fluid Thickness Tests

Fluid thickness tests were conducted to measure the film thickness profiles of the fluid under dry conditions. Two tests were performed for each dilution. For each test, 1 litre of fluid was poured onto a flat plate mounted on a test stand inclined by 10°. Thickness measurements were taken at the 15-cm (6") line at select time intervals over a 30-minute period. Tests were conducted at -3°C.

3.5 Test Logs

Details of each test conducted are provided in the test logs included as Table 3.1 (snow), Table 3.2 (freezing precipitation), and Table 3.3 (frost).

Table 3.1: Summary of Tests Performed (Snow)

Test No.	Date	Snow Type	Fluid Name	Fluid Dilution	Test Temp. (°C)	Icing Intensity (g/dm²/h)	Endurance Time (min)
1	28-Dec-18	Natural Snow	Polar Guard Xtend	100%	-7.7	9.6	116.6
4	28-Dec-18	Natural Snow	Polar Guard Xtend	75%	-7.8	6.9	101.5
8	28-Dec-18	Natural Snow	Polar Guard Xtend	100%	-5.7	35.8	43.5
9	28-Dec-18	Natural Snow	Polar Guard Xtend	75%	-5.8	40.1	23.3
15	7-Jan-19	Natural Snow	Polar Guard Xtend	100%	-11.2	17.2	25.9
16	7-Jan-19	Natural Snow	Polar Guard Xtend	75%	-11.2	19.6	29.5
22	8-Jan-19	Natural Snow	Polar Guard Xtend	100%	-9.0	15.5	70.9
23	8-Jan-19	Natural Snow	Polar Guard Xtend	75%	-9.7	23.8	32.0
27	8-Jan-19	Natural Snow	Polar Guard Xtend	100%	-8.5	18.9	50.5
38	8-Jan-19	Natural Snow	Polar Guard Xtend	75%	-4.6	8.9	109.3
41	8-Jan-19	Natural Snow	Polar Guard Xtend	50%	-4.1	6.6	16.3
42	18-Jan-19	Natural Snow	Polar Guard Xtend	100%	-14.5	1.7	283.3
43	18-Jan-19	Natural Snow	Polar Guard Xtend	75%	-15.3	1.4	148.7
54	18-Jan-19	Natural Snow	Polar Guard Xtend	100%	-13.2	2.3	219.3
55	18-Jan-19	Natural Snow	Polar Guard Xtend	75%	-13.6	2.0	172.6
61	29-Jan-19	Natural Snow	Polar Guard Xtend	100%	-14.5	6.0	85.4
62	29-Jan-19	Natural Snow	Polar Guard Xtend	75%	-14.6	5.0	72.8
67	29-Jan-19	Natural Snow	Polar Guard Xtend	100%	-10.7	6.5	103.2
68	29-Jan-19	Natural Snow	Polar Guard Xtend	75%	-10.6	5.5	71.8
75	2-Feb-19	Natural Snow	Polar Guard Xtend	100%	-9.1	4.6	139.4
76	2-Feb-19	Natural Snow	Polar Guard Xtend	75%	-9.2	3.6	96.1
79	2-Feb-19	Natural Snow	Polar Guard Xtend	75%	-8.5	7.9	66.7
84	2-Feb-19	Natural Snow	Polar Guard Xtend	100%	-8.3	8.3	101.9
85	2-Feb-19	Natural Snow	Polar Guard Xtend	100%	-7.4	5.7	140.9
86	2-Feb-19	Natural Snow	Polar Guard Xtend	75%	-7.7	8.4	62.1
96	12-Feb-19	Natural Snow	Polar Guard Xtend	100%	-11.8	12.7	63.1
97	12-Feb-19	Natural Snow	Polar Guard Xtend	75%	-11.9	10.7	33.8
104	12-Feb-19	Natural Snow	Polar Guard Xtend	100%	-9.6	17.5	91.0
105	12-Feb-19	Natural Snow	Polar Guard Xtend	75%	-9.9	17.1	44.8
111	12-Feb-19	Natural Snow	Polar Guard Xtend	100%	-7.9	23.9	64.9
112	12-Feb-19	Natural Snow	Polar Guard Xtend	75%	-8.2	23.0	34.6
118	12-Feb-19	Natural Snow	Polar Guard Xtend	100%	-6.5	31.3	50.8
119	12-Feb-19	Natural Snow	Polar Guard Xtend	75%	-6.5	31.0	34.3
125	13-Feb-19	Natural Snow	Polar Guard Xtend	100%	-7.3	44.1	37.8
126	13-Feb-19	Natural Snow	Polar Guard Xtend	75%	-7.1	37.8	23.6
131	13-Feb-19	Natural Snow	Polar Guard Xtend	100%	-7.3	54.4	31.6
134	13-Feb-19	Natural Snow	Polar Guard Xtend	75%	-7.3	61.1	17.6

Table 3.1: Summary of Tests Performed (Snow) (cont'd)

Test No.	Date	Snow Type	Fluid Name	Fluid Dilution	Test Temp. (°C)	Icing Intensity (g/dm²/h)	Endurance Time (min)
142	13-Feb-19	Natural Snow	Polar Guard Xtend	75%	-6.9	30.3	29.7
143	13-Feb-19	Natural Snow	Polar Guard Xtend	100%	-6.7	20.0	70.6
147	15-Feb-19	Natural Snow	Polar Guard Xtend	50%	-5.1	11.5	11.6
153	15-Feb-19	Natural Snow	Polar Guard Xtend	50%	-3.0	10.1	13.3
159	21-Feb-19	Natural Snow	Polar Guard Xtend	100%	-5.9	22.7	57.5
160	21-Feb-19	Natural Snow	Polar Guard Xtend	75%	-5.8	20.5	41.8
165	21-Feb-19	Natural Snow	Polar Guard Xtend	100%	-7.1	37.6	38.9
166	21-Feb-19	Natural Snow	Polar Guard Xtend	75%	-6.6	49.6	16.5
170	21-Feb-19	Natural Snow	Polar Guard Xtend	100%	-7.3	22.5	66.8
171	21-Feb-19	Natural Snow	Polar Guard Xtend	75%	-7.3	30.9	21.2
177	21-Feb-19	Natural Snow	Polar Guard Xtend	100%	-7.3	7.4	152.3
178	21-Feb-19	Natural Snow	Polar Guard Xtend	75%	-7.1	7.8	106.8
195	3-Mar-19	Natural Snow	Polar Guard Xtend	50%	-3.1	3.0	30.7
199	3-Mar-19	Natural Snow	Polar Guard Xtend	50%	-3.6	1.9	42.7
211	10-Mar-19	Natural Snow	Polar Guard Xtend	100%	-1.8	37.2	45.2
212	10-Mar-19	Natural Snow	Polar Guard Xtend	75%	-1.8	38.3	25.7
213	10-Mar-19	Natural Snow	Polar Guard Xtend	50%	-1.8	40.1	8.9
220	10-Mar-19	Natural Snow	Polar Guard Xtend	100%	-1.8	46.7	39.3
221	10-Mar-19	Natural Snow	Polar Guard Xtend	75%	-1.8	42.1	27.7
222	10-Mar-19	Natural Snow	Polar Guard Xtend	50%	-1.8	43.5	5.4
229	10-Mar-19	Natural Snow	Polar Guard Xtend	100%	-0.9	40.1	48.1
230	10-Mar-19	Natural Snow	Polar Guard Xtend	75%	-1.3	39.0	32.8
231	10-Mar-19	Natural Snow	Polar Guard Xtend	50%	-1.3	24.7	10.6
235	10-Mar-19	Natural Snow	Polar Guard Xtend	50%	0.7	7.8	33.0
240	10-Mar-19	Natural Snow	Polar Guard Xtend	100%	-7.9	52.4	39.0
241	10-Mar-19	Natural Snow	Polar Guard Xtend	75%	-8.0	62.6	10.7
249	10-Mar-19	Natural Snow	Polar Guard Xtend	100%	-6.6	29.0	65.4
250	10-Mar-19	Natural Snow	Polar Guard Xtend	75%	-6.8	28.5	51.8
258	10-Mar-19	Natural Snow	Polar Guard Xtend	100%	-1.4	21.9	91.4
259	10-Mar-19	Natural Snow	Polar Guard Xtend	75%	-1.6	20.4	76.3
260	10-Mar-19	Natural Snow	Polar Guard Xtend	50%	-1.9	20.4	19.3
267	10-Mar-19	Natural Snow	Polar Guard Xtend	100%	0.2	33.5	76.3
268	10-Mar-19	Natural Snow	Polar Guard Xtend	75%	0.2	36.1	45.3
269	10-Mar-19	Natural Snow	Polar Guard Xtend	50%	0.2	42.9	9.4
273	30-Mar-19	Natural Snow	Polar Guard Xtend	50%	-4.4	17.9	9.3
275	30-Mar-19	Natural Snow	Polar Guard Xtend	50%	-4.4	20.4	9.2

Table 3.1: Summary of Tests Performed (Snow) (cont'd)

Test No.	Date	Snow Type	Fluid Name	Fluid Dilution	Test Temp. (°C)	Icing Intensity (g/dm²/h)	Endurance Time (min)
280	30-Mar-19	Natural Snow	Polar Guard Xtend	100%	-4.2	28.9	58.3
281	30-Mar-19	Natural Snow	Polar Guard Xtend	75%	-4.2	28.8	46.5
284	30-Mar-19	Natural Snow	Polar Guard Xtend	50%	-4.2	27.9	8.0
286	30-Mar-19	Natural Snow	Polar Guard Xtend	50%	-4.3	23.6	8.3
288	30-Mar-19	Natural Snow	Polar Guard Xtend	50%	-4.5	12.8	13.5
AS17	25-Apr-19	Artificial Snow	Polar Guard Xtend	100%	-18.0	3.0	74.6
AS18	26-Apr-19	Artificial Snow	Polar Guard Xtend	100%	-18.0	4.0	81.4
AS19	24-Apr-19	Artificial Snow	Polar Guard Xtend	100%	-18.0	10.2	30.0
AS20	25-Apr-19	Artificial Snow	Polar Guard Xtend	100%	-18.0	24.6	19.5
AS21	18-Apr-19	Artificial Snow	Polar Guard Xtend	100%	-25.0	3.0	68.1
AS22	15-Apr-19	Artificial Snow	Polar Guard Xtend	100%	-25.0	4.1	56.2
AS23	5-Apr-19	Artificial Snow	Polar Guard Xtend	100%	-25.0	10.2	19.7
AS24	17-Apr-19	Artificial Snow	Polar Guard Xtend	100%	-25.0	25.2	14.2

Table 3.2: Summary of Tests Performed (Freezing Precipitation)

Test No.	Date	Precipitation Type	Fluid Name	Fluid Dilution	Test Temp. (°C)	Icing Intensity (g/dm²/h)	Endurance Time (min)
5	11-Apr-19	Cold-Soaked Box	Polar Guard Xtend	100%	0.8	5.1	100.1
6	11-Apr-19	Cold-Soaked Box	Polar Guard Xtend	100%	0.8	5.4	99.5
7	11-Apr-19	Cold-Soaked Box	Polar Guard Xtend	75%	0.9	5.4	115.6
8	11-Apr-19	Cold-Soaked Box	Polar Guard Xtend	75%	0.9	4.9	128.2
19	11-Apr-19	Cold-Soaked Box	Polar Guard Xtend	100%	1.1	76.1	19.8
20	11-Apr-19	Cold-Soaked Box	Polar Guard Xtend	100%	1.1	76.9	17.8
21	11-Apr-19	Cold-Soaked Box	Polar Guard Xtend	75%	1.1	76.6	8.1
22	11-Apr-19	Cold-Soaked Box	Polar Guard Xtend	75%	1.1	75.4	9.1
35	3-Apr-19	Freezing Drizzle	Polar Guard Xtend	100%	-3.1	4.9	133.2
36	3-Apr-19	Freezing Drizzle	Polar Guard Xtend	100%	-3.1	5.0	131.6
37	3-Apr-19	Freezing Drizzle	Polar Guard Xtend	75%	-3.1	5.1	110.6
38	3-Apr-19	Freezing Drizzle	Polar Guard Xtend	75%	-3.1	5.4	111.6
39	3-Apr-19	Freezing Drizzle	Polar Guard Xtend	50%	-3.1	5.0	23.9
40	3-Apr-19	Freezing Drizzle	Polar Guard Xtend	50%	-3.1	5.0	24.6
53	3-Apr-19	Freezing Drizzle	Polar Guard Xtend	100%	-3.1	13.5	125.7
54	3-Apr-19	Freezing Drizzle	Polar Guard Xtend	100%	-3.1	13.2	130.4
55	3-Apr-19	Freezing Drizzle	Polar Guard Xtend	75%	-3.1	13.5	72.4
56	3-Apr-19	Freezing Drizzle	Polar Guard Xtend	75%	-3.1	13.1	76.9
57	3-Apr-19	Freezing Drizzle	Polar Guard Xtend	50%	-3.0	13.5	8.0
58	3-Apr-19	Freezing Drizzle	Polar Guard Xtend	50%	-3.0	13.1	8.8
69	4-Apr-19	Freezing Drizzle	Polar Guard Xtend	100%	-10.2	4.9	96.9
70	4-Apr-19	Freezing Drizzle	Polar Guard Xtend	100%	-10.2	4.8	105.3
71	4-Apr-19	Freezing Drizzle	Polar Guard Xtend	75%	-10.1	5.1	75.0
72	4-Apr-19	Freezing Drizzle	Polar Guard Xtend	75%	-10.1	5.3	75.9
83	4-Apr-19	Freezing Drizzle	Polar Guard Xtend	100%	-10.1	13.2	32.8
84	4-Apr-19	Freezing Drizzle	Polar Guard Xtend	100%	-10.1	13.3	31.0
85	4-Apr-19	Freezing Drizzle	Polar Guard Xtend	75%	-10.2	13.0	29.1
86	4-Apr-19	Freezing Drizzle	Polar Guard Xtend	75%	-10.2	13.2	26.6
99	10-Apr-19	Freezing Fog	Polar Guard Xtend	100%	-3.2	2.1	257.5
100	10-Apr-19	Freezing Fog	Polar Guard Xtend	100%	-3.2	2.2	262.3
101	10-Apr-19	Freezing Fog	Polar Guard Xtend	75%	-3.2	1.9	212.7
102	10-Apr-19	Freezing Fog	Polar Guard Xtend	75%	-3.2	2.3	210.9
103	10-Apr-19	Freezing Fog	Polar Guard Xtend	50%	-3.0	2.0	23.6
104	10-Apr-19	Freezing Fog	Polar Guard Xtend	50%	-3.0	1.8	25.3
117	10-Apr-19	Freezing Fog	Polar Guard Xtend	100%	-3.1	5.3	136.6
118	10-Apr-19	Freezing Fog	Polar Guard Xtend	100%	-3.1	5.1	162.0
119	10-Apr-19	Freezing Fog	Polar Guard Xtend	75%	-3.1	5.1	97.4

Table 3.2: Summary of Tests Performed (Freezing Precipitation) (cont'd)

Test No.	Date	Precipitation Type	Fluid Name	Fluid Dilution	Test Temp. (°C)	Icing Intensity (g/dm²/h)	Endurance Time (min)
120	10-Apr-19	Freezing Fog	Polar Guard Xtend	75%	-3.1	5.1	80.3
121	10-Apr-19	Freezing Fog	Polar Guard Xtend	50%	-3.1	5.3	12.1
122	10-Apr-19	Freezing Fog	Polar Guard Xtend	50%	-3.1	5.1	11.5
133	9-Apr-19	Freezing Fog	Polar Guard Xtend	100%	-14.1	2.0	110.6
134	9-Apr-19	Freezing Fog	Polar Guard Xtend	100%	-14.1	2.0	113.4
135	9-Apr-19	Freezing Fog	Polar Guard Xtend	75%	-14.1	2.1	83.9
136	9-Apr-19	Freezing Fog	Polar Guard Xtend	75%	-14.1	2.0	85.7
147	9-Apr-19	Freezing Fog	Polar Guard Xtend	100%	-14.0	4.9	59.8
148	9-Apr-19	Freezing Fog	Polar Guard Xtend	100%	-14.0	4.9	57.7
149	9-Apr-19	Freezing Fog	Polar Guard Xtend	75%	-14.1	4.6	58.0
150	9-Apr-19	Freezing Fog	Polar Guard Xtend	75%	-14.0	4.9	59.0
169	8-Apr-19	Freezing Fog	Polar Guard Xtend	100%	-25.3	5.0	22.8
170	8-Apr-19	Freezing Fog	Polar Guard Xtend	100%	-25.2	4.6	25.4
187	5-Apr-19	Light Freezing Rain	Polar Guard Xtend	100%	-2.9	13.0	111.4
188	5-Apr-19	Light Freezing Rain	Polar Guard Xtend	100%	-2.9	13.0	105.5
189	5-Apr-19	Light Freezing Rain	Polar Guard Xtend	75%	-2.9	13.2	58.8
190	5-Apr-19	Light Freezing Rain	Polar Guard Xtend	75%	-2.9	12.8	60.4
191	5-Apr-19	Light Freezing Rain	Polar Guard Xtend	50%	-2.9	13.4	10.1
192	5-Apr-19	Light Freezing Rain	Polar Guard Xtend	50%	-2.9	13.3	7.5
205	5-Apr-19	Light Freezing Rain	Polar Guard Xtend	100%	-3.0	25.1	59.2
206	5-Apr-19	Light Freezing Rain	Polar Guard Xtend	100%	-3.0	25.4	60.6
207	5-Apr-19	Light Freezing Rain	Polar Guard Xtend	75%	-3.0	24.8	27.3
208	5-Apr-19	Light Freezing Rain	Polar Guard Xtend	75%	-3.0	25.5	25.4
209	5-Apr-19	Light Freezing Rain	Polar Guard Xtend	50%	-3.1	25.1	6.5
210	5-Apr-19	Light Freezing Rain	Polar Guard Xtend	50%	-3.1	24.9	6.4
221	4-Apr-19	Light Freezing Rain	Polar Guard Xtend	100%	-9.8	13.5	57.7
222	4-Apr-19	Light Freezing Rain	Polar Guard Xtend	100%	-9.8	13.4	51.0
223	4-Apr-19	Light Freezing Rain	Polar Guard Xtend	75%	-9.8	13.4	46.0
224	4-Apr-19	Light Freezing Rain	Polar Guard Xtend	75%	-9.8	12.9	52.4
235	5-Apr-19	Light Freezing Rain	Polar Guard Xtend	100%	-10.1	25.3	51.6
236	5-Apr-19	Light Freezing Rain	Polar Guard Xtend	100%	-10.1	25.4	44.4
237	5-Apr-19	Light Freezing Rain	Polar Guard Xtend	75%	-10.0	25.4	24.8
238	5-Apr-19	Light Freezing Rain	Polar Guard Xtend	75%	-10.0	25.8	25.9
159R	8-Apr-19	Freezing Fog	Polar Guard Xtend	100%	-25.0	1.9	39.8
160R	8-Apr-19	Freezing Fog	Polar Guard Xtend	100%	-25.0	2.0	39.5
191R	5-Apr-19	Light Freezing Rain	Polar Guard Xtend	50%	-2.8	13.4	9.7
192R	5-Apr-19	Light Freezing Rain	Polar Guard Xtend	50%	-2.8	13.3	8.8

Table 3.3: Summary of Tests Performed (Natural Frost)

Test No.	Date	Precipitation Type	Fluid Name	Fluid Dilution	Test Duration (min.)	Average Rate (g/dm²/h)	Temp (°C)	Wind Speed (km/h)	Average RH (%)	Comments
5	Feb-11-19	Natural Frost	Polar Guard Xtend	75%	68	0.02	-12.2	7	57	Did Not Fail
10	Feb-17-19	Natural Frost	Polar Guard Xtend	75%	375	0.05	-14.3	8	74	Did Not Fail
13	Feb-17-19	Natural Frost	Polar Guard Xtend	100%	427	0.05	-14.0	9	73	Did Not Fail
19	Feb-19-19	Natural Frost	Polar Guard Xtend	100%	447	0.07	-16.7	5	80	Did Not Fail
23	Feb-19-19	Natural Frost	Polar Guard Xtend	75%	198	0.05	-15.8	5	76	
31	Mar-18-19	Natural Frost	Polar Guard Xtend	100%	601	0.06	-8.0	5	66	Did Not Fail
35	Mar-18-19	Natural Frost	Polar Guard Xtend	75%	545	0.06	-8.4	5	68	Did Not Fail
38	Apr-16-19	Natural Frost	Polar Guard Xtend	75%	309	0.10	0.8	6	72	Did Not Fail
41	Apr-16-19	Natural Frost	Polar Guard Xtend	50%	277	0.10	1.1	6	71	

4. RESULTS AND DISCUSSION

The methods used to evaluate the test data are provided in the report "*Methodology for Endurance Time Testing of Type II, III, and IV Fluids – Winter 2018-19,*" which is provided as an annex to this report. The results of the data analyses and a discussion of the findings are presented in this section.

4.1 Results

The results of the endurance time and thickness tests are described in this section.

4.1.1 Endurance Time Tests – Natural Snow and Freezing Precipitation

Figures 4.1 to 4.16 present the endurance time data collected in natural snow, artificial snow, and freezing precipitation (freezing drizzle, light freezing rain, freezing fog, and rain on cold-soaked surface).

These figures show the effect of temperature, precipitation type, and precipitation rate on fluid endurance time in the conditions encompassed by the Type IV HOT guidelines. The figures include the current Type IV generic holdover times for comparative purposes.

Multi-variable regression analysis was performed on these data sets as described in the annex. Table 4.1 provides the outputs from the multi-variable regression analyses. These outputs were used to derive fluid-specific holdover times for all conditions encompassed by Type IV fluid-specific HOT tables. One exception is the snow cells in temperature bands colder than -14°C (see Subsection 4.2.2).

4.1.2 Endurance Time Tests – Natural Frost

The natural frost data was presented in Table 3.3. The test durations were compared to the Type IV generic holdover times. Tests that were not completed (due to active frost ending before fluid failure could occur) surpassed the generic holdover times. This analysis indicates the Type IV generic frost holdover times can be considered substantiated for Cryotech Polar Guard Xtend.

Additional natural frost tests will be completed in winter 2019-20 with retained samples of Cryotech Polar Guard Xtend.

4.1.3 Fluid Thickness Tests

Figure 4.17 shows the fluid thickness test data. As described in Subsection 3.4, two tests were conducted at an ambient temperature of -3°C. The final fluid thicknesses are displayed in Figure 4.18.

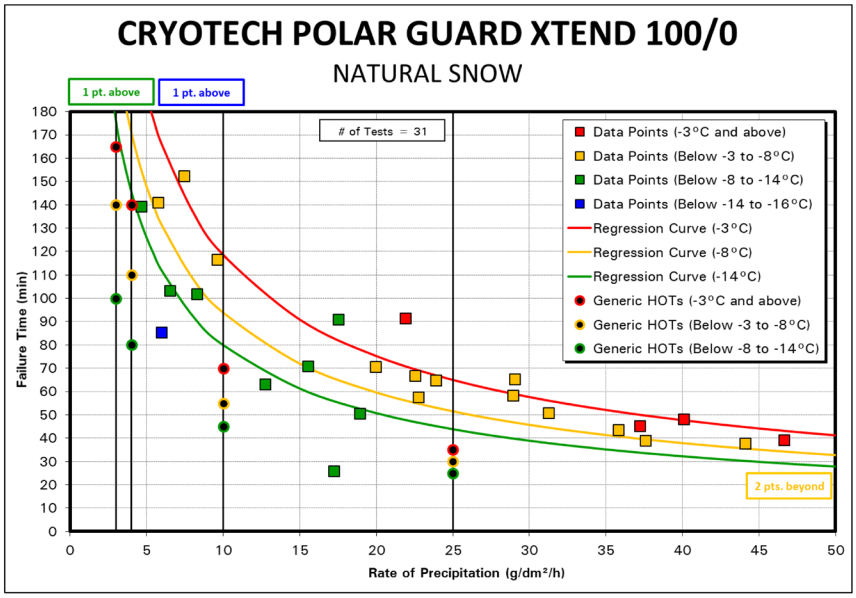


Figure 4.1: Type IV 100/0 – Natural Snow

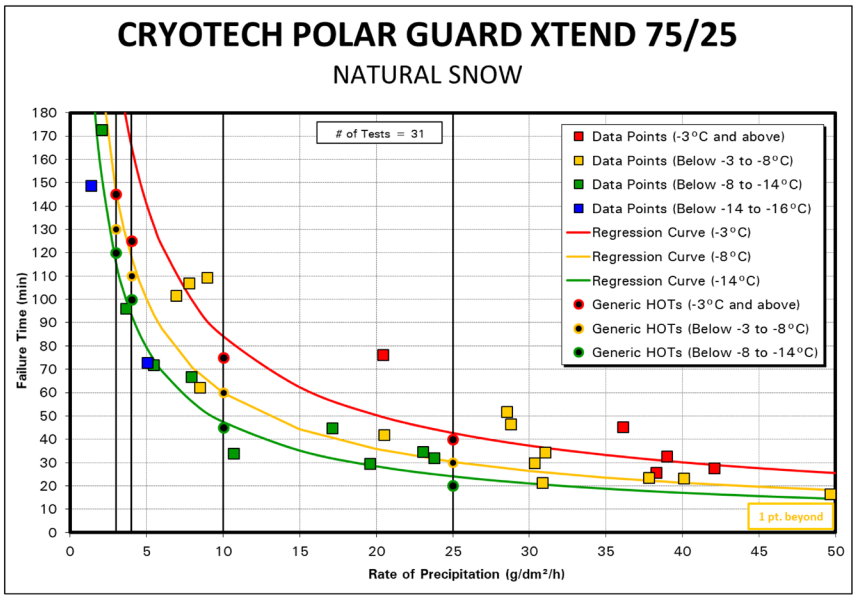


Figure 4.2: Type IV 75/25 – Natural Snow

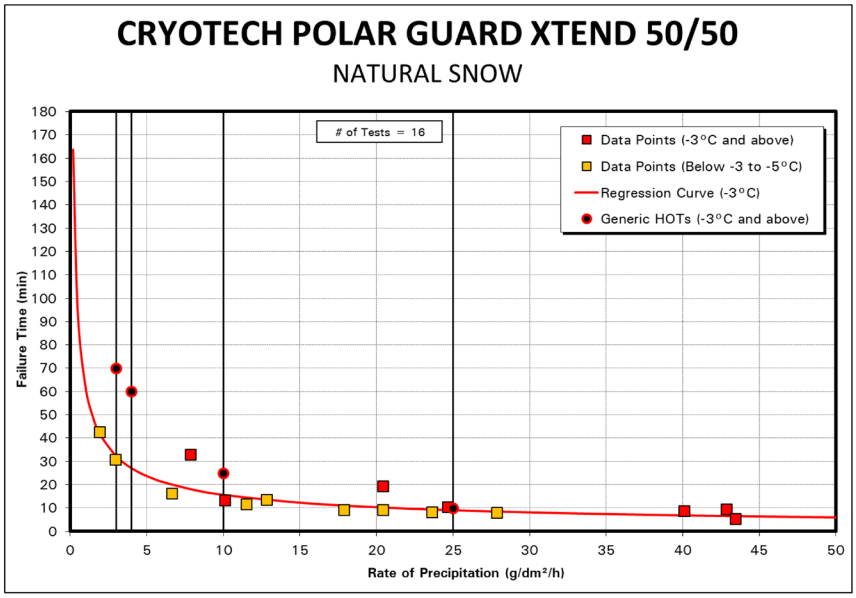


Figure 4.3: Type IV 50/50 – Natural Snow

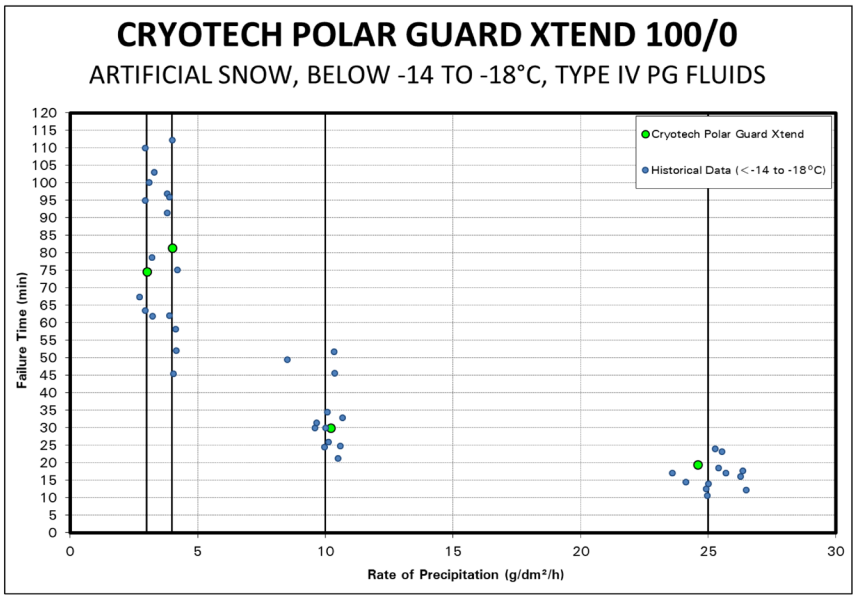


Figure 4.4: Type IV 100/0 – Artificial Snow at -18°C with Historical Results

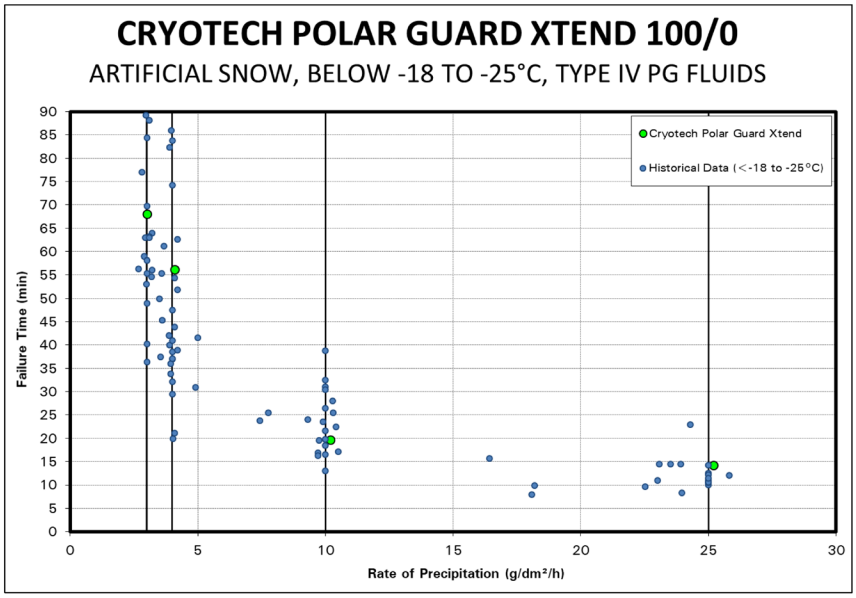


Figure 4.5: Type IV 100/0 – Artificial Snow at -25°C with Historical Results

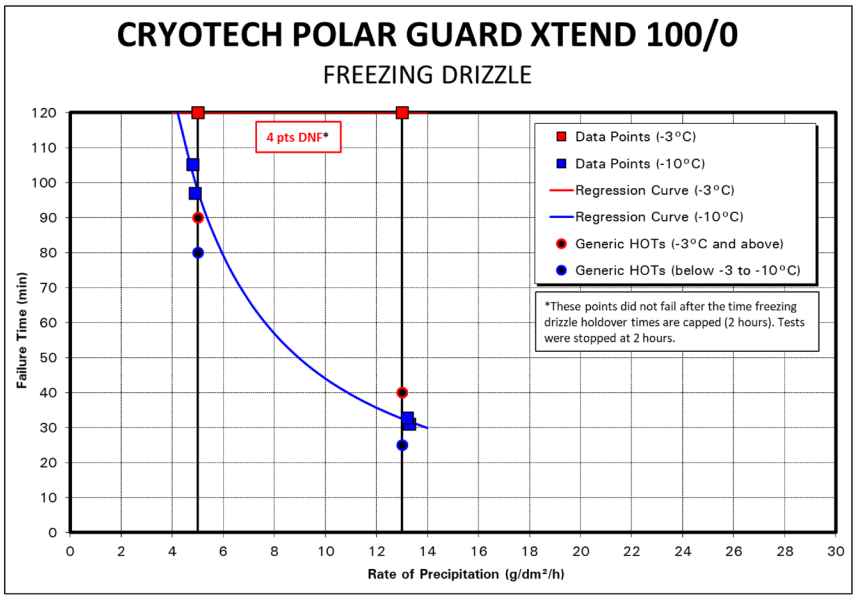


Figure 4.6: Type IV 100/0 – Freezing Drizzle

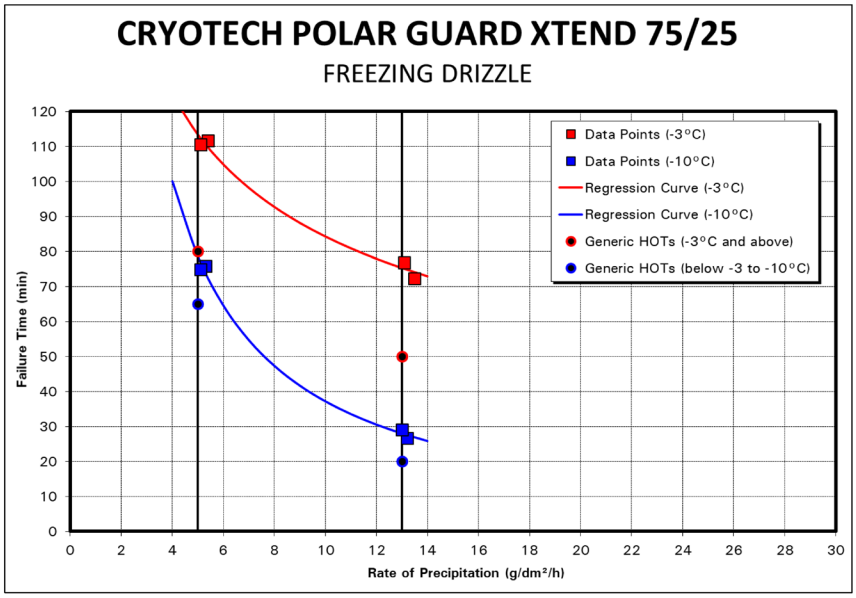


Figure 4.7: Type IV 75/25 – Freezing Drizzle

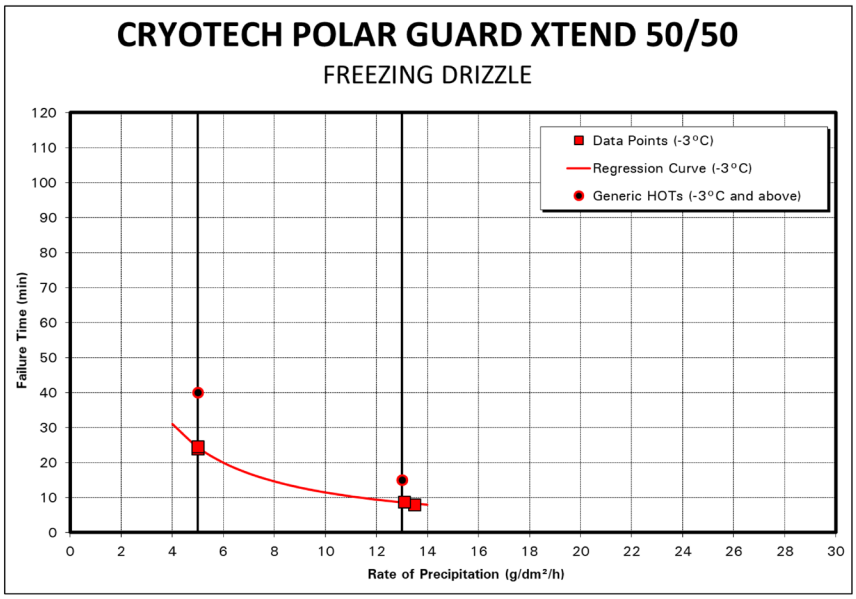


Figure 4.8: Type IV 50/50 – Freezing Drizzle

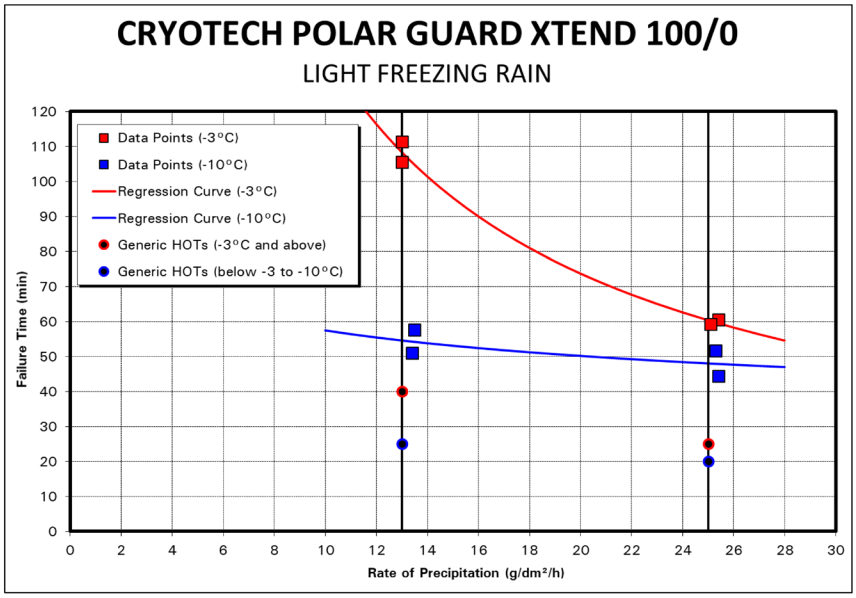


Figure 4.9: Type IV 100/0 – Light Freezing Rain

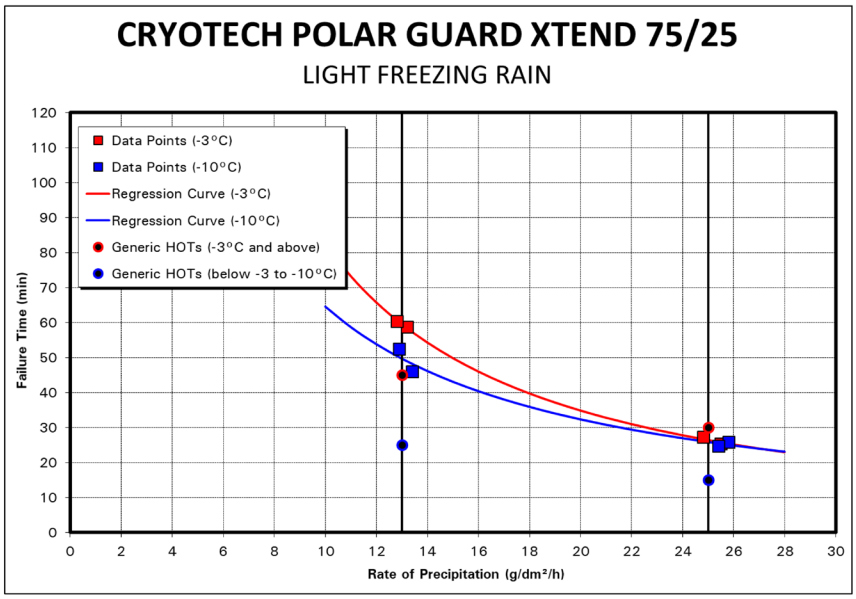


Figure 4.10: Type IV 75/25 – Light Freezing Rain

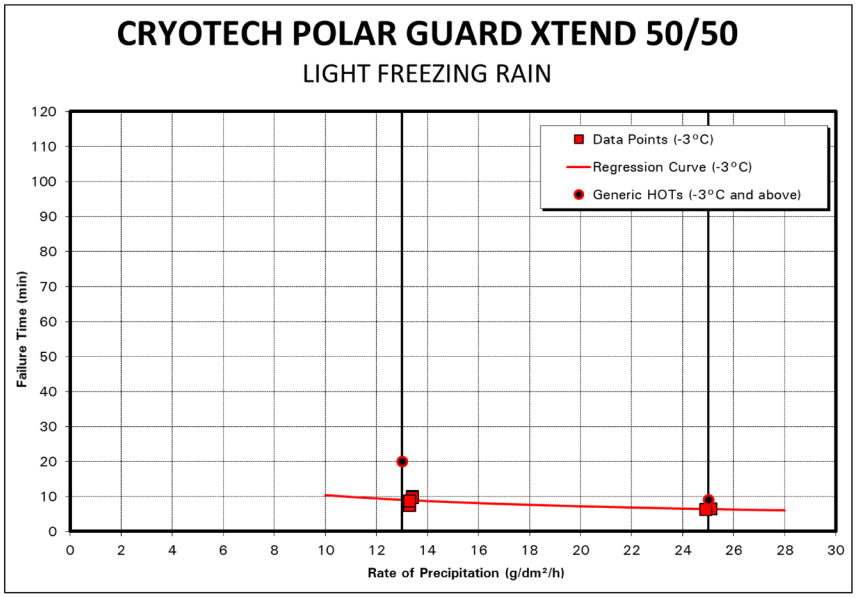


Figure 4.11: Type IV 50/50 – Light Freezing Rain

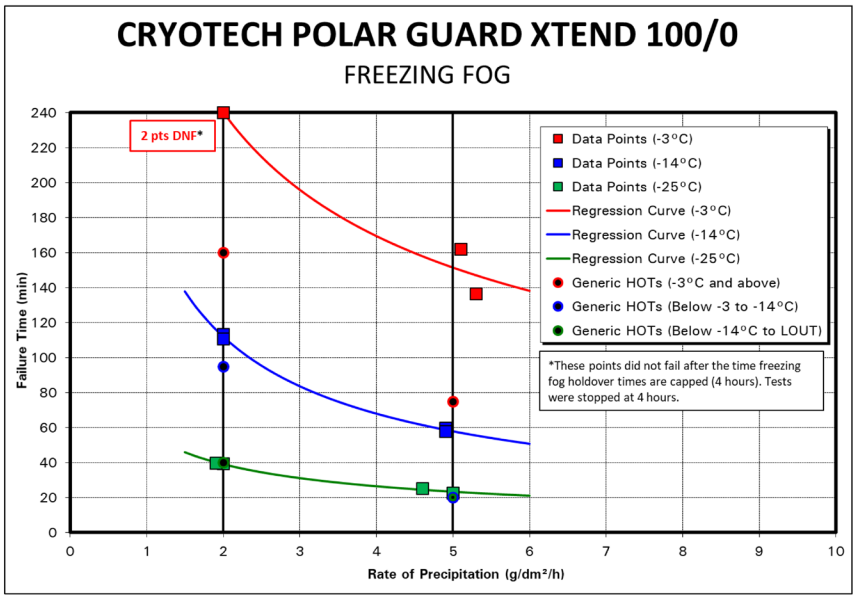


Figure 4.12: Type IV 100/0 – Freezing Fog

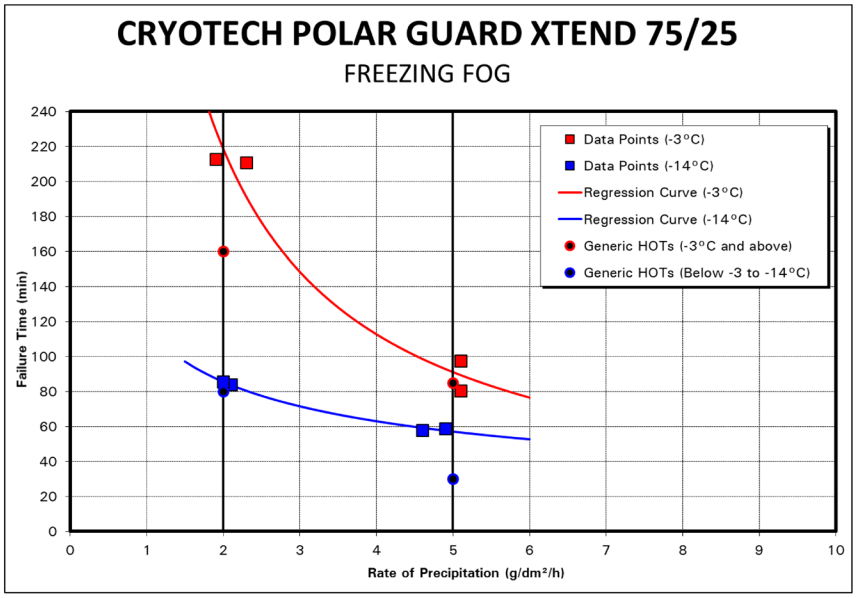


Figure 4.13: Type IV 75/25 – Freezing Fog

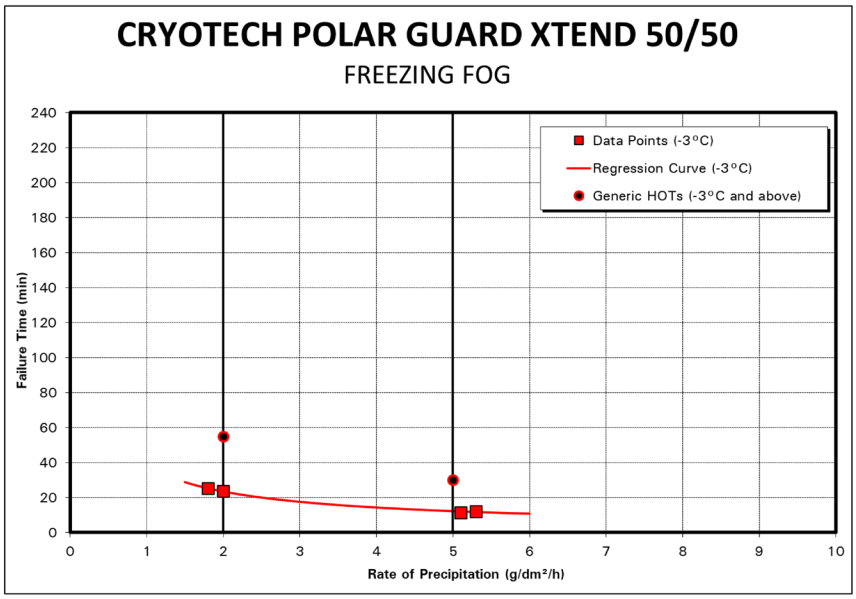


Figure 4.14: Type IV 50/50 – Freezing Fog

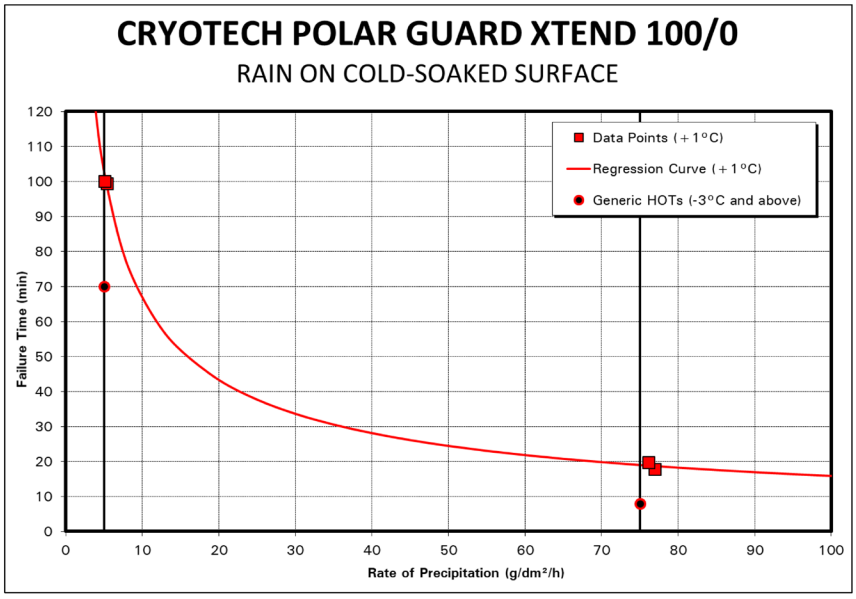


Figure 4.15: Type IV 100/0 – Rain on Cold-Soaked Surface

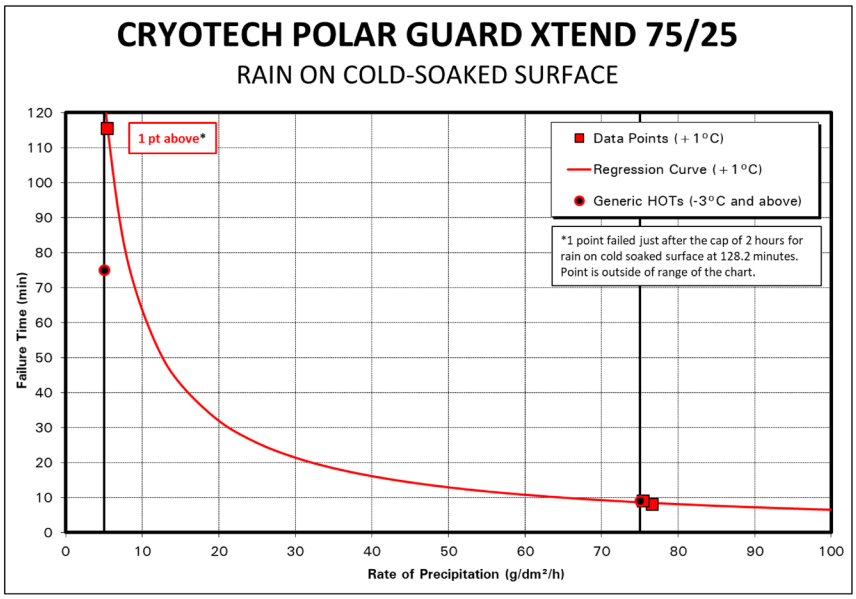


Figure 4.16: Type IV 75/25 – Rain on Cold-Soaked Surface

Table 4.1: Regression Equation Coefficients for Cryotech Polar Guard Xtend

Natural Snow

Fluid	Dil	Temp.	R^2	Intercept (I)	Coeff. Rate (A)	Coeff. Tem (B)	Total Pts.
Cryotech Polar Guard Xtend	100%	≥ -14°C	85%	2.9681	-0.6559	-0.3399	31
Cryotech Polar Guard Xtend	75%	≥ -14°C	88%	3.0132	-0.7421	-0.4945	31
Cryotech Polar Guard Xtend	50%	≥ -14°C	91%	2.1061	-0.6000	-0.4454	16

General Equation $t = 10^{I} R^{A} (2\text{-}T)^{B}$

Simulated Freezing Fog

Fluid	Dil	Temp.	R^2	Intercept (I)	Coeff. Rate (A)	Total Pts.
Cryotech Polar Guard Xtend	100%	-3°C	95%	2.5325	-0.5036	4
Cryotech Polar Guard Xtend	75%	-3°C	96%	2.6286	-0.9581	4
Cryotech Polar Guard Xtend	50%	-3°C	99%	1.5878	-0.7207	4
Cryotech Polar Guard Xtend	100%	-14°C	100%	2.2661	-0.7204	4
Cryotech Polar Guard Xtend	75%	-14°C	99%	2.0655	-0.4408	4
Cryotech Polar Guard Xtend	100%	-25°C	99%	1.7603	-0.5578	4

General Equation $t = 10^{I} R^{A}$

Simulated Freezing Drizzle

Fluid	Dil	Temp.	R^2	Intercept (I)	Coeff. Rate (A)	Total Pts.
Cryotech Polar Guard Xtend	100%	-3°C	100%	2.0792	0.0000	4
Cryotech Polar Guard Xtend	75%	-3°C	99%	2.3539	-0.4282	4
Cryotech Polar Guard Xtend	50%	-3°C	100%	2.1463	-1.0888	4
Cryotech Polar Guard Xtend	100%	-10°C	100%	2.7919	-1.1481	4
Cryotech Polar Guard Xtend	75%	-10°C	100%	2.6503	-1.0796	4

General Equation $t = 10^{I} R^{A}$

Simulated Light Freezing Rain

Fluid	Dil	Temp.	R^2	Intercept (I)	Coeff. Rate (A)	Total Pts.
Cryotech Polar Guard Xtend	100%	-3°C	99%	3.0299	-0.8932	4
Cryotech Polar Guard Xtend	75%	-3°C	100%	3.1569	-1.2402	4
Cryotech Polar Guard Xtend	50%	-3°C	72%	1.5422	-0.5245	6
Cryotech Polar Guard Xtend	100%	-10°C	45%	1.9558	-0.1963	4
Cryotech Polar Guard Xtend	75%	-10°C	99%	2.8061	-0.9960	4

General Equation $t = 10^{I} R^{A}$

Simulated Rain on Cold-Soaked Wing

Fluid	Dil	Temp.	R^2	Intercept (I)	Coeff. Rate (A)	Total Pts.
Cryotech Polar Guard Xtend	100%	+1°C	100%	2.4479	-0.6234	4
Cryotech Polar Guard Xtend	75%	+1°C	100%	2.7857	-0.9845	4

General Equation $t = 10^{I} R^{A}$

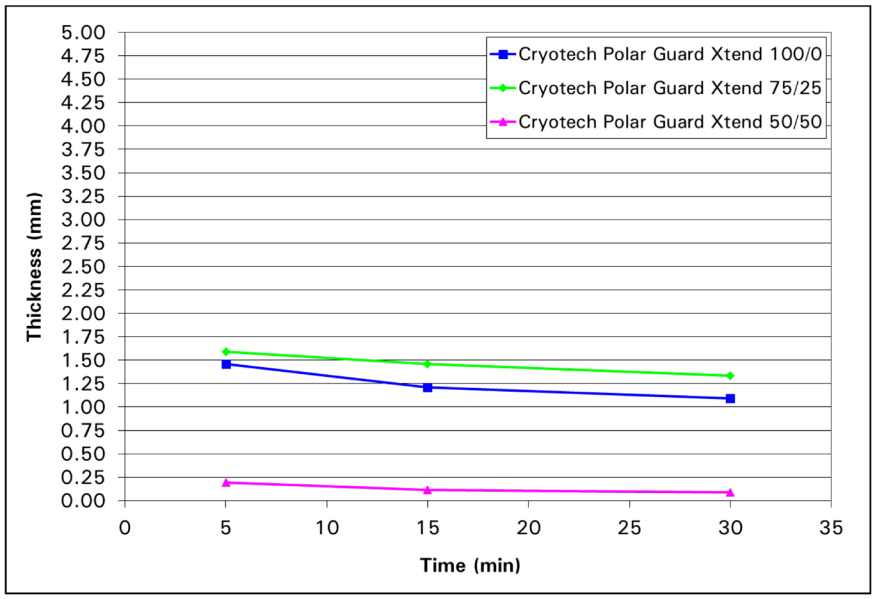


Figure 4.17: Fluid Thickness Profiles of Cryotech Polar Guard Xtend

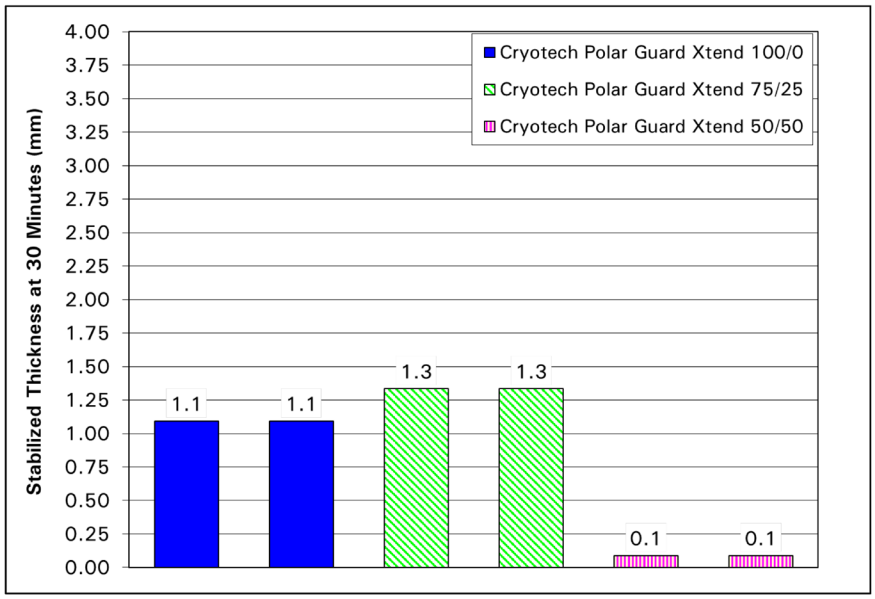


Figure 4.18: Final Fluid Thickness of Cryotech Polar Guard Xtend

4.2 Discussion

4.2.1 Holdover Time Table

The holdover times described in Subsection 4.1 were used to populate a fluid-specific HOT table for Cryotech Polar Guard Xtend. At the manufacturer's request, the HOT table includes values for the 100/0 dilution only. The HOT table is shown in both the TC format (Table 4.2) and FAA format (Table 4.3) at the end of this chapter.

4.2.2 Holdover Times in Snow at Temperatures Below -14°C

Due to the cost associated with collecting endurance time data in very cold snow conditions, all Type II/IV fluids that have not undergone (optional) supplemental fluid-specific testing in very cold snow are given generic HOT values for snow at temperatures below -14°C. These generic values were determined analytically in the winter of 2018-19, and are based on limited fluid-specific natural snow data and an analysis of relative fluid performance.

The generic values differ for Type II and Type IV fluids and for ethylene glycol (EG) and propylene glycol (PG) based fluids. Accordingly, Cryotech Polar Guard Xtend has been given Type IV PG-specific generic values in the "Below -14°C to -18°C," "Below -18°C to -25°C," and "Below -25°C to lowest operational use temperature (LOUT)" snow cells.

4.2.3 Holdover Times in Frost

It should be noted that frost holdover times are not included in the fluid-specific HOT tables. This is due to a decision made by TC and the FAA in May 2009 to move frost holdover times from the generic and fluid-specific HOT tables to a separate frost HOT table. Accordingly, frost holdover times have not been included in the Cryotech Polar Guard Xtend fluid-specific HOT table.

4.2.4 Fluid Viscosity

The viscosities of the fluid samples used in this testing were measured using both the AS9968 method and the manufacturer's designated method. The APS measured viscosities appear at the beginning of this document and will be published as the lowest on-wing viscosity (LOWV) values for the fluid. In order for the fluid-specific

holdover times provided in this document to be valid, operators must ensure that the viscosity of the fluid being used is equal or greater than the published LOWV.

4.2.5 Lowest Operational Use Temperatures (LOUTs)

The LOUT for Type II/III/IV fluids is determined by the higher of:

a) The lowest temperature at which the fluid meets the aerodynamic acceptance test for a given aircraft type; and

b) The actual freezing point of the fluid plus its freezing point buffer of 7°C (13°F).

The aerodynamic acceptance and freezing point information for the 100/0 dilution of this fluid is provided at the beginning of this document. Although the fluid met the aerodynamic acceptance test requirement for -31°C, the manufacturer requested that the LOUT be capped at -29°C. As such, the LOUT for Cryotech Polar Guard Xtend (100/0) is -29°C (-20°F).

The aerodynamic acceptance information for the 75/25 and 50/50 dilutions of this fluid was not provided. As a result, the fluid LOUT for these dilutions is unknown.

4.2.6 Lowest and Highest Usable Precipitation Rates in Snow

The lowest usable precipitation rates (LUPRs) and highest usable precipitation rates (HUPRs) for Cryotech Polar Guard Xtend were determined by analysing the natural snow data sets using the analysis methodology described in the report "*Methodology for Endurance Time Testing of Type II, III, and IV Fluids – Winter 2018-19*," which is provided as an annex to this report. The resulting statistics are shown in Tables 4.4 (LUPR statistics) and 4.5 (HUPR statistics).

The analysis determined the LUPRs for Cryotech Polar Guard Xtend are:

- 100/0 = 3 g/dm²/h;
- 75/25 = 3 g/dm²/h; and
- 50/50 = 3 g/dm²/h.

The analysis determined the HUPRs for Cryotech Polar Guard Xtend are:

- 100/0 = 50 g/dm²/h;
- 75/25 = 50 g/dm²/h; and
- 50/50 = 50 g/dm²/h.

4.2.7 Publication of Holdover Times

As Cryotech intends to commercialize Polar Guard Xtend, TC and the FAA will publish its fluid-specific HOT table in their 2019-20 HOT Guidelines. The guidelines will also include the LOWV and LOUT information; the regression and LUPR/HUPR data will be published in the related TC and FAA Regression Information documents.

Table 4.2: Fluid Specific Holdover Time Guidelines – Cryotech Polar Guard Xtend (TC Format)

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	2:30 - 4:00	2:00	2:00 - 2:00	1:05 - 2:00	2:00 - 2:00	1:00 - 1:50	0:20 - 1:45	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A	CAUTION: No holdover time guidelines exist	
below -3 to -8°C (below 27 to 18°F)	100/0	1:00 - 1:50	2:00	1:35 - 2:00	0:50 - 1:35	0:35 - 1:40	0:50 - 0:55		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14°C (below 18 to 7°F)	100/0	1:00 - 1:50	2:00	1:20 - 2:00	0:45 - 1:20	0:35 - 1:40[7]	0:50 - 0:55[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18°C (below 7 to 0°F)	100/0	0:25 - 0:40	0:30	0:09 - 0:30	0:02 - 0:09				
below -18 to -25°C (below 0 to -13°F)	100/0	0:25 - 0:40	0:10	0:03 - 0:10	0:01 - 0:03				
below -25 to -29°C (below -13 to -20°F)	100/0	0:25 - 0:40	0:07	0:02 - 0:07	0:00 - 0:02				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table 42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

Table 4.3: Fluid Specific Holdover Time Guidelines – Cryotech Polar Guard Xtend (FAA Format)

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	2:30 - 4:00	3:00 - 3:00	2:00 - 3:00	1:05 - 2:00	2:00 - 2:00	1:00 - 1:50	0:20 - 1:45	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A		
below -3 to -8 °C (below 27 to 18 °F)	100/0	1:00 - 1:50	2:50 - 3:00	1:35 - 2:50	0:50 - 1:35	0:35 - 1:40	0:50 - 0:55		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14 °C (below 18 to 7 °F)	100/0	1:00 - 1:50	2:25 - 2:55	1:20 - 2:25	0:45 - 1:20	0:35 - 1:40[7]	0:50 - 0:55[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:25 - 0:40	0:30 - 0:45	0:09 - 0:30	0:02 - 0:09				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:25 - 0:40	0:10 - 0:20	0:03 - 0:10	0:01 - 0:03				
below -25 to -29 °C (below -13 to -20 °F)	100/0	0:25 - 0:40	0:07 - 0:10	0:02 - 0:07	0:00 - 0:02				

CAUTION: No holdover time guidelines exist

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table 42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

Table 4.4: LUPR Statistics – Cryotech Polar Guard Xtend

Data Measure	100/0		75/25		50/50	
	Stat	Rating	Stat	Rating	Stat	Rating
Data Points < = 10.0	9	40	10	40	4	20
Data Points < = 9.5	8	40	10	40	4	40
Data Points < = 8.5	8	40	9	40	4	40
Data Points < = 7.5	7	40	6	40	3	40
Data Points < = 6.5	6	40	5	40	2	30
Data Points < = 5.5	3	40	5	40	2	30
Data Points < = 4.5	2	30	3	40	2	30
Data Points < = 3.5	2	30	2	30	2	30
Negative Scatter 0-10 g	-5%	40	-8%	40	-4%	40

Rate	100/0		75/25		50/50	
	Score	Pass/Fail	Score	Pass/Fail	Score	Pass/Fail
9 g/dm²/h	40	pass	40	pass	34	pass
8 g/dm²/h	40	pass	40	pass	34	pass
7 g/dm²/h	40	pass	40	pass	34	pass
6 g/dm²/h	40	pass	40	pass	29	pass
5 g/dm²/h	40	pass	40	pass	29	pass
4 g/dm²/h	35	pass	40	pass	29	pass
3 g/dm²/h	35	pass	35	pass	29	pass

LUPR	100/0	75/25	50/50
	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h

Table 4.5: HUPR Statistics – Cryotech Polar Guard Xtend

Data Measure	100/0		75/25		50/50	
	Stat	Rating	Stat	Rating	Stat	Rating
Data Points >20 g	16	40	18	40	8	40
Data Points ≥15 g	21	40	20	40	9	40
Data Points ≥20 g	17	40	18	40	8	40
Data Points ≥25 g	12	40	14	40	4	40
Data Points ≥30 g	10	40	12	40	3	40
Data Points ≥35 g	8	40	9	40	3	40
Data Points ≥40 g	5	40	5	40	3	40
Negative Scatter >25 g	-5%	40	-10%	30	-9%	40

Rate	100/0		75/25		50/50	
	Score	Pass/Fail	Score	Pass/Fail	Score	Pass/Fail
25 g/dm²/h	40	pass	38	pass	40	pass
30 g/dm²/h	40	pass	38	pass	40	pass
35 g/dm²/h	40	pass	38	pass	40	pass
40 g/dm²/h	40	pass	38	pass	40	pass
45 g/dm²/h	40	pass	38	pass	40	pass
50 g/dm²/h	40	pass	38	pass	40	pass

HUPR	100/0	75/25	50/50
	50 g/dm²/h	50 g/dm²/h	50 g/dm²/h

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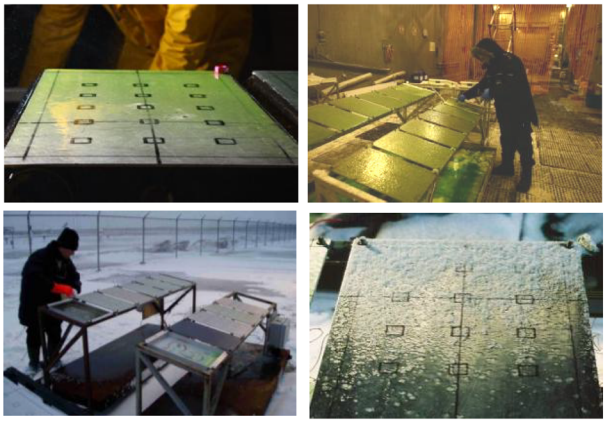
APPENDIX G

AIRCRAFT GROUND ANTI-ICING FLUID ENDURANCE TIME TEST RESULTS – LNT E450 (TYPE IV) SUPPLEMENTAL TESTING TO SUPPORT LOUT CHANGE

AIRCRAFT GROUND ANTI-ICING FLUID ENDURANCE TIME TEST RESULTS

LNT E450 (Type IV)
Supplemental Testing to Support LOUT Change



Prepared for

LNT Solutions

by

APS Aviation Inc.

These tests were made possible with the guidance, participation and contribution of Transport Canada and the Federal Aviation Administration.

July 2019
Version 1.0
Report No. L-E450 2018-19

AIRCRAFT GROUND ANTI-ICING FLUID ENDURANCE TIME TEST RESULTS

LNT E450 (Type IV)
Supplemental Testing to Support LOUT Change

Prepared for

LNT Solutions

Prepared by:



Benjamin Bernier, B.Sc.
Junior Project Leader

July 5, 2019
Date

Reviewed by:



John D'Avirro, Eng., PBDM
Director, Aviation Services

July 5, 2019
Date

These tests were made possible with the guidance, participation and contribution of Transport Canada and the Federal Aviation Administration.

July 2019
Version 1.0
Report No. L-E450 2018-19

FLUID IDENTIFICATION AND CHARACTERISTICS

Manufacturer:	LNT Solutions		
Fluid Test Name:	E450		
Fluid Commercial Name:	E450		
Fluid Type / Base / Colour:	Type IV / Ethylene Glycol / Green		
Batch #:	45SN051218L		
Date of Receipt:	January 21st, 2019		
Brix (Measured):	Neat fluid:	31.50°	
Freeze Point (Stated):	Neat fluid:	Not Provided	
Aerodynamic LOUT (AMIL):	Neat fluid:	Not Provided	
Viscosity (Manufacturer):		**LOWV**	**Measured**
	Neat fluid[1]:	45,300 cP	41,000 cP

[1] Spindle SC4-34/13R, small sample adapter, 9 mL of fluid, 0°C, 0.3 rpm, for 10.0 minutes

SUMMARY

The primary objective of this project was to measure the endurance time performance of **LNT Solutions E450** over a subset of the conditions encompassed by the Holdover Time (HOT) tables. This report contains the results of these measurements and was completed with the support of the fluid manufacturer, Transport Canada (TC), and the Federal Aviation Administration (FAA).

In the winter of 2018-19, LNT Solutions submitted a request to regulators to modify the lowest operational use temperature (LOUT) for LNT E450, a previously commercialized Type IV fluid. The manufacturer's intent was to decrease the LOUT from the current value of -22.5°C to -32.5°C. The manufacturer submitted a sample of LNT E450 to AMIL to undergo aerodynamic acceptance testing at the new proposed LOUT. The results of the aerodynamic acceptance testing are still pending.

LNT E450 was most recently listed in the 2018-19 HOT Guidelines with an LOUT of -22.5°C. No endurance time testing had ever been completed with this fluid at the newly proposed LOUT of -32.5°C. In order to support the requested LOUT change, supplemental endurance time data was required to measure the endurance time performance of the fluid at -32.5°C.

Lowest on-wing viscosity (LOWV) samples of LNT E450 were submitted to APS Aviation Inc. (APS) in the winter of 2018-19 for endurance time testing in freezing fog and artificial snow conditions.

Tests were carried out according to the protocol provided in Aerospace Recommended Practice (ARP) 5485. The test procedure consisted of pouring fluids onto clean aluminum test surfaces inclined at 10°; the onset of failure was recorded as a function of time in natural and simulated precipitation.

Artificial snow tests were conducted at PMG Technologies in Blainville, QC. Freezing fog tests were conducted at the National Research Council Canada (NRC) Climatic Engineering Facility (CEF) in Ottawa.

The data collected was used to derive new HOT values for LNT E450 in snow and freezing fog in the newly created "Below -25 to -32.5°C" temperature band. The proposed LOUT change also resulted in changes to the snow HOTs in the in the modified "Below -18 to -25°C" temperature band. The proposed updates to the existing fluid-specific HOT table are shown on the following page.

SUMMARY

LNT Solutions E450 Fluid Holdover Times

Outside Air Temperature (°C)	Type IV Fluid Concentration Neat Fluid/ Water (Vol %/Vol %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)							
		Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets*			Freezing Drizzle	Light Freezing Rain	Rain on Cold Soaked Wing	Other
			Very Light	Light	Moderate				
-3 and above	100/0	1:50-2:55	2:25-2:45	1:35-2:25	1:00-1:35	1:35-2:00	0:55-1:20	0:25-2:00	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A	CAUTION: No holdover time guidelines exist	
below -3 to -8	100/0	1:30-3:55	2:05-2:20	1:20-2:05	0:50-1:20	1:45-2:00	1:05-1:40		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14	100/0	1:30-3:55	1:50-2:05	1:10-1:50	0:45-1:10	1:45-2:00	1:05-1:40		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18	100/0	0:35-1:05	3:00-3:00	1:05-3:00	0:20-1:05				
below -18 to -25	100/0	0:35-1:05	1:35-2:15	0:30-1:35	0:10-0:30				
below -25 to -32.5	100/0	0:25-1:00	0:40-1:00	0:15-0:40	0:04-0:15				

FAA values shown, Transport Canada will publish only the lower values for very light snow and caps all snow HOTs at two hours

Values in blue represent proposed changes to the LNT E450 fluid-specific HOT table

TABLE OF CONTENTS

1. INTRODUCTION 1

2. METHODOLOGY 2

3. DESCRIPTION OF DATA 3

3.1 Test Counts 3
3.2 Test Logs 3

4. RESULTS AND DISCUSSION 5

4.1 Results 5
4.1.1 Endurance Time Tests – Artificial Snow 5
4.1.2 Endurance Time Tests – Freezing Fog 5
4.2 Discussion 8
4.2.1 Updated Fluid-Specific Holdover Time Table 8
4.2.2 Holdover Times in Snow, Below -25°C to -32.5°C 8
4.2.3 Fluid Viscosity 8
4.2.4 Lowest Operational Use Temperatures (LOUTs) 9
4.2.5 Publication of Holdover Times 9

ANNEX: Methodology for Endurance Time Testing of Type II, III, and IV Fluids – Winter 2018-19

LIST OF FIGURES AND TABLES

Figures

Figure 4.1: Type IV 100/0 – Artificial Snow at -25°C and -33°C 6
Figure 4.2: Type IV Neat – Freezing Fog 7

Tables

Table 3.1: Summary of Tests Performed (Artificial Snow) 4
Table 3.2: Summary of Tests Performed (Freezing Fog) 4
Table 4.1: LNT E450 Artificial Snow Performance at -25°C vs. -33°C 6
Table 4.2: LNT E450 Freezing Fog Regression Coefficients (Below -25 to -32.5°C) 7
Table 4.3: Fluid Specific Holdover Time Guidelines – LNT E450 (TC Format) 10
Table 4.4: Fluid Specific Holdover Time Guidelines – LNT E450 (FAA Format) 10

GLOSSARY

APS	APS Aviation Inc.
ARP	Aerospace Recommended Practice
CEF	Climatic Engineering Facility
FAA	Federal Aviation Administration
HOT	Holdover Time
LOUT	Lowest Operational Use Temperature
LOWV	Lowest On-Wing Viscosity
NRC	National Research Council Canada
TC	Transport Canada

1. INTRODUCTION

This report has been created with the support of the fluid manufacturer, Transport Canada (TC), and the Federal Aviation Administration (FAA).

In the winter of 2018-19, LNT Solutions submitted a request to regulators to modify the lowest operational use temperature (LOUT) for LNT E450, a previously commercialized Type IV fluid. The manufacturer's intent was to decrease the LOUT from the current value of -22.5°C to -32.5°C. The manufacturer submitted a sample of LNT E450 to AMIL to undergo aerodynamic acceptance testing at the new proposed LOUT. The results of the aerodynamic acceptance testing are still pending.

LNT E450 was most recently listed in the 2018-19 HOT Guidelines with an LOUT of -22.5°C. No endurance time testing had ever been completed with this fluid at the newly proposed LOUT of -32.5°C. In order to support the requested LOUT change, supplemental endurance time data was required to measure the endurance time performance of the fluid at -32.5°C.

This report provides a detailed account of supplemental endurance time testing conducted by APS Aviation Inc. (APS) with **LNT E450**. It describes the test methodology used, endurance time data collected, and analysis completed to derive updated fluid-specific holdover times for the fluid.

2. METHODOLOGY

Tests were carried out according to SAE Aerospace Recommended Practice (ARP) 5485, which provides the procedure and requirements for endurance time testing with Type II, III, and IV fluids under natural and simulated conditions.

The test methodology for endurance time testing carried out in the winter of 2018-19 is documented in detail in the report *"Methodology for Endurance Time Testing of Type II, III, and IV Fluids – Winter 2018-19."* A copy of this report is provided as an annex to this document.

The methodology report summarizes the key aspects of the test methodology, including some aspects included in ARP5485 and some aspects which are not included in ARP5485. It includes sections on:

a) Test Sites;
b) Test Equipment;
c) Test Procedures;
d) Precipitation Rates used in Type I, II, III and IV Endurance Time Testing;
e) Ambient Temperatures used in Type I, II, III and IV Endurance Time Testing;
f) Freezing Precipitation Droplet Sizes; and
g) Analysis Methodologies.

The data, analysis, and results provided in this report are a function of the test and analysis methodologies described in the methodology report. They should only be used in conjunction with the methodologies described therein.

3. DESCRIPTION OF DATA

This section provides a summary of the number of tests conducted. Breakdowns are provided for the number of tests performed by test type, precipitation type, and test temperature.

3.1 Test Counts

All artificial snow tests were conducted at PMG Technologies in Blainville, QC. All freezing fog tests were conducted at the National Research Council's Climatic Engineering Facility in Ottawa, ON. The breakdown of tests conducted is summarized below by precipitation type and test temperature.

Precipitation Type	Test Temperature	
	-25°C	-33°C
Artificial Snow	8	8
Freezing Fog	0	4

3.2 Test Logs

Details of each test conducted are provided in the test logs included as Table 3.1 (artificial snow) and Table 3.2 (freezing fog).

Table 3.1: Summary of Tests Performed (Artificial Snow)

Test No.	Date	Snow Type	Fluid Name	Fluid Dilution	Test Temp. (°C)	Icing Intensity (g/dm²/h)	Endurance Time (min)
AS41	17-Apr-19	Artificial Snow	LNT E450	100%	-25.0	4.0	151.8
AS42	22-Apr-19	Artificial Snow	LNT E450	100%	-25.0	4.2	165.0
AS43	5-Apr-19	Artificial Snow	LNT E450	100%	-25.0	10.0	42.4
AS44	23-Apr-19	Artificial Snow	LNT E450	100%	-25.0	10.1	49.2
AS45	18-Apr-19	Artificial Snow	LNT E450	100%	-25.0	25.3	17.2
AS46	23-Apr-19	Artificial Snow	LNT E450	100%	-25.0	25.4	19.0
AS47	16-Apr-19	Artificial Snow	LNT E450	100%	-33.0	4.0	104.8
AS48	16-Apr-19	Artificial Snow	LNT E450	100%	-33.0	4.0	89.8
AS49	16-Apr-19	Artificial Snow	LNT E450	100%	-33.0	10.0	30.3
AS50	16-Apr-19	Artificial Snow	LNT E450	100%	-33.0	10.0	32.3
AS51	16-Apr-19	Artificial Snow	LNT E450	100%	-33.0	25.0	15.9
AS52	16-Apr-19	Artificial Snow	LNT E450	100%	-33.0	25.0	14.3
AS53	29-Apr-19	Artificial Snow	LNT E450	100%	-33.0	3.0	104.0
AS54	29-Apr-19	Artificial Snow	LNT E450	100%	-33.0	3.1	118.1
AS55	29-Apr-19	Artificial Snow	LNT E450	100%	-25.0	3.2	194.1
AS56	29-Apr-19	Artificial Snow	LNT E450	100%	-25.0	2.9	201.3

Table 3.2: Summary of Tests Performed (Freezing Fog)

Test No.	Date	Precipitation Type	Fluid Name	Fluid Dilution	Test Temp. (°C)	Icing Intensity (g/dm²/h)	Endurance Time (min)
177	8-Apr-19	Freezing Fog	LNT E450	100%	-33.2	2.1	57.2
178	8-Apr-19	Freezing Fog	LNT E450	100%	-33.2	2.2	55.7
179	8-Apr-19	Freezing Fog	LNT E450	100%	-33.0	4.9	24.4
180	8-Apr-19	Freezing Fog	LNT E450	100%	-33.0	4.7	26.2

4. RESULTS AND DISCUSSION

The methods used to evaluate the test data are provided in the report "*Methodology for Endurance Time Testing of Type II, III, and IV Fluids – Winter 2018-19,*" which is provided as an annex to this report. The results of the data analyses and a discussion of the findings are presented in this section.

4.1 Results

The results of the endurance time tests are described in this section.

4.1.1 Endurance Time Tests – Artificial Snow

Figure 4.1 shows the endurance time data collected in artificial snow at -25 and -33°C.

Table 4.1 shows the relative endurance time performance of the fluid in artificial snow at -25 vs. -33°C.

4.1.2 Endurance Time Tests – Freezing Fog

Figure 4.2 shows the endurance time data collected in freezing fog. The chart depicts both the newly collected LNT E450 freezing fog data (from the 2018-19 testing season) and the original LNT E450 freezing fog data (from the 2013-14 testing season).

The figure shows the effect of temperature, precipitation type and precipitation rate on fluid endurance time in the freezing fog condition. The figure includes the current Type IV generic holdover times for comparative purposes.

Regression analysis was performed on the data collected in 2018-19, as described in the annex. Table 4.2 provides the outputs from the regression analysis. These outputs were used to derive the fluid-specific holdover time for LNT E450 in freezing fog in the "Below -25 to -32.5°C" temperature band.

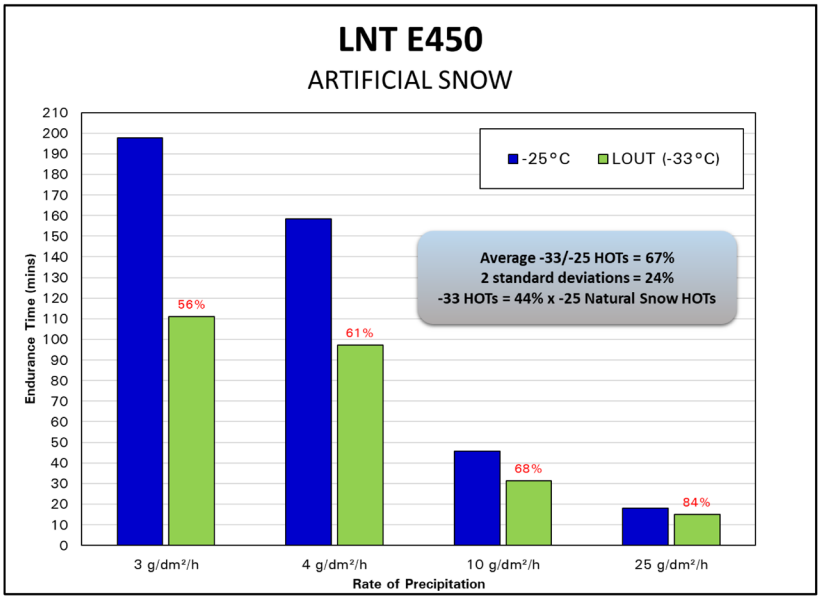


Figure 4.1: Type IV 100/0 – Artificial Snow at -25°C and -33°C

Table 4.1: LNT E450 Artificial Snow Performance at -25°C vs. -33°C

Rate (g/dm²/h)	Fail Time at -25°C (min)	Fail Time at -33°C (min)	-33 HOT as % of -25 HOT
3	197.7	111.1	56%
4	158.4	97.3	61%
10	45.8	31.3	68%
25	18.1	15.1	84%
Average			**67%**
Standard Deviation			**12%**

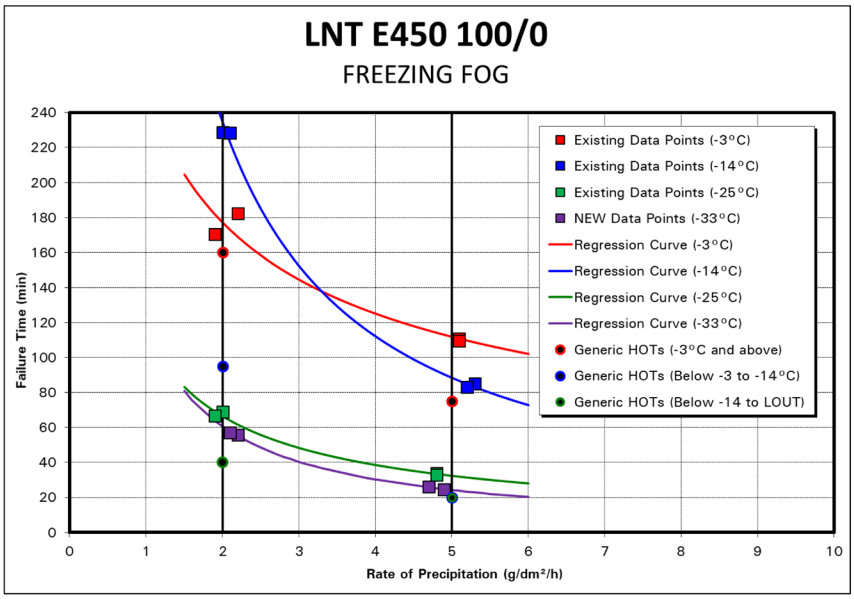


Figure 4.2: Type IV Neat – Freezing Fog

Table 4.2: LNT E450 Freezing Fog Regression Coefficients (Below -25 to -32.5°C)

Fluid		Dil	Temp.	R^2	Intercept (I)	Coeff. Rate (A)	Total Pts.
LNT E450		100%	-33°C	100%	2.0842	-1.0003	4

General Equation $t = 10^{I} R^{A}$

4.2 Discussion

4.2.1 Updated Fluid-Specific Holdover Time Table

The holdover times described in Subsection 4.1 were used to update the fluid-specific HOT table for LNT E450.

Modifications have been made to the HOT values in the "Below -18 to -25°C temperature band (previously "Below -18 to -22.5°C). Values have been added for the newly created "Below -25°C to LOUT" temperature band.

The updated HOT table is shown in both the TC format (Table 4.3) and FAA format (Table 4.4) at the end of this chapter. New/modified values are depicted in blue font.

The LOUT change from -22.5 to -32.5°C is pending receipt of updated freezing point and aerodynamic acceptance test results for LNT E450. At the time of writing this report, the HOT guidelines reflect that the data remains pending.

4.2.2 Holdover Times in Snow, Below -25°C to -32.5°C

In order to determine holdover times for LNT E450 in snow in the coldest temperature band (below -25 to -32.5°C), artificial snow testing was performed with LNT E450 at -25°C and -33°C. The performance of the fluid at -33°C relative to -25°C was then calculated (see Table 4.2).

On average, endurance times at -33°C were 67 percent of those at -25°C. For added safety, two standard deviations were subtracted from this statistic, resulting in a relative performance factor of 44 percent. This factor was applied to the natural snow holdover times for -25°C; this provided the holdover times for snow in the coldest temperature band, below -25°C to -32.5°C.

4.2.3 Fluid Viscosity

The viscosities of the fluid samples used in this testing were measured using the manufacturer's designated method. The APS measured viscosities appear at the beginning of this document.

The measured sample viscosity was slightly below the published lowest on-wing viscosity (LOWV) value for this fluid, therefore the sample was considered suitable for use in holdover time development.

4.2.4 Lowest Operational Use Temperatures (LOUTs)

The LOUT for Type II/III/IV fluids is determined by the higher of:

a) The lowest temperature at which the fluid meets the aerodynamic acceptance test for a given aircraft type; and

b) The actual freezing point of the fluid plus its freezing point buffer of 7°C (13°F).

Updated aerodynamic acceptance test and freezing point test results were not available at the time of publication of this report.

4.2.5 Publication of Holdover Times

LNT E450 is already currently listed within the HOT guidelines at an LOUT of -22.5°C.

TC and the FAA have agreed to publish the updated fluid-specific HOT table (with the reduced LOUT) in their 2019-20 HOT guidelines. At the time of writing this report, the guidelines reflect that the freezing point and aerodynamic acceptance test results for LNT E450 are pending.

Table 4.3: Fluid Specific Holdover Time Guidelines – LNT E450 (TC Format)

Outside Air Temperature (°C)	Type IV Fluid Concentration Neat Fluid/ Water (Vol %/Vol %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)							
		Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets*			Freezing Drizzle	Light Freezing Rain	Rain on Cold Soaked Wing	Other
			Very Light	Light	Moderate				
-3 and above	100/0	1:50-2:55	2:00	1:35-2:00	1:00-1:35	1:35-2:00	0:55-1:20	0:25-2:00	CAUTION: No holdover time guidelines exist
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A		
below -3 to -8	100/0	1:30-3:55	2:00	1:20-2:00	0:50-1:20	1:45-2:00	1:05-1:40		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14	100/0	1:30-3:55	1:50	1:10-1:50	0:45-1:10	1:45-2:00	1:05-1:40		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18	100/0	0:35-1:05	2:00	1:05-2:00	0:20-1:05				
below -18 to -25	100/0	0:35-1:05	1:35	0:30-1:35	0:10-0:30				
below -25 to -32.5	100/0	0:25-1:00	0:40	0:15-0:40	0:04-0:15				

***Values in blue represent proposed changes to the LNT E450 fluid-specific HOT table*

Table 4.4: Fluid Specific Holdover Time Guidelines – LNT E450 (FAA Format)

Outside Air Temperature (°C)	Type IV Fluid Concentration Neat Fluid/ Water (Vol %/Vol %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)							
		Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets*			Freezing Drizzle	Light Freezing Rain	Rain on Cold Soaked Wing	Other
			Very Light	Light	Moderate				
-3 and above	100/0	1:50-2:55	2:25-2:45	1:35-2:25	1:00-1:35	1:35-2:00	0:55-1:20	0:25-2:00	CAUTION: No holdover time guidelines exist
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A		
below -3 to -8	100/0	1:30-3:55	2:05-2:20	1:20-2:05	0:50-1:20	1:45-2:00	1:05-1:40		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14	100/0	1:30-3:55	1:50-2:05	1:10-1:50	0:45-1:10	1:45-2:00	1:05-1:40		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18	100/0	0:35-1:05	3:00-3:00	1:05-3:00	0:20-1:05				
below -18 to -25	100/0	0:35-1:05	1:35-2:15	0:30-1:35	0:10-0:30				
below -25 to -32.5	100/0	0:25-1:00	0:40-1:00	0:15-0:40	0:04-0:15				

***Values in blue represent proposed changes to the LNT E450 fluid-specific HOT table*

APPENDIX H

TRANSPORT CANADA AND FEDERAL AVIATION ADMINISTRATION HOLDOVER TIME GUIDELINES, WINTER 2019-2020

TRANSPORT CANADA
HOLDOVER TIME (HOT) GUIDELINES
WINTER 2019-2020

Transport Canada
Holdover Time (HOT) Guidelines
Winter 2019-2020

Original Issue: August 6, 2019

This document should be used in conjunction with the most recent version of the TP 14052E - *Guidelines for Aircraft Ground Icing Operations*. These two documents complement each other and should be used together for a thorough understanding of the subject matter.

Questions or comments on the content of the holdover time guidelines should be addressed to Transport Canada Civil Aviation Communication Centre
Telephone 1-800-305-2059 Facsimile 613-957-4208 e-mail services@tc.gc.ca

To receive notification of HOT Guideline updates, subscribe to or update your e news subscription at the following Transport Canada Web site: http://wwwapps.tc.gc.ca/Comm/5/ListServ/menu.aspx. Subscribing to e-news will require an email address and selecting Holdover Time (HOT) Guidelines under Publications / Air Transportation / Aviation Safety - Safety Information.

CHANGE CONTROL RECORDS

This page indicates any changes made to individual pages within the document. Changed pages have sidebars to assist in identifying where significant changes have been made on these pages.

It is the responsibility of the end user to periodically check the following website for updates: http://www.tc.gc.ca/eng/civilaviation/standards/commerce-holdovertime-menu-1877.htm.

REVISION	*DATE*	*DESCRIPTION OF CHANGES*	*AFFECTED PAGES*	*AUTHOR*

TABLE OF CONTENTS

Change Control Records **2**
Table of Contents **3**
How to Use This Document **4**
Highlights and Changes for Winter 2019-2020 ..... **5**
Holdover Time (HOT) Guidelines for Winter 2019-2020 ..... **6**
Table 1: Active Frost Holdover Times for SAE Type I, Type II, Type III, and Type IV Fluids 7
Table 2: Holdover Times for SAE Type I Fluid on Critical Aircraft Surfaces Composed Predominantly of Aluminum 8
Table 3: Holdover Times for SAE Type I Fluid on Critical Aircraft Surfaces Composed Predominantly of Composites 9
Table 4: Generic Holdover Times for SAE Type II Fluids 10
Table 5: Type II Holdover Times for ABAX ECOWING 26 11
Table 6: Type II Holdover Times for ABAX ECOWING AD-2 12
Table 7: Type II Holdover Times for Aviation Shaanxi Hi-Tech Cleanwing II 13
Table 8: Type II Holdover Times for Beijing Yadilite Aviation YD-102 Type II 14
Table 9: Type II Holdover Times for Clariant Safewing MP II FLIGHT 15
Table 10: Type II Holdover Times for Clariant Safewing MP II FLIGHT PLUS 16
Table 11: Type II Holdover Times for Cryotech Polar Guard® II 17
Table 12: Type II Holdover Times for Kilfrost ABC-K Plus 18
Table 13: Type II Holdover Times for Kilfrost Ice Clear II 19
Table 14: Type II Holdover Times for Newave Aerochemical FCY-2 20
Table 15: Type II Holdover Times for Newave Aerochemical FCY-2 Bio+ 21
Table 16: Type II Holdover Times for Oksayd Defrost PG 2 22
Table 17: Type II Holdover Times for ROMCHIM ADD-PROTECT Type II 23
Table 18: Type III Holdover Times for AllClear AeroClear MAX Applied Unheated on Low Speed Aircraft 24
Table 19: Type III Holdover Times for AllClear AeroClear MAX Applied Unheated on High Speed Aircraft 25
Table 20: Generic Holdover Times for SAE Type IV Fluids 26
Table 21: Type IV Holdover Times for ABAX ECOWING AD-49 27
Table 22: Type IV Holdover Times for AllClear ClearWing EG 28
Table 23: Type IV Holdover Times for CHEMCO ChemR EG IV 29
Table 24: Type IV Holdover Times for Clariant Max Flight 04 30
Table 25: Type IV Holdover Times for Clariant Max Flight AVIA 31
Table 26: Type IV Holdover Times for Clariant Max Flight SNEG 32
Table 27: Type IV Holdover Times for Clariant Safewing EG IV NORTH 33
Table 28: Type IV Holdover Times for Clariant Safewing MP IV LAUNCH 34
Table 29: Type IV Holdover Times for Clariant Safewing MP IV LAUNCH PLUS 35
Table 30: Type IV Holdover Times for Cryotech Polar Guard® Advance 36
Table 31: Type IV Holdover Times for Cryotech Polar Guard® Xtend 37
Table 32: Type IV Holdover Times for Dow Chemical UCAR™ Endurance EG106 38
Table 33: Type IV Holdover Times for Dow Chemical UCAR™ FlightGuard AD-49 39
Table 34: Type IV Holdover Times for Inland Technologies ECO-SHIELD® 40
Table 35: Type IV Holdover Times for Kilfrost ABC-S Plus 41
Table 36: Type IV Holdover Times for LNT Solutions E450 42
Table 37: Type IV Holdover Times for Newave Aerochemical FCY 9311 43
Table 38: Type IV Holdover Times for Oksayd Defrost ECO 4 44
Table 39: Type IV Holdover Times for Oksayd Defrost EG 4 45
Table 40: Type IV Holdover Times for Shaanxi Cleanway Aviation Cleansurface IV 46
Allowance Times Tables for Winter 2019-2020 ..... **47**
Table 41: Allowance Times for SAE Type III Fluids 48
Table 42: Allowance Times for SAE Type IV Fluids 49
Supplemental Guidance for Winter 2019-2020 ..... **50**
Table 43: Snowfall Intensities as a Function of Prevailing Visibility 51
Table 44: Type I Fluids Tested for Anti-Icing Performance and Aerodynamic Acceptance 52
Table 45: Type II Fluids Tested for Anti-Icing Performance and Aerodynamic Acceptance 55
Table 46: Type III Fluids Tested for Anti-Icing Performance and Aerodynamic Acceptance 57
Table 47: Type IV Fluids Tested for Anti-Icing Performance and Aerodynamic Acceptance 58
Table 48: Guidelines for the Application of SAE Type I Fluid 61
Table 49: Guidelines for the Application of SAE Type II and IV Fluid 62
Table 50: Guidelines for the Application of Unheated SAE Type III Fluid 63
Appendix A: Adjusted Holdover Time (HOT) Guidelines **A-1**
Appendix B: Testing Laboratories **B-1**

HOW TO USE THIS DOCUMENT

Complementary Document

This document should be used in conjunction with the most recent version of the TP 14052E - Guidelines for Aircraft Ground Icing Operations. These two documents complement each other and should be used together for a thorough understanding of the subject matter.

Applicability

A new version of this document is published for each winter operating season, typically early in the August preceding the winter operating season. Updates to the winter's document may be published any time after the Original Issue document is published. When a new document is published, either mid-season or each new season, the previous document becomes obsolete. It is the responsibility of the end user to periodically check for document updates on the following website: http://www.tc.gc.ca/eng/civilaviation/standards/commerce-holdovertime-menu-1877.htm.

Main Document Structure and Content

This document is divided into several sections.

- Change Control Records: Provides details of any changes made to the document in mid-season document updates.
- Table of Contents: Provides a list of sections, tables, and appendices in the document.
- How to Use This Document: Provides top level guidance on how to use the document.
- Highlights and Changes for Winter 2019-2020: Describes key changes made to the document for the current winter operating season.
- Holdover Time Guidelines: Series of tables which provide estimated holdover times (in hh:mm). Fluids are divided by fluid type (Type I, II, III, and IV), aircraft construction materials (Type I only), fluid brand (Type II, III, IV), aircraft rotation speed (Type III only), and fluid application temperature (Type III only). Columns in the tables divide the information by precipitation type; rows in the tables divide the information by temperature and fluid dilution.
- Allowance Times Tables: Tables which provide allowance times (in minutes) for Type III and Type IV fluids. Rows in the tables divide the information by precipitation type; columns in the tables divide the information by temperature.
- Supplementary Guidance: Series of tables which provide supplementary information for using the holdover time guidelines and allowance times tables. Includes a table for estimating snowfall intensity from prevailing visibility, tables of fluid information (one table per fluid type), and tables of fluid application guidance (by fluid type).

Appendices

The appendices contain complementary content.

- Appendix A: Provides adjusted holdover time guidelines (holdover time guidelines and allowance times tables) for operations when flaps and slats are deployed prior to de/anti-icing.
- Appendix B: Provides information on laboratories involved in testing de/anti-icing fluids.

HIGHLIGHTS AND CHANGES FOR WINTER 2019-2020

CHANGED FROM PREVIOUS YEAR

The principal changes from the previous year are briefly indicated herein.

Holdover Time Tables

- Fluid-specific HOT guidelines have been created for three new fluids: ROMCHIM ADD-PROTECT Type II (Type II), AllClear ClearWing EG (Type IV), and Cryotech Polar Guard® Xtend (Type IV).
- Minor decreases have been made to the Type II generic holdover times as a result of the new fluids and data.
- Minor decreases have been made to the Type IV generic holdover times as a result of the new fluids and data.
- The analysis methodology used to determine HOTs for very cold snow (below -14°C) for Type II and Type IV fluids which do not have fluid-specific very cold snow data was updated this year. As a result, HOTs for very cold snow for all Type II/IV fluids which do not have fluid-specific data have been updated (primarily reductions). Note that the updated values are different for Type II vs. Type IV fluids and for propylene glycol vs. ethylene glycol based fluids. Fluids which are not affected by this change include: Clariant Safewing MP II FLIGHT, Clariant Safewing MP IV LAUNCH, Clariant Safewing MP IV LAUNCH PLUS, Cryotech Polar Guard® II, Cryotech Polar Guard® Advance, Dow Endurance EG106, and LNT Solutions E450.
- The protocol used to determine fluid-specific HOTs for snow below -29°C was finalized this year. This resulted in minor changes to the snow HOTs in the "below -25°C to LOUT" temperature band for Cryotech Polar Guard® II and Cryotech Polar Guard® Advance.

Allowance Times Tables

- The third note in the Type IV allowance time tables has been modified to clarify that if the glycol type is unknown, no allowance times exist for aircraft with rotation speeds of less than 115 knots.

Supplemental Guidance

- The list of fluids (Tables 44, 45, 46 and 47) has been updated to reflect the latest information available on all de/anti-icing fluids.
- The table for the application of Heated Type III fluid has been removed as there are currently no Type III fluids with HOTs for heated applications.
- The first note in the Type II/III/IV fluid application table has been modified to make clear that HOTs do not exist below the lowest temperatures stated in the HOT table bands.

UNCHANGED FROM PREVIOUS YEAR

Holdover Time Tables

- The active frost holdover time (HOT) guidelines are unchanged.
- The Type I HOT guidelines are unchanged.

Allowance Times Tables

- The Type III allowance times tables are unchanged.

Supplemental Guidance

- The Type I and Type III Unheated fluid application tables are unchanged.

HOLDOVER TIME (HOT) GUIDELINES FOR WINTER 2019-2020

TABLE 1: ACTIVE FROST HOLDOVER TIMES FOR SAE TYPE I, TYPE II, TYPE III, AND TYPE IV FLUIDS

Outside Air Temperature[1,2,3]	Type I
-1°C and above (30°F and above)	0:45 *(0:35)*[5]
below -1 to -3°C (below 30 to 27°F)	
below -3 to -10°C (below 27 to 14°F)	
below -10 to -14°C (below 14 to 7°F)	
below -14 to -21°C (below 7 to -6°F)	
below -21 to -25°C (below -6 to -13°F)	
below -25°C to LOUT (below -13°F to LOUT)	

Outside Air Temperature[2,3]	Concentration Fluid/Water By % Volume	Type II	Type III[4]	Type IV
-1°C and above (30°F and above)	100/0	8:00	2:00	12:00
	75/25	5:00	1:00	5:00
	50/50	3:00	0:30	3:00
below -1 to -3°C (below 30 to 27°F)	100/0	8:00	2:00	12:00
	75/25	5:00	1:00	5:00
	50/50	1:30	0:30	3:00
below -3 to -10°C (below 27 to 14°F)	100/0	8:00	2:00	10:00
	75/25	5:00	1:00	5:00
below -10 to -14°C (below 14 to 7°F)	100/0	6:00	2:00	6:00
	75/25	1:00	1:00	1:00
below -14 to -21°C (below 7 to -6°F)	100/0	6:00	2:00	6:00
below -21 to -25°C (below -6 to -13°F)	100/0	2:00	2:00	4:00
below -25°C (below -13°F)	100/0	No Holdover Time Guidelines Exist		

NOTES

1 Type I Fluid / Water Mixture must be selected so that the freezing point of the mixture is at least 10°C (18°F) below outside air temperature.
2 Ensure that the lowest operational use temperature (LOUT) is respected.
3 Changes in outside air temperature (OAT) over the course of longer frost events can be significant; the appropriate holdover time to use is the one provided for the coldest OAT that has occurred in the time between the de/anti-icing fluid application and takeoff.
4 To use the Type III fluid frost holdover times, the fluid brand being used must be known. AllClear AeroClear MAX must be applied unheated.
5 Value in parentheses is for aircraft with critical surfaces that are predominantly or entirely constructed of composite materials.

CAUTIONS

- The responsibility for the application of these data remains with the user.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE 2: HOLDOVER TIMES FOR SAE TYPE I FLUID ON CRITICAL AIRCRAFT SURFACES COMPOSED PREDOMINANTLY OF ALUMINUM

Outside Air Temperature[1,2]	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[3,4]	Light Snow, Snow Grains or Snow Pellets[3,4]	Moderate Snow, Snow Grains or Snow Pellets[3]	Freezing Drizzle[5]	Light Freezing Rain	Rain on Cold Soaked Wing[6]	Other[7]
-3°C and above (27°F and above)	0:11 - 0:17	0:18	0:11 - 0:18	0:06 - 0:11	0:09 - 0:13	0:04 - 0:06	0:02 - 0:05	
below -3 to -6°C (below 27 to 21°F)	0:08 - 0:13	0:14	0:08 - 0:14	0:05 - 0:08	0:05 - 0:09	0:04 - 0:06	CAUTION: No holdover time guidelines exist	
below -6 to -10°C (below 21 to 14°F)	0:06 - 0:10	0:11	0:06 - 0:11	0:04 - 0:06	0:04 - 0:07	0:02 - 0:05		
below -10°C (below 14°F)	0:05 - 0:09	0:07	0:04 - 0:07	0:02 - 0:04				

NOTES

1 Type I fluid / water mixture must be selected so that the freezing point of the mixture is at least 10°C (18°F) below outside air temperature.
2 Ensure that the lowest operational use temperature (LOUT) is respected.
3 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
4 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
5 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
6 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
7 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.

CAUTIONS

- These holdover times apply to aircraft with critical surfaces constructed predominantly or entirely of aluminum materials that have demonstrated satisfactory use of these holdover times.
- The responsibility for the application of these data remains with the user.
- Takeoff after the longest applicable holdover time has been exceeded is not permitted for Type I fluids.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE 3: HOLDOVER TIMES FOR SAE TYPE I FLUID ON CRITICAL AIRCRAFT SURFACES COMPOSED PREDOMINANTLY OF COMPOSITES

Outside Air Temperature[1,2]	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[3,4]	Light Snow, Snow Grains or Snow Pellets[3,4]	Moderate Snow, Snow Grains or Snow Pellets[3]	Freezing Drizzle[5]	Light Freezing Rain	Rain on Cold Soaked Wing[6]	Other[7]
-3°C and above (27°F and above)	0:09 - 0:16	0:12	0:06 - 0:12	0:03 - 0:06	0:08 - 0:13	0:04 - 0:06	0:01 - 0:05	
below -3 to -6°C (below 27 to 21°F)	0:06 - 0:08	0:11	0:05 - 0:11	0:02 - 0:05	0:05 - 0:09	0:04 - 0:06	CAUTION: No holdover time guidelines exist	
below -6 to -10°C (below 21 to 14°F)	0:04 - 0:08	0:09	0:05 - 0:09	0:02 - 0:05	0:04 - 0:07	0:02 - 0:05		
below -10°C (below 14°F)	0:04 - 0:07	0:07	0:04 - 0:07	0:02 - 0:04				

NOTES

1 Type I fluid / water mixture must be selected so that the freezing point of the mixture is at least 10°C (18°F) below outside air temperature.
2 Ensure that the lowest operational use temperature (LOUT) is respected.
3 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
4 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
5 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
6 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
7 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.

CAUTIONS

- These holdover times apply to newer aircraft with critical surfaces constructed predominantly or entirely of composite materials.
- The responsibility for the application of these data remains with the user.
- Takeoff after the longest applicable holdover time has been exceeded is not permitted for Type I fluids.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE 4: GENERIC HOLDOVER TIMES FOR SAE TYPE II FLUIDS

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets[2,3]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	0:55 - 1:50	0:25 - 0:50	0:30 - 1:00	0:20 - 0:35	0:08 - 0:45	
	75/25	0:25 - 0:55	0:15 - 0:25	0:15 - 0:40	0:10 - 0:20	0:04 - 0:25	
	50/50	0:15 - 0:25	0:05 - 0:10	0:08 - 0:15	0:06 - 0:09	CAUTION: No holdover time guidelines exist	
below -3 to -8°C (below 27 to 18°F)	100/0	0:30 - 0:45	0:20 - 0:35	0:20 - 0:45	0:15 - 0:20		
	75/25	0:25 - 0:50	0:10 - 0:20	0:15 - 0:25	0:08 - 0:15		
below -8 to -14°C (below 18 to 7°F)	100/0	0:30 - 0:45	0:15 - 0:30	0:20 - 0:45[7]	0:15 - 0:20[7]		
	75/25	0:25 - 0:50	0:08 - 0:20	0:15 - 0:25[7]	0:08 - 0:15[7]		
below -14 to -18°C (below 7 to 0°F)	100/0	0:15 - 0:25	0:02 - 0:07				
below -18 to -25°C (below 0 to -13°F)	100/0	0:15 - 0:25[8]	0:01 - 0:03[8]				
below -25°C to LOUT (below -13°F to LOUT)	100/0	0:15 - 0:25[8]	0:00 - 0:01[8]				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10°C (14°F).
8 If the LOUT is unknown, no holdover time guidelines exist below -24°C (-11°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE 5: TYPE II HOLDOVER TIMES FOR ABAX ECOWING 26

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	1:25 - 2:35	1:35	1:00 - 1:35	0:40 - 1:00	0:50 - 1:35	0:40 - 0:50	0:20 - 1:25	
	75/25	1:05 - 1:55	1:20	0:40 - 1:20	0:20 - 0:40	0:45 - 1:05	0:25 - 0:35	0:10 - 1:00	
	50/50	0:30 - 0:45	0:40	0:20 - 0:40	0:07 - 0:20	0:15 - 0:25	0:08 - 0:10	CAUTION: No holdover time guidelines exist	
below -3 to -8°C (below 27 to 18°F)	100/0	0:45 - 2:15	1:30	0:55 - 1:30	0:35 - 0:55	0:30 - 1:10	0:15 - 0:35		
	75/25	0:35 - 1:15	1:05	0:35 - 1:05	0:20 - 0:35	0:20 - 0:50	0:15 - 0:25		
below -8 to -14°C (below 18 to 7°F)	100/0	0:45 - 2:15	1:25	0:55 - 1:25	0:35 - 0:55	0:30 - 1:10[7]	0:15 - 0:35[7]		
	75/25	0:35 - 1:15	0:55	0:30 - 0:55	0:15 - 0:30	0:20 - 0:50[7]	0:15 - 0:25[7]		
below -14 to -18°C (below 7 to 0°F)	100/0	0:25 - 0:45	0:20	0:07 - 0:20	0:02 - 0:07				
below -18 to -25°C (below 0 to -13°F)	100/0	0:25 - 0:45	0:09	0:03 - 0:09	0:01 - 0:03				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE 6: TYPE II HOLDOVER TIMES FOR ABAX ECOWING AD-2

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	1:20 - 3:00	2:00	1:15 - 2:00	0:40 - 1:15	0:40 - 1:40	0:30 - 0:45	0:09 - 1:25	
	75/25	1:15 - 1:25	1:45	0:55 - 1:45	0:25 - 0:55	0:35 - 1:05	0:20 - 0:30	0:04 - 0:50	
	50/50	0:15 - 0:30	0:35	0:15 - 0:35	0:07 - 0:15	0:09 - 0:15	0:06 - 0:09	CAUTION: No holdover time guidelines exist	
below -3 to -8°C (below 27 to 18°F)	100/0	0:45 - 2:30	2:00	1:00 - 2:00	0:30 - 1:00	0:25 - 1:10	0:20 - 0:30		
	75/25	0:35 - 1:55	1:40	0:50 - 1:40	0:25 - 0:50	0:15 - 0:55	0:20 - 0:35		
below -8 to -14°C (below 18 to 7°F)	100/0	0:45 - 2:30	1:45	0:55 - 1:45	0:30 - 0:55	0:25 - 1:10[7]	0:20 - 0:30[7]		
	75/25	0:35 - 1:55	1:35	0:50 - 1:35	0:25 - 0:50	0:15 - 0:55[7]	0:20 - 0:35[7]		
below -14 to -18°C (below 7 to 0°F)	100/0	0:15 - 0:40	0:20	0:07 - 0:20	0:02 - 0:07				
below -18 to -25°C (below 0 to -13°F)	100/0	0:15 - 0:40	0:09	0:03 - 0:09	0:01 - 0:03				
below -25 to -27°C (below -13 to -17°F)	100/0	0:15 - 0:40	0:05	0:01 - 0:05	0:00 - 0:01				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE 7: TYPE II HOLDOVER TIMES FOR AVIATION SHAANXI HI-TECH CLEANWING II

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets[2,3]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	0:55 - 1:50	0:30 - 0:55	0:35 - 1:05	0:25 - 0:35	0:10 - 0:55	
	75/25	0:50 - 1:20	0:25 - 0:45	0:35 - 1:00	0:20 - 0:30	0:07 - 0:50	
	50/50	0:35 - 1:00	0:15 - 0:30	0:20 - 0:40	0:10 - 0:20	CAUTION: No holdover time guidelines exist	
below -3 to -8°C (below 27 to 18°F)	100/0	0:45 - 1:50	0:30 - 0:55	0:30 - 0:55	0:20 - 0:25		
	75/25	0:40 - 1:45	0:25 - 0:45	0:35 - 0:40	0:20 - 0:25		
below -8 to -14°C (below 18 to 7°F)	100/0	0:45 - 1:50	0:30 - 0:55	0:30 - 0:55[7]	0:20 - 0:25[7]		
	75/25	0:40 - 1:45	0:25 - 0:45	0:35 - 0:40[7]	0:20 - 0:25[7]		
below -14 to -18°C (below 7 to 0°F)	100/0	0:20 - 0:50	0:02 - 0:07				
below -18 to -25°C (below 0 to -13°F)	100/0	0:20 - 0:50	0:01 - 0:03				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE 8: TYPE II HOLDOVER TIMES FOR BEIJING YADILITE AVIATION YD-102 TYPE II

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	1:10 - 2:00	1:40	0:50 - 1:40	0:25 - 0:50	0:40 - 1:15	0:35 - 0:40	0:10 - 1:00	
	75/25	0:25 - 0:55	0:50	0:25 - 0:50	0:15 - 0:25	0:15 - 0:40	0:10 - 0:20	0:04 - 0:25	
	50/50	0:15 - 0:25	0:25	0:10 - 0:25	0:05 - 0:10	0:08 - 0:15	0:07 - 0:09	CAUTION: No holdover time guidelines exist	
below -3 to -8°C (below 27 to 18°F)	100/0	0:45 - 1:30	1:15	0:35 - 1:15	0:20 - 0:35	0:35 - 0:50	0:25 - 0:25		
	75/25	0:30 - 0:50	0:40	0:20 - 0:40	0:10 - 0:20	0:15 - 0:25	0:09 - 0:15		
below -8 to -14°C (below 18 to 7°F)	100/0	0:45 - 1:30	1:00	0:30 - 1:00	0:15 - 0:30	0:35 - 0:50[7]	0:25 - 0:25[7]		
	75/25	0:30 - 0:50	0:35	0:20 - 0:35	0:08 - 0:20	0:15 - 0:25[7]	0:09 - 0:15[7]		
below -14 to -18°C (below 7 to 0°F)	100/0	0:20 - 0:45	0:20	0:07 - 0:20	0:02 - 0:07				
below -18 to -25°C (below 0 to -13°F)	100/0	0:20 - 0:45	0:09	0:03 - 0:09	0:01 - 0:03				
below -25 to -29°C (below -13 to -20°F)	100/0	0:20 - 0:45	0:05	0:01 - 0:05	0:00 - 0:01				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE 9: TYPE II HOLDOVER TIMES FOR CLARIANT SAFEWING MP II FLIGHT

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	3:30 - 4:00	2:00	1:35 - 2:00	1:00 - 1:35	1:20 - 2:00	0:45 - 1:25	0:10 - 1:30	
	75/25	1:50 - 2:45	2:00	1:20 - 2:00	0:40 - 1:20	1:10 - 1:30	0:30 - 0:55	0:06 - 0:50	
	50/50	0:55 - 1:45	0:45	0:25 - 0:45	0:10 - 0:25	0:20 - 0:30	0:10 - 0:15	CAUTION: No holdover time guidelines exist	
below -3 to -8°C (below 27 to 18°F)	100/0	0:55 - 1:45	2:00	1:15 - 2:00	0:45 - 1:15	0:35 - 1:30	0:25 - 0:45		
	75/25	0:25 - 1:05	1:45	0:55 - 1:45	0:30 - 0:55	0:25 - 1:10	0:20 - 0:35		
below -8 to -14°C (below 18 to 7°F)	100/0	0:55 - 1:45	1:50	1:05 - 1:50	0:40 - 1:05	0:35 - 1:30[7]	0:25 - 0:45[7]		
	75/25	0:25 - 1:05	1:20	0:40 - 1:20	0:20 - 0:40	0:25 - 1:10[7]	0:20 - 0:35[7]		
below -14 to -18°C (below 7 to 0°F)	100/0	0:30 - 0:50	1:10	0:25 - 1:10	0:08 - 0:25				
below -18 to -25°C (below 0 to -13°F)	100/0	0:30 - 0:50	0:30	0:10 - 0:30	0:03 - 0:10				
below -25 to -29°C (below -13 to -20°F)	100/0	0:30 - 0:50	0:20	0:07 - 0:20	0:02 - 0:07				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE 10: TYPE II HOLDOVER TIMES FOR CLARIANT SAFEWING MP II FLIGHT PLUS

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets[2,3]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	2:40 - 4:00	0:50 - 1:50	1:25 - 2:00	0:45 - 1:00	0:15 - 2:00	
	75/25	2:35 - 4:00	1:00 - 1:45	1:35 - 2:00	0:50 - 1:15	0:15 - 1:15	
	50/50	1:05 - 2:20	0:15 - 0:25	0:30 - 1:05	0:15 - 0:20	CAUTION: No holdover time guidelines exist	
below -3 to -8°C (below 27 to 18°F)	100/0	0:40 - 2:20	0:40 - 1:30	0:35 - 1:25	0:35 - 0:55		
	75/25	0:30 - 1:45	1:00 - 1:40	0:25 - 1:10	0:30 - 0:45		
below -8 to -14°C (below 18 to 7°F)	100/0	0:40 - 2:20	0:35 - 1:15	0:35 - 1:25[7]	0:35 - 0:55[7]		
	75/25	0:30 - 1:45	0:55 - 1:40	0:25 - 1:10[7]	0:30 - 0:45[7]		
below -14 to -18°C (below 7 to 0°F)	100/0	0:20 - 0:40	0:02 - 0:07				
below -18 to -25°C (below 0 to -13°F)	100/0	0:20 - 0:40	0:01 - 0:03				
below -25 to -29°C (below -13 to -20°F)	100/0	0:20 - 0:40	0:00 - 0:01				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE 11: TYPE II HOLDOVER TIMES FOR CRYOTECH POLAR GUARD® II

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	2:50 - 4:00	2:00	1:55 - 2:00	1:05 - 1:55	1:35 - 2:00	1:15 - 1:30	0:15 - 2:00	
	75/25	2:30 - 4:00	2:00	1:25 - 2:00	0:40 - 1:25	1:40 - 2:00	0:40 - 1:10	0:09 - 1:40	
	50/50	0:50 - 1:25	1:10	0:25 - 1:10	0:10 - 0:25	0:20 - 0:45	0:09 - 0:20		
below -3 to -8°C (below 27 to 18°F)	100/0	0:55 - 2:30	2:00	1:25 - 2:00	0:50 - 1:25	0:35 - 1:35	0:35 - 0:45		
	75/25	0:40 - 1:30	2:00	1:05 - 2:00	0:30 - 1:05	0:25 - 1:05	0:35 - 0:45		
below -8 to -14°C (below 18 to 7°F)	100/0	0:55 - 2:30	2:00	1:10 - 2:00	0:40 - 1:10	0:35 - 1:35[7]	0:35 - 0:45[7]		
	75/25	0:40 - 1:30	2:00	0:55 - 2:00	0:25 - 0:55	0:25 - 1:05[7]	0:35 - 0:45[7]		
below -14 to -18°C (below 7 to 0°F)	100/0	0:25 - 0:50	1:35	0:35 - 1:35	0:10 - 0:35				
below -18 to -25°C (below 0 to -13°F)	100/0	0:25 - 0:50	0:40	0:15 - 0:40	0:04 - 0:15				
below -25 to -30.5°C (below -13 to -23°F)	100/0	0:25 - 0:50	0:25	0:07 - 0:25	0:02 - 0:07				

CAUTION: No holdover time guidelines exist

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE 12: TYPE II HOLDOVER TIMES FOR KILFROST ABC-K PLUS

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets[2,3]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	2:15 - 3:45	1:00 - 1:40	1:50 - 2:00	1:00 - 1:25	0:20 - 2:00	
	75/25	1:40 - 2:30	0:35 - 1:10	1:25 - 2:00	0:50 - 1:10	0:15 - 2:00	
	50/50	0:35 - 1:05	0:07 - 0:15	0:20 - 0:30	0:10 - 0:15	CAUTION: No holdover time guidelines exist	
below -3 to -8°C (below 27 to 18°F)	100/0	0:30 - 1:05	0:55 - 1:30	0:25 - 1:00	0:15 - 0:35		
	75/25	0:25 - 1:25	0:35 - 1:05	0:20 - 0:55	0:09 - 0:30		
below -8 to -14°C (below 18 to 7°F)	100/0	0:30 - 1:05	0:50 - 1:25	0:25 - 1:00[7]	0:15 - 0:35[7]		
	75/25	0:25 - 1:25	0:35 - 1:05	0:20 - 0:55[7]	0:09 - 0:30[7]		
below -14 to -18°C (below 7 to 0°F)	100/0	0:30 - 0:55	0:02 - 0:07				
below -18 to -25°C (below 0 to -13°F)	100/0	0:30 - 0:55	0:01 - 0:03				
below -25 to -29°C (below -13 to -20°F)	100/0	0:30 - 0:55	0:00 - 0:01				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE 13: TYPE II HOLDOVER TIMES FOR KILFROST ICE CLEAR II

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	1:05 - 2:00	2:00	1:05 - 2:00	0:35 - 1:05	0:35 - 1:00	0:25 - 0:40	0:10 - 1:05	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A		
below -3 to -8°C (below 27 to 18°F)	100/0	0:55 - 1:55	1:45	0:55 - 1:45	0:30 - 0:55	0:40 - 1:00	0:25 - 0:30		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14°C (below 18 to 7°F)	100/0	0:55 - 1:55	1:40	0:55 - 1:40	0:30 - 0:55	0:40 - 1:00[7]	0:25 - 0:30[7]	CAUTION: No holdover time guidelines exist	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18°C (below 7 to 0°F)	100/0	0:30 - 0:55	0:20	0:07 - 0:20	0:02 - 0:07				
below -18 to -24°C (below 0 to -11°F)	100/0	0:30 - 0:55	0:09	0:03 - 0:09	0:01 - 0:03				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE 14: TYPE II HOLDOVER TIMES FOR NEWAVE AEROCHEMICAL FCY-2

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets[2,3]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	1:15 - 2:25	0:30 - 0:55	0:35 - 1:05	0:25 - 0:35	0:08 - 0:45	
	75/25	0:50 - 1:30	0:20 - 0:40	0:25 - 0:45	0:15 - 0:25	0:05 - 0:25	
	50/50	0:25 - 0:35	0:15 - 0:25	0:10 - 0:20	0:07 - 0:10	CAUTION: No holdover time guidelines exist	
below -3 to -8°C (below 27 to 18°F)	100/0	0:45 - 1:30	0:20 - 0:40	0:20 - 0:45	0:15 - 0:20		
	75/25	0:30 - 1:05	0:15 - 0:25	0:15 - 0:30	0:08 - 0:15		
below -8 to -14°C (below 18 to 7°F)	100/0	0:45 - 1:30	0:15 - 0:30	0:20 - 0:45[7]	0:15 - 0:20[7]		
	75/25	0:30 - 1:05	0:10 - 0:20	0:15 - 0:30[7]	0:08 - 0:15[7]		
below -14 to -18°C (below 7 to 0°F)	100/0	0:25 - 0:35	0:02 - 0:07				
below -18 to -25°C (below 0 to -13°F)	100/0	0:25 - 0:35	0:01 - 0:03				
below -25 to -28°C (below -13 to -18°F)	100/0	0:25 - 0:35	0:00 - 0:01				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE 15: TYPE II HOLDOVER TIMES FOR NEWAVE AEROCHEMICAL FCY-2 BIO+

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	1:25 - 2:30	2:00	1:05 - 2:00	0:30 - 1:05	0:50 - 1:20	0:25 - 0:45	0:08 - 1:15	
	75/25	0:45 - 1:20	1:20	0:40 - 1:20	0:20 - 0:40	0:25 - 0:50	0:15 - 0:25	0:06 - 0:35	
	50/50	0:15 - 0:30	0:25	0:15 - 0:25	0:08 - 0:15	0:10 - 0:20	0:08 - 0:10	CAUTION: No holdover time guidelines exist	
below -3 to -8°C (below 27 to 18°F)	100/0	0:40 - 1:30	1:25	0:40 - 1:25	0:20 - 0:40	0:35 - 1:05	0:15 - 0:30		
	75/25	0:30 - 1:05	0:50	0:25 - 0:50	0:10 - 0:25	0:20 - 0:35	0:15 - 0:20		
below -8 to -14°C (below 18 to 7°F)	100/0	0:40 - 1:30	1:00	0:30 - 1:00	0:15 - 0:30	0:35 - 1:05[7]	0:15 - 0:30[7]		
	75/25	0:30 - 1:05	0:35	0:20 - 0:35	0:08 - 0:20	0:20 - 0:35[7]	0:15 - 0:20[7]		
below -14 to -18°C (below 7 to 0°F)	100/0	0:20 - 1:00	0:20	0:07 - 0:20	0:02 - 0:07				
below -18 to -25°C (below 0 to -13°F)	100/0	0:20 - 1:00	0:09	0:03 - 0:09	0:01 - 0:03				
below -25 to -28.5°C (below -13 to -19°F)	100/0	0:20 - 1:00	0:05	0:01 - 0:05	0:00 - 0:01				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE 16: TYPE II HOLDOVER TIMES FOR OKSAYD DEFROST PG 2

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	0:55 - 1:50	1:50	0:55 - 1:50	0:30 - 0:55	0:30 - 1:00	0:20 - 0:35	0:10 - 1:20	
	75/25	1:05 - 2:00	1:45	0:45 - 1:45	0:20 - 0:45	0:25 - 0:50	0:15 - 0:30	0:06 - 0:35	
	50/50	1:00 - 1:50	2:00	1:00 - 2:00	0:30 - 1:00	0:30 - 0:50	0:15 - 0:30	CAUTION: No holdover time guidelines exist	
below -3 to -8°C (below 27 to 18°F)	100/0	0:55 - 1:25	1:25	0:45 - 1:25	0:25 - 0:45	0:35 - 0:50	0:20 - 0:30		
	75/25	0:40 - 1:20	1:10	0:30 - 1:10	0:15 - 0:30	0:25 - 0:40	0:15 - 0:20		
below -8 to -14°C (below 18 to 7°F)	100/0	0:55 - 1:25	1:15	0:40 - 1:15	0:20 - 0:40	0:35 - 0:50[7]	0:20 - 0:30[7]		
	75/25	0:40 - 1:20	0:55	0:25 - 0:55	0:10 - 0:25	0:25 - 0:40[7]	0:15 - 0:20[7]		
below -14 to -18°C (below 7 to 0°F)	100/0	0:35 - 1:05	0:20	0:07 - 0:20	0:02 - 0:07				
below -18 to -25°C (below 0 to -13°F)	100/0	0:35 - 1:05	0:09	0:03 - 0:09	0:01 - 0:03				
below -25 to -27°C (below -13 to -17°F)	100/0	0:35 - 1:05	0:05	0:01 - 0:05	0:00 - 0:01				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE 17: TYPE II HOLDOVER TIMES FOR ROMCHIM ADD-PROTECT TYPE II

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	1:40 - 3:30	1:55	1:00 - 1:55	0:30 - 1:00	0:40 - 1:35	0:25 - 0:45	0:09 - 0:50	
	75/25	0:40 - 1:10	1:00	0:30 - 1:00	0:15 - 0:30	0:25 - 0:40	0:15 - 0:25	0:05 - 0:25	
	50/50	0:20 - 0:35	0:30	0:15 - 0:30	0:09 - 0:15	0:10 - 0:30	0:08 - 0:10	CAUTION: No holdover time guidelines exist	
below -3 to -8°C (below 27 to 18°F)	100/0	0:30 - 0:45	1:20	0:40 - 1:20	0:20 - 0:40	0:25 - 0:50	0:20 - 0:30		
	75/25	0:30 - 0:55	0:40	0:25 - 0:40	0:10 - 0:25	0:20 - 0:30	0:15 - 0:20		
below -8 to -14°C (below 18 to 7°F)	100/0	0:30 - 0:45	1:05	0:35 - 1:05	0:15 - 0:35	0:25 - 0:50[7]	0:20 - 0:30[7]		
	75/25	0:30 - 0:55	0:35	0:20 - 0:35	0:09 - 0:20	0:20 - 0:30[7]	0:15 - 0:20[7]		
below -14 to -18°C (below 7 to 0°F)	100/0	0:15 - 0:25	0:20	0:07 - 0:20	0:02 - 0:07				
below -18 to -25°C (below 0 to -13°F)	100/0	0:15 - 0:25	0:09	0:03 - 0:09	0:01 - 0:03				
below -25 to -28°C (below -13 to -18°F)	100/0	0:15 - 0:25	0:05	0:01 - 0:05	0:00 - 0:01				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE 18: TYPE III HOLDOVER TIMES FOR ALLCLEAR AEROCLEAR MAX APPLIED UNHEATED ON LOW SPEED AIRCRAFT[1]

Outside Air Temperature[2]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[3,4]	Light Snow, Snow Grains or Snow Pellets[3,4]	Moderate Snow, Snow Grains or Snow Pellets[3]	Freezing Drizzle[5]	Light Freezing Rain	Rain on Cold Soaked Wing[6]	Other[7]
-3°C and above (27°F and above)	100/0	0:45 - 1:55	1:20	0:40 - 1:20	0:18 - 0:40	0:25 - 0:50	0:14 - 0:25	0:05 - 0:40	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A	CAUTION: No holdover time guidelines exist	
below -3 to -10°C (below 27 to 14°F)	100/0	0:50 - 1:40	1:20	0:40 - 1:20	0:18 - 0:40	0:25 - 0:45	0:15 - 0:25		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -10 to -16°C (below 14 to 3°F)	100/0	0:40 - 1:45	1:20	0:40 - 1:20	0:18 - 0:40				

NOTES

1 These holdover times are for aircraft conforming to the SAE AS5900 low speed aerodynamic test criterion. Fluid must be applied unheated to use these holdover times. No holdover times exist for this fluid applied heated.
2 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type III fluid cannot be used.
3 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
4 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
5 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
6 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
7 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE 19: TYPE III HOLDOVER TIMES FOR ALLCLEAR AEROCLEAR MAX APPLIED UNHEATED ON HIGH SPEED AIRCRAFT[1]

Outside Air Temperature[2]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[3,4]	Light Snow, Snow Grains or Snow Pellets[3,4]	Moderate Snow, Snow Grains or Snow Pellets[3]	Freezing Drizzle[5]	Light Freezing Rain	Rain on Cold Soaked Wing[6]	Other[7]
-3°C and above (27°F and above)	100/0	0:45 - 1:55	1:20	0:40 - 1:20	0:18 - 0:40	0:25 - 0:50	0:14 - 0:25	0:05 - 0:40	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A	CAUTION: No holdover time guidelines exist	
below -3 to -10°C (below 27 to 14°F)	100/0	0:50 - 1:40	1:20	0:40 - 1:20	0:18 - 0:40	0:25 - 0:45	0:15 - 0:25		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -10 to -25°C (below 14 to -13°F)	100/0	0:40 - 1:45	1:20	0:40 - 1:20	0:18 - 0:40				
below -25 to -35°C (below -13 to -31°F)	100/0	0:25 - 1:00	0:45	0:20 - 0:45	0:10 - 0:20				

NOTES

1 These holdover times are for aircraft conforming to the SAE AS5900 high speed aerodynamic test criterion. Fluid must be applied unheated to use these holdover times. No holdover times exist for this fluid applied heated.
2 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type III fluid cannot be used.
3 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
4 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
5 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
6 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
7 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table 41 provides allowance times for ice pellets and small hail for SAE Type III fluids, applied unheated).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE 20: GENERIC HOLDOVER TIMES FOR SAE TYPE IV FLUIDS

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	1:15 - 2:40	2:00	1:10 - 2:00	0:35 - 1:10	0:40 - 1:30	0:25 - 0:40	0:08 - 1:10	
	75/25	1:25 - 2:40	2:00	1:15 - 2:00	0:40 - 1:15	0:50 - 1:20	0:30 - 0:45	0:09 - 1:15	
	50/50	0:30 - 0:55	1:00	0:25 - 1:00	0:10 - 0:25	0:15 - 0:40	0:09 - 0:20	CAUTION: No holdover time guidelines exist	
below -3 to -8°C (below 27 to 18°F)	100/0	0:20 - 1:35	1:50	0:55 - 1:50	0:30 - 0:55	0:25 - 1:20	0:20 - 0:25		
	75/25	0:30 - 1:20	1:50	1:00 - 1:50	0:30 - 1:00	0:20 - 1:05	0:15 - 0:25		
below -8 to -14°C (below 18 to 7°F)	100/0	0:20 - 1:35	1:20	0:45 - 1:20	0:25 - 0:45	0:25 - 1:20[7]	0:20 - 0:25[7]		
	75/25	0:30 - 1:20	1:40	0:45 - 1:40	0:20 - 0:45	0:20 - 1:05[7]	0:15 - 0:25[7]		
below -14 to -18°C (below 7 to 0°F)	100/0	0:20 - 0:40	0:30	0:09 - 0:30	0:02 - 0:09				
below -18 to -25°C (below 0 to -13°F)	100/0	0:20 - 0:40[8]	0:10[8]	0:03 - 0:10[8]	0:01 - 0:03[8]				
below -25°C to LOUT (below -13°F to LOUT)	100/0	0:20 - 0:40[8]	0:07[8]	0:02 - 0:07[8]	0:00 - 0:02[8]				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table 42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10°C (14°F).
8 If the LOUT is unknown, no holdover time guidelines exist below -22.5°C (-8.5°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE 21: TYPE IV HOLDOVER TIMES FOR ABAX ECOWING AD-49

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	3:20 - 4:00	2:00	1:55 - 2:00	1:00 - 1:55	1:25 - 2:00	1:00 - 1:25	0:10 - 1:55	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A		
below -3 to -8°C (below 27 to 18°F)	100/0	0:20 - 1:35	2:00	1:30 - 2:00	0:45 - 1:30	0:25 - 1:25	0:20 - 0:25		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14°C (below 18 to 7°F)	100/0	0:20 - 1:35	2:00	1:15 - 2:00	0:40 - 1:15	0:25 - 1:25[7]	0:20 - 0:25[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18°C (below 7 to 0°F)	100/0	0:25 - 0:40	0:30	0:09 - 0:30	0:02 - 0:09				
below -18 to -25°C (below 0 to -13°F)	100/0	0:25 - 0:40	0:10	0:03 - 0:10	0:01 - 0:03				
below -25 to -26°C (below -13 to -15°F)	100/0	0:25 - 0:40	0:07	0:02 - 0:07	0:00 - 0:02				

CAUTION: No holdover time guidelines exist

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table 42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE 22: TYPE IV HOLDOVER TIMES FOR ALLCLEAR CLEARWING EG

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	1:50 - 3:15	2:00	1:20 - 2:00	0:40 - 1:20	1:10 - 1:35	0:30 - 1:00	0:10 - 1:30	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A		
below -3 to -8°C (below 27 to 18°F)	100/0	1:35 - 3:45	2:00	1:10 - 2:00	0:35 - 1:10	1:05 - 1:30	0:30 - 1:00		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14°C (below 18 to 7°F)	100/0	1:35 - 3:45	2:00	1:05 - 2:00	0:30 - 1:05	1:05 - 1:30[7]	0:30 - 1:00[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18°C (below 7 to 0°F)	100/0	0:55 - 2:00	0:50	0:25 - 0:50	0:10 - 0:25				
below -18 to -25°C (below 0 to -13°F)	100/0	0:55 - 2:00	0:40	0:15 - 0:40	0:05 - 0:15				
below -25 to -29°C (below -13 to -20°F)	100/0	0:55 - 2:00	0:25	0:08 - 0:25	0:02 - 0:08				

CAUTION: No holdover time guidelines exist

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table 42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE 23: TYPE IV HOLDOVER TIMES FOR CHEMCO CHEMR EG IV

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	2:05 - 3:35	2:00	1:15 - 2:00	0:35 - 1:15	0:45 - 1:40	0:25 - 0:40	0:09 - 1:45	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A	CAUTION: No holdover time guidelines exist	
below -3 to -8°C (below 27 to 18°F)	100/0	1:25 - 3:40	2:00	1:15 - 2:00	0:35 - 1:15	1:00 - 1:35	0:35 - 0:50		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14°C (below 18 to 7°F)	100/0	1:25 - 3:40	2:00	1:15 - 2:00	0:35 - 1:15	1:00 - 1:35[7]	0:35 - 0:50[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18°C (below 7 to 0°F)	100/0	0:40 - 1:25	0:50	0:25 - 0:50	0:10 - 0:25				
below -18 to -25°C (below 0 to -13°F)	100/0	0:40 - 1:25	0:40	0:15 - 0:40	0:05 - 0:15				
below -25 to -27°C (below -13 to -17°F)	100/0	0:40 - 1:25	0:25	0:08 - 0:25	0:02 - 0:08				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table 42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE 24: TYPE IV HOLDOVER TIMES FOR CLARIANT MAX FLIGHT 04

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	2:40 - 4:00	2:00	2:00 - 2:00	1:25 - 2:00	2:00 - 2:00	1:10 - 1:30	0:20 - 2:00	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A	CAUTION: No holdover time guidelines exist	
below -3 to -8°C (below 27 to 18°F)	100/0	0:50 - 2:30	2:00	1:40 - 2:00	0:50 - 1:40	0:25 - 1:30	0:20 - 0:40		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14°C (below 18 to 7°F)	100/0	0:50 - 2:30	2:00	1:10 - 2:00	0:35 - 1:10	0:25 - 1:30[7]	0:20 - 0:40[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18°C (below 7 to 0°F)	100/0	0:20 - 0:45	0:30	0:09 - 0:30	0:02 - 0:09				
below -18 to -23.5°C (below 0 to -10°F)	100/0	0:20 - 0:45	0:10	0:03 - 0:10	0:01 - 0:03				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table 42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE 25: TYPE IV HOLDOVER TIMES FOR CLARIANT MAX FLIGHT AVIA

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	3:05 - 4:00	2:00	1:45 - 2:00	1:00 - 1:45	1:25 - 2:00	0:55 - 1:10	0:09 - 2:00	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A	CAUTION: No holdover time guidelines exist	
below -3 to -8°C (below 27 to 18°F)	100/0	1:45 - 3:55	2:00	1:25 - 2:00	0:50 - 1:25	1:10 - 2:00	0:55 - 1:30		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14°C (below 18 to 7°F)	100/0	1:45 - 3:55	2:00	1:15 - 2:00	0:40 - 1:15	1:10 - 2:00[7]	0:55 - 1:30[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18°C (below 7 to 0°F)	100/0	0:35 - 1:25	0:50	0:25 - 0:50	0:10 - 0:25				
below -18 to -25°C (below 0 to -13°F)	100/0	0:35 - 1:25	0:40	0:15 - 0:40	0:05 - 0:15				
below -25 to -28.5°C (below -13 to -19°F)	100/0	0:35 - 1:25	0:25	0:08 - 0:25	0:02 - 0:08				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table 42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE 26: TYPE IV HOLDOVER TIMES FOR CLARIANT MAX FLIGHT SNEG

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	2:25 - 4:00	2:00	1:40 - 2:00	0:55 - 1:40	2:00 - 2:00	0:50 - 1:40	0:20 - 1:30	
	75/25	4:00 - 4:00	2:00	1:30 - 2:00	0:55 - 1:30	1:30 - 2:00	1:05 - 1:20	0:15 - 1:45	
	50/50	1:30 - 3:30	1:45	0:45 - 1:45	0:20 - 0:45	0:35 - 1:10	0:15 - 0:30	CAUTION: No holdover time guidelines exist	
below -3 to -8°C (below 27 to 18°F)	100/0	0:45 - 2:20	2:00	1:20 - 2:00	0:45 - 1:20	0:30 - 1:25	0:25 - 0:40		
	75/25	0:30 - 1:25	1:55	1:10 - 1:55	0:45 - 1:10	0:20 - 1:05	0:20 - 0:40		
below -8 to -14°C (below 18 to 7°F)	100/0	0:45 - 2:20	2:00	1:10 - 2:00	0:40 - 1:10	0:30 - 1:25[7]	0:25 - 0:40[7]		
	75/25	0:30 - 1:25	1:40	1:00 - 1:40	0:40 - 1:00	0:20 - 1:05[7]	0:20 - 0:40[7]		
below -14 to -18°C (below 7 to 0°F)	100/0	0:20 - 0:50	0:30	0:09 - 0:30	0:02 - 0:09				
below -18 to -25°C (below 0 to -13°F)	100/0	0:20 - 0:50	0:10	0:03 - 0:10	0:01 - 0:03				
below -25 to -29°C (below -13 to -20°F)	100/0	0:20 - 0:50	0:07	0:02 - 0:07	0:00 - 0:02				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table 42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE 27: TYPE IV HOLDOVER TIMES FOR CLARIANT SAFEWING EG IV NORTH

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	2:20 - 3:55	2:00	1:40 - 2:00	0:50 - 1:40	1:30 - 2:00	0:50 - 0:55	0:08 - 2:00	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A		
below -3 to -8°C (below 27 to 18°F)	100/0	1:45 - 4:00	2:00	1:30 - 2:00	0:50 - 1:30	1:05 - 1:50	0:55 - 1:25		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14°C (below 18 to 7°F)	100/0	1:45 - 4:00	2:00	1:30 - 2:00	0:50 - 1:30	1:05 - 1:50[7]	0:55 - 1:25[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18°C (below 7 to 0°F)	100/0	0:40 - 1:20	0:50	0:25 - 0:50	0:10 - 0:25				
below -18 to -25°C (below 0 to -13°F)	100/0	0:40 - 1:20	0:40	0:15 - 0:40	0:05 - 0:15				
below -25 to -30°C (below -13 to -22°F)	100/0	0:40 - 1:20	0:25	0:08 - 0:25	0:02 - 0:08				

CAUTION: No holdover time guidelines exist

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table 42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE 28: TYPE IV HOLDOVER TIMES FOR CLARIANT SAFEWING MP IV LAUNCH

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	4:00 - 4:00	2:00	1:45 - 2:00	1:05 - 1:45	1:30 - 2:00	1:00 - 1:40	0:15 - 1:40	
	75/25	3:40 - 4:00	2:00	1:45 - 2:00	1:00 - 1:45	1:40 - 2:00	0:45 - 1:15	0:10 - 1:45	
	50/50	1:25 - 2:45	1:25	0:45 - 1:25	0:25 - 0:45	0:30 - 0:50	0:20 - 0:25	CAUTION: No holdover time guidelines exist	
below -3 to -8°C (below 27 to 18°F)	100/0	1:00 - 1:55	2:00	1:30 - 2:00	0:55 - 1:30	0:35 - 1:40	0:25 - 0:45		
	75/25	0:40 - 1:20	2:00	1:30 - 2:00	0:50 - 1:30	0:25 - 1:10	0:25 - 0:45		
below -8 to -14°C (below 18 to 7°F)	100/0	1:00 - 1:55	2:00	1:20 - 2:00	0:50 - 1:20	0:35 - 1:40[7]	0:25 - 0:45[7]		
	75/25	0:40 - 1:20	2:00	1:25 - 2:00	0:45 - 1:25	0:25 - 1:10[7]	0:25 - 0:45[7]		
below -14 to -18°C (below 7 to 0°F)	100/0	0:30 - 0:50	1:15	0:20 - 1:15	0:06 - 0:20				
below -18 to -25°C (below 0 to -13°F)	100/0	0:30 - 0:50	0:30	0:09 - 0:30	0:02 - 0:09				
below -25 to -28.5°C (below -13 to -19°F)	100/0	0:30 - 0:50	0:20	0:06 - 0:20	0:01 - 0:06				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table 42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE 29: TYPE IV HOLDOVER TIMES FOR CLARIANT SAFEWING MP IV LAUNCH PLUS

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	3:55 - 4:00	2:00	2:00 - 2:00	0:55 - 2:00	2:00 - 2:00	1:00 - 2:00	0:20 - 2:00	
	75/25	3:55 - 4:00	2:00	1:55 - 2:00	0:50 - 1:55	2:00 - 2:00	1:20 - 1:25	0:20 - 1:50	
	50/50	1:15 - 1:50	1:35	0:45 - 1:35	0:20 - 0:45	0:25 - 1:00	0:15 - 0:20	CAUTION: No holdover time guidelines exist	
below -3 to -8°C (below 27 to 18°F)	100/0	0:55 - 2:15	2:00	1:40 - 2:00	0:45 - 1:40	0:25 - 1:35	0:25 - 0:40		
	75/25	0:40 - 2:00	2:00	1:30 - 2:00	0:35 - 1:30	0:20 - 1:05	0:20 - 0:30		
below -8 to -14°C (below 18 to 7°F)	100/0	0:55 - 2:15	2:00	1:25 - 2:00	0:40 - 1:25	0:25 - 1:35[7]	0:25 - 0:40[7]		
	75/25	0:40 - 2:00	2:00	1:15 - 2:00	0:30 - 1:15	0:20 - 1:05[7]	0:20 - 0:30[7]		
below -14 to -18°C (below 7 to 0°F)	100/0	0:25 - 0:50	1:15	0:25 - 1:15	0:07 - 0:25				
below -18 to -25°C (below 0 to -13°F)	100/0	0:25 - 0:50	0:30	0:09 - 0:30	0:03 - 0:09				
below -25 to -29°C (below -13 to -20°F)	100/0	0:25 - 0:50	0:20	0:06 - 0:20	0:02 - 0:06				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table 42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE 30: TYPE IV HOLDOVER TIMES FOR CRYOTECH POLAR GUARD® ADVANCE

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	2:50 - 4:00	2:00	1:55 - 2:00	1:05 - 1:55	1:35 - 2:00	1:15 - 1:30	0:15 - 2:00	
	75/25	2:30 - 4:00	2:00	1:25 - 2:00	0:40 - 1:25	1:40 - 2:00	0:40 - 1:10	0:09 - 1:40	
	50/50	0:50 - 1:25	1:10	0:25 - 1:10	0:10 - 0:25	0:20 - 0:45	0:09 - 0:20		
below -3 to -8°C (below 27 to 18°F)	100/0	0:55 - 2:30	2:00	1:25 - 2:00	0:50 - 1:25	0:35 - 1:35	0:35 - 0:45		
	75/25	0:40 - 1:30	2:00	1:05 - 2:00	0:30 - 1:05	0:25 - 1:05	0:35 - 0:45		
below -8 to -14°C (below 18 to 7°F)	100/0	0:55 - 2:30	2:00	1:10 - 2:00	0:40 - 1:10	0:35 - 1:35[7]	0:35 - 0:45[7]		
	75/25	0:40 - 1:30	2:00	0:55 - 2:00	0:25 - 0:55	0:25 - 1:05[7]	0:35 - 0:45[7]		
below -14 to -18°C (below 7 to 0°F)	100/0	0:25 - 0:50	1:35	0:35 - 1:35	0:10 - 0:35				
below -18 to -25°C (below 0 to -13°F)	100/0	0:25 - 0:50	0:40	0:15 - 0:40	0:04 - 0:15				
below -25 to -30.5°C (below -13 to -23°F)	100/0	0:25 - 0:50	0:25	0:07 - 0:25	0:02 - 0:07				

CAUTION: No holdover time guidelines exist

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table 42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE 31: TYPE IV HOLDOVER TIMES FOR CRYOTECH POLAR GUARD® XTEND

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	2:30 - 4:00	2:00	2:00 - 2:00	1:05 - 2:00	2:00 - 2:00	1:00 - 1:50	0:20 - 1:45	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A		
below -3 to -8°C (below 27 to 18°F)	100/0	1:00 - 1:50	2:00	1:35 - 2:00	0:50 - 1:35	0:35 - 1:40	0:50 - 0:55		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14°C (below 18 to 7°F)	100/0	1:00 - 1:50	2:00	1:20 - 2:00	0:45 - 1:20	0:35 - 1:40[7]	0:50 - 0:55[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18°C (below 7 to 0°F)	100/0	0:25 - 0:40	0:30	0:09 - 0:30	0:02 - 0:09				
below -18 to -25°C (below 0 to -13°F)	100/0	0:25 - 0:40	0:10	0:03 - 0:10	0:01 - 0:03				
below -25 to -29°C (below -13 to -20°F)	100/0	0:25 - 0:40	0:07	0:02 - 0:07	0:00 - 0:02				

CAUTION: No holdover time guidelines exist

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table 42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE 32: TYPE IV HOLDOVER TIMES FOR DOW CHEMICAL UCAR™ ENDURANCE EG106

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	2:05 - 3:10	2:00	1:20 - 2:00	0:40 - 1:20	1:10 - 2:00	0:50 - 1:15	0:20 - 2:00	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A	CAUTION: No holdover time guidelines exist	
below -3 to -8°C (below 27 to 18°F)	100/0	1:50 - 3:20	2:00	1:10 - 2:00	0:35 - 1:10	0:55 - 1:50	0:45 - 1:10		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14°C (below 18 to 7°F)	100/0	1:50 - 3:20	2:00	1:05 - 2:00	0:30 - 1:05	0:55 - 1:50[7]	0:45 - 1:10[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18°C (below 7 to 0°F)	100/0	0:30 - 1:05	1:45	0:50 - 1:45	0:25 - 0:50				
below -18 to -25°C (below 0 to -13°F)	100/0	0:30 - 1:05	1:30	0:40 - 1:30	0:20 - 0:40				
below -25 to -29°C (below -13 to -20°F)	100/0	0:30 - 1:05	1:20	0:40 - 1:20	0:20 - 0:40				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table 42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE 33: TYPE IV HOLDOVER TIMES FOR DOW CHEMICAL UCAR™ FLIGHTGUARD AD-49

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	3:20 - 4:00	2:00	1:55 - 2:00	1:00 - 1:55	1:25 - 2:00	1:00 - 1:25	0:10 - 1:55	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A		
below -3 to -8°C (below 27 to 18°F)	100/0	0:20 - 1:35	2:00	1:30 - 2:00	0:45 - 1:30	0:25 - 1:25	0:20 - 0:25		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14°C (below 18 to 7°F)	100/0	0:20 - 1:35	2:00	1:15 - 2:00	0:40 - 1:15	0:25 - 1:25[7]	0:20 - 0:25[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18°C (below 7 to 0°F)	100/0	0:25 - 0:40	0:30	0:09 - 0:30	0:02 - 0:09				
below -18 to -25°C (below 0 to -13°F)	100/0	0:25 - 0:40	0:10	0:03 - 0:10	0:01 - 0:03				
below -25 to -26°C (below -13 to -15°F)	100/0	0:25 - 0:40	0:07	0:02 - 0:07	0:00 - 0:02				

CAUTION: No holdover time guidelines exist

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table 42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE 34: TYPE IV HOLDOVER TIMES FOR INLAND TECHNOLOGIES ECO-SHIELD®

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	1:15 - 2:40	2:00	1:20 - 2:00	0:45 - 1:20	0:40 - 1:30	0:35 - 0:40	0:15 - 1:35	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A		
below -3 to -8°C (below 27 to 18°F)	100/0	1:10 - 2:35	2:00	1:10 - 2:00	0:40 - 1:10	0:50 - 1:25	0:30 - 0:40		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14°C (below 18 to 7°F)	100/0	1:10 - 2:35	1:55	1:05 - 1:55	0:35 - 1:05	0:50 - 1:25[7]	0:30 - 0:40[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18°C (below 7 to 0°F)	100/0	0:30 - 1:00	0:30	0:09 - 0:30	0:02 - 0:09				
below -18 to -25°C (below 0 to -13°F)	100/0	0:30 - 1:00	0:10	0:03 - 0:10	0:01 - 0:03				
below -25 to -25.5°C (below -13 to -14°F)	100/0	0:30 - 1:00	0:07	0:02 - 0:07	0:00 - 0:02				

CAUTION: No holdover time guidelines exist

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table 42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE 35: TYPE IV HOLDOVER TIMES FOR KILFROST ABC-S PLUS

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	2:10 - 4:00	2:00	2:00 - 2:00	1:15 - 2:00	1:50 - 2:00	1:05 - 2:00	0:25 - 2:00	
	75/25	1:25 - 2:40	2:00	1:15 - 2:00	0:45 - 1:15	1:00 - 1:20	0:30 - 0:50	0:10 - 1:20	
	50/50	0:30 - 0:55	1:00	0:30 - 1:00	0:15 - 0:30	0:15 - 0:40	0:15 - 0:20	CAUTION: No holdover time guidelines exist	
below -3 to -8°C (below 27 to 18°F)	100/0	0:55 - 3:30	2:00	1:50 - 2:00	1:05 - 1:50	0:25 - 1:35	0:20 - 0:30		
	75/25	0:45 - 1:50	1:50	1:05 - 1:50	0:40 - 1:05	0:20 - 1:10	0:15 - 0:25		
below -8 to -14°C (below 18 to 7°F)	100/0	0:55 - 3:30	2:00	1:45 - 2:00	1:00 - 1:45	0:25 - 1:35[7]	0:20 - 0:30[7]		
	75/25	0:45 - 1:50	1:45	1:00 - 1:45	0:35 - 1:00	0:20 - 1:10[7]	0:15 - 0:25[7]		
below -14 to -18°C (below 7 to 0°F)	100/0	0:40 - 1:00	0:30	0:09 - 0:30	0:02 - 0:09				
below -18 to -25°C (below 0 to -13°F)	100/0	0:40 - 1:00	0:10	0:03 - 0:10	0:01 - 0:03				
below -25 to -28°C (below -13 to -18°F)	100/0	0:40 - 1:00	0:07	0:02 - 0:07	0:00 - 0:02				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table 42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE 36: TYPE IV HOLDOVER TIMES FOR LNT SOLUTIONS E450

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	1:50 - 2:55	2:00	1:35 - 2:00	1:00 - 1:35	1:35 - 2:00	0:55 - 1:20	0:25 - 2:00	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A		
below -3 to -8°C (below 27 to 18°F)	100/0	1:30 - 3:55	2:00	1:20 - 2:00	0:50 - 1:20	1:45 - 2:00	1:05 - 1:40		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14°C (below 18 to 7°F)	100/0	1:30 - 3:55	1:50	1:10 - 1:50	0:45 - 1:10	1:45 - 2:00[7]	1:05 - 1:40[7]	CAUTION: No holdover time guidelines exist	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18°C (below 7 to 0°F)	100/0	0:35 - 1:05	2:00	1:05 - 2:00	0:20 - 1:05				
below -18 to -25°C[8] (below 0 to -13°F)[8]	100/0	0:35 - 1:05	1:35	0:30 - 1:35	0:10 - 0:30				
below -25 to -32.5°C[8] (below -13 to -26°F)[8]	100/0	0:25 - 1:00	0:40	0:15 - 0:40	0:04 - 0:15				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table 42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10°C (14°F).
8 Use LOUT of -22.5°C (-9°F) unless indicated otherwise by fluid manufacturer.

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE 37: TYPE IV HOLDOVER TIMES FOR NEWAVE AEROCHEMICAL FCY 9311

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	1:55 - 4:00	2:00	1:10 - 2:00	0:35 - 1:10	1:10 - 2:00	0:40 - 1:05	0:15 - 1:25	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A	CAUTION: No holdover time guidelines exist	
below -3 to -8°C (below 27 to 18°F)	100/0	0:35 - 2:05	1:50	0:55 - 1:50	0:30 - 0:55	0:35 - 1:20	0:20 - 0:35		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14°C (below 18 to 7°F)	100/0	0:35 - 2:05	1:35	0:50 - 1:35	0:25 - 0:50	0:35 - 1:20[7]	0:20 - 0:35[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18°C (below 7 to 0°F)	100/0	0:30 - 0:55	0:30	0:09 - 0:30	0:02 - 0:09				
below -18 to -25°C (below 0 to -13°F)	100/0	0:30 - 0:55	0:10	0:03 - 0:10	0:01 - 0:03				
below -25 to -29.5°C (below -13 to -21°F)	100/0	0:30 - 0:55	0:07	0:02 - 0:07	0:00 - 0:02				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table 42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE 38: TYPE IV HOLDOVER TIMES FOR OKSAYD DEFROST ECO 4

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	1:30 - 2:40	2:00	1:15 - 2:00	0:35 - 1:15	1:05 - 1:30	0:40 - 1:05	0:15 - 1:10	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A		
below -3 to -8°C (below 27 to 18°F)	100/0	0:55 - 2:35	2:00	1:05 - 2:00	0:35 - 1:05	0:50 - 1:20	0:35 - 0:50		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14°C (below 18 to 7°F)	100/0	0:55 - 2:35	2:00	1:00 - 2:00	0:30 - 1:00	0:50 - 1:20[7]	0:35 - 0:50[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18°C (below 7 to 0°F)	100/0	0:30 - 0:50	0:30	0:09 - 0:30	0:02 - 0:09				
below -18 to -25°C (below 0 to -13°F)	100/0	0:30 - 0:50	0:10	0:03 - 0:10	0:01 - 0:03				
below -25 to -25.5°C (below -13 to -14°F)	100/0	0:30 - 0:50	0:07	0:02 - 0:07	0:00 - 0:02				

CAUTION: No holdover time guidelines exist

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table 42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE 39: TYPE IV HOLDOVER TIMES FOR OKSAYD DEFROST EG 4

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	2:45 - 4:00	2:00	2:00 - 2:00	1:25 - 2:00	2:00 - 2:00	1:00 - 1:45	0:20 - 2:00	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A	CAUTION: No holdover time guidelines exist	
below -3 to -8°C (below 27 to 18°F)	100/0	2:20 - 4:00	2:00	2:00 - 2:00	1:15 - 2:00	1:00 - 2:00	1:20 - 1:50		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14°C (below 18 to 7°F)	100/0	2:20 - 4:00	2:00	1:55 - 2:00	1:10 - 1:55	1:00 - 2:00[7]	1:20 - 1:50[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18°C (below 7 to 0°F)	100/0	0:45 - 2:25	0:50	0:25 - 0:50	0:10 - 0:25				
below -18 to -25°C (below 0 to -13°F)	100/0	0:45 - 2:25	0:40	0:15 - 0:40	0:05 - 0:15				
below -25 to -26°C (below -13 to -15°F)	100/0	0:45 - 2:25	0:25	0:08 - 0:25	0:02 - 0:08				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table 42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE 40: TYPE IV HOLDOVER TIMES FOR SHAANXI CLEANWAY AVIATION CLEANSURFACE IV

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	2:50 - 4:00	2:00	1:55 - 2:00	1:00 - 1:55	2:00 - 2:00	1:25 - 1:30	0:15 - 2:00	
	75/25	2:35 - 4:00	2:00	1:35 - 2:00	0:45 - 1:35	0:50 - 2:00	0:35 - 0:45	0:09 - 1:15	
	50/50	1:05 - 2:25	1:40	0:40 - 1:40	0:15 - 0:40	0:25 - 0:50	0:15 - 0:20	CAUTION: No holdover time guidelines exist	
below -3 to -8°C (below 27 to 18°F)	100/0	1:00 - 3:05	2:00	1:05 - 2:00	0:35 - 1:05	0:35 - 1:45	0:20 - 0:35		
	75/25	0:50 - 1:55	2:00	1:00 - 2:00	0:30 - 1:00	0:30 - 1:20	0:25 - 0:40		
below -8 to -14°C (below 18 to 7°F)	100/0	1:00 - 3:05	1:20	0:45 - 1:20	0:25 - 0:45	0:35 - 1:45[7]	0:20 - 0:35[7]		
	75/25	0:50 - 1:55	1:40	0:45 - 1:40	0:20 - 0:45	0:30 - 1:20[7]	0:25 - 0:40[7]		
below -14 to -18°C (below 7 to 0°F)	100/0	0:30 - 0:50	0:30	0:09 - 0:30	0:02 - 0:09				
below -18 to -25°C (below 0 to -13°F)	100/0	0:30 - 0:50	0:10	0:03 - 0:10	0:01 - 0:03				
below -25 to -28.5°C (below -13 to -19°F)	100/0	0:30 - 0:50	0:07	0:02 - 0:07	0:00 - 0:02				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table 42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

ALLOWANCE TIMES TABLES FOR WINTER 2019-2020

TABLE 41: ALLOWANCE TIMES FOR SAE TYPE III FLUIDS[1]

Precipitation Type	Outside Air Temperature		
	-5°C and above	Below -5 to -10°C	Below -10°C[2]
Light Ice Pellets	10 minutes	10 minutes	**Caution: No allowance times currently exist**
Light Ice Pellets Mixed with Snow	10 minutes	10 minutes	
Light Ice Pellets Mixed with Freezing Drizzle	7 minutes	5 minutes	
Light Ice Pellets Mixed with Freezing Rain	7 minutes	5 minutes	
Light Ice Pellets Mixed with Rain	7 minutes[3]		
Moderate Ice Pellets (or Small Hail)[4]	5 minutes	5 minutes	

NOTES

1 These allowance times are for use with undiluted (100/0) fluids applied unheated on aircraft with rotation speeds of 100 knots or greater.
2 Ensure that the lowest operational use temperature (LOUT) is respected.
3 No allowance times exist in this condition for temperatures below 0°C; consider use of light ice pellets mixed with freezing rain.
4 If no intensity is reported with small hail, use the "moderate ice pellets or small hail" allowance times. If an intensity is reported with small hail, the ice pellet condition with the equivalent intensity can be used, e.g. if light small hail is reported, the "light ice pellets" allowance times can be used. This also applies in mixed conditions, e.g. if light small hail mixed with snow is reported, use the "light ice pellets mixed with snow" allowance times.

CAUTIONS

- The responsibility for the application of these data remains with the user.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- Allowance time cannot be extended by an inspection of the aircraft critical surfaces.
- Takeoff is allowed up to 90 minutes after start of fluid application if the precipitation stops at or before the allowance time expires and does not restart. The OAT must not decrease during the 90 minutes to use this guidance in conditions of light ice pellets mixed with either: freezing drizzle, freezing rain or rain.

TABLE 42: ALLOWANCE TIMES FOR SAE TYPE IV FLUIDS[1]

Precipitation Type	Outside Air Temperature			
	-5°C and above	Below -5 to -10°C	Below -10 to -16°C	Below -16 to -22°C[2]
Light Ice Pellets	50 minutes	30 minutes	30 minutes[3]	30 minutes[3]
Light Ice Pellets Mixed with Snow	40 minutes	15 minutes	15 minutes[3]	
Light Ice Pellets Mixed with Freezing Drizzle	25 minutes	10 minutes	**Caution: No allowance times currently exist**	
Light Ice Pellets Mixed with Freezing Rain	25 minutes	10 minutes		
Light Ice Pellets Mixed with Rain	25 minutes[4]			
Moderate Ice Pellets (or Small Hail)[5]	25 minutes[6]	10 minutes	10 minutes[3]	10 minutes[7]
Moderate Ice Pellets (or Small Hail)[5] Mixed with Freezing Drizzle	10 minutes	7 minutes	**Caution: No allowance times currently exist**	
Moderate Ice Pellets (or Small Hail)[5] Mixed with Rain	10 minutes[8]			

NOTES

1 These allowance times are for use with undiluted (100/0) fluids applied on aircraft with rotation speeds of 100 knots or greater. All Type IV fluids are propylene glycol based with the exception of AllClear ClearWing EG, CHEMCO ChemR EG IV, Clariant Max Flight AVIA, Clariant Safewing EG IV NORTH, Dow EG106, LNT Solutions E450 and Oksayd Defrost EG 4, which are ethylene glycol based.
2 Ensure that the lowest operational use temperature (LOUT) is respected.
3 No allowance times exist for propylene glycol (PG) fluids when used on aircraft with rotation speeds less than 115 knots. If the glycol type is unknown, no allowance times exist for aircraft with rotation speeds of less than 115 knots.
4 No allowance times exist in this condition for temperatures below 0°C; consider use of light ice pellets mixed with freezing rain.
5 If no intensity is reported with small hail, use the "moderate ice pellets or small hail" allowance times. If an intensity is reported with small hail, the ice pellet condition with the equivalent intensity can be used, e.g. if light small hail is reported, the "light ice pellets" allowance times can be used. This also applies in mixed conditions, e.g. if light small hail mixed with snow is reported, use the "light ice pellets mixed with snow" allowance times.
6 Allowance time is 15 minutes for propylene glycol (PG) fluids or when the fluid type is unknown.
7 No allowance times exist for propylene glycol (PG) fluids in this condition for temperatures below -16°C.
8 No allowance times exist in this condition for temperatures below 0°C.

CAUTIONS

- The responsibility for the application of these data remains with the user.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- Allowance time cannot be extended by an inspection of the aircraft critical surfaces.
- Takeoff is allowed up to 90 minutes after start of fluid application if the precipitation stops at or before the allowance time expires and does not restart. The OAT must not decrease during the 90 minutes to use this guidance in conditions of light ice pellets mixed with either: freezing drizzle, freezing rain or rain.

SUPPLEMENTAL GUIDANCE FOR WINTER 2019-2020

TABLE 43: SNOWFALL INTENSITIES AS A FUNCTION OF PREVAILING VISIBILITY[1]

Lighting	Temperature Range		Visibility in Snow in Statute Miles (Metres)			
	°C	°F	Heavy	Moderate	Light	Very Light
Darkness	-1 and above	30 and above	≤1 (≤1600)	>1 to 2½ (>1600 to 4000)	>2½ to 4 (>4000 to 6400)	>4 (>6400)
	Below -1	Below 30	≤3/4 (≤1200)	>3/4 to 1½ (>1200 to 2400)	>1½ to 3 (>2400 to 4800)	>3 (>4800)
Daylight	-1 and above	30 and above	≤½ (≤800)	>½ to 1½ (>800 to 2400)	>1½ to 3 (>2400 to 4800)	>3 (>4800)
	Below -1	Below 30	≤3/8 (≤600)	>3/8 to 7/8 (>600 to 1400)	>7/8 to 2 (>1400 to 3200)	>2 (>3200)

NOTES

1 Based on: *Relationship between Visibility and Snowfall Intensity* (TP 14151E), Transportation Development Centre, Transport Canada, November 2003; and *Theoretical Considerations in the Estimation of Snowfall Rate Using Visibility* (TP 12893E), Transportation Development Centre, Transport Canada, November 1998.

HOW TO READ AND USE THE TABLE

The METAR/SPECI reported visibility or flight crew observed visibility will be used with this visibility table to establish snowfall intensity for Type I, II, III and IV holdover time guidelines, during snow, snow grain, or snow pellet precipitation conditions.

This visibility table will also be used when snow, snow grains or snow pellets are accompanied by blowing or drifting snow in the METAR/SPECI.

RVR values should not be used with this table.

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

In the above METAR the snowfall intensity is reported as light. However, based upon the Transport Canada "Snowfall Intensities as a Function of Prevailing Visibility" table, with a visibility of 1 statute mile, in darkness and a temperature of -6°C, the snowfall intensity is classified as moderate. The snowfall intensity of moderate - not the METAR reported intensity of light - will be used to determine which holdover time guideline value is appropriate for the fluid in use.

TABLE 44:
TYPE I FLUIDS TESTED FOR ANTI-ICING PERFORMANCE AND AERODYNAMIC ACCEPTANCE

(see cautions and notes on page 60)

COMPANY NAME	FLUID NAME	TYPE OF GLYCOL[1]	EXPIRY[2] (Y-M-D)	LOWEST OPERATIONAL USE TEMPERATURE[3]				
				DILUTION[4,5] (FLUID/WATER)	LOW SPEED AERODYNAMIC TEST[6]		HIGH SPEED AERODYNAMIC TEST[6]	
					°C	°F	°C	°F
ABAX Industries	DE-950	PG	22-04-25	71/29	-26	-15	-31	-24
ADDCON EUROPE GmbH	IceFree I.80	PG	21-03-14	70/30	-26	-15	-32	-26
ALAB Industries	WDF 1	EG	22-03-02	70/30	-40	-40	-45	-49
AllClear Systems LLC	Lift-Off E-188	EG	22-05-15	70/30	-40	-40	-41.5	-43
AllClear Systems LLC	Lift-Off P-88	PG	22-05-15	70/30	-24.5	-12	-29.5	-21
Arcton Ltd.	Arctica DG ready-to-use	DEG	22-03-26	as supplied	-26	-15	-26	-15
Arcton Ltd.	*Arctica DG 91 Concentrate*	*DEG*	*17-07-16[9]*	*75/25*	*Not tested[10]*	*Not tested[10]*	*-25*	*-13*
AVIAFLUID International Ltd.	AVIAFLO EG	EG	21-06-19	70/30	-40.5	-41	-44	-47
Aviation Shaanxi Hi-Tech Physical Chemical Co. Ltd.	Cleanwing I	PG	19-09-30	75/25	Not tested[10]	Not tested[10]	-39.5	-39
Aviation Xi'an High-Tech Physical Chemical Co. Ltd.	KHF-1	PG	23-05-24	75/25	Not tested[10]	Not tested[10]	-38.5	-37
Beijing Wangye Aviation Chemical Product Co Ltd.	KLA-1	EG	19-09-08	60/40	Not tested[10]	Not tested[10]	-30.5	-23
Beijing Wangye Aviation Chemical Product Co Ltd.	KLA-1A	EG	22-05-22	60/40	Not tested[10]	Not tested[10]	-32	-26
Beijing Yadilite Aviation Advanced Materials Corporation	YD-101 Type I	PG	21-03-07	60/40	Not tested[10]	Not tested[10]	-30	-22
Beijing Yadilite Aviation Advanced Materials Corporation	YD-101A Type I	EG	21-03-07	70/30	Not tested[10]	Not tested[10]	-38	-36
Boryszew S.A.	*Borygo Plane I*	*PG*	*17-12-04[9]*	*75/25*	*-25*	*-13*	*-30*	*-22*
CHEMCO Inc.	CHEMR EG I	EG	20-04-01	70/30	-37	-35	-43	-45
CHEMCO Inc.	CHEMR REG I	EG	22-05-25	75/25	-36.5	-34	-43.5	-46
Clariant Produkte (Deutschland) GmbH	Octaflo EF Concentrate	PG	22-03-28	65/35	-25	-13	-33	-27
Clariant Produkte (Deutschland) GmbH	*Octaflo EG Concentrate*	*EG*	*17-07-23[9]*	*70/30*	*-40.5*	*-41*	*-44*	*-47*
Clariant Produkte (Deutschland) GmbH	Octaflo LYOD	EG	20-03-16	70/30	-40	-40	-45.5	-50
Clariant Produkte (Deutschland) GmbH	Safewing EG I 1996 (88)	EG	19-10-15	70/30	-39.5	-39	-41.5	-43
Clariant Produkte (Deutschland) GmbH	Safewing MP I 1938 ECO	PG	20-05-11	65/35	-25.5	-14	-32	-26
Clariant Produkte (Deutschland) GmbH	Safewing MP I 1938 ECO (80)	PG	20-05-20	71/29	-25	-13	-32.5	-27
Clariant Produkte (Deutschland) GmbH	Safewing MP I 1938 ECO (80) Premix 55% i.g. ready-to-use	PG	21-02-24	as supplied	Not tested[10]	Not tested[10]	-19	-2

TABLE 44 (CONT'D):
TYPE I FLUIDS TESTED FOR ANTI-ICING PERFORMANCE AND AERODYNAMIC ACCEPTANCE

(see cautions and notes on page 60)

COMPANY NAME	FLUID NAME	TYPE OF GLYCOL[1]	EXPIRY[2] (Y-M-D)	LOWEST OPERATIONAL USE TEMPERATURE[3]				
				DILUTION[4,5] (FLUID/WATER)	LOW SPEED AERODYNAMIC TEST[6]		HIGH SPEED AERODYNAMIC TEST[6]	
					°C	°F	°C	°F
Clariant Produkte (Deutschland) GmbH	Safewing MP I ECO PLUS (80)	PG	23-04-12	71/29	-25	-13	-33	-27
Clariant Produkte (Deutschland) GmbH	Safewing MP I LFD 80	PG	21-04-29	71/29	Not tested[10]	Not tested[10]	-33	-27
Clariant Produkte (Deutschland) GmbH	Safewing MP I LFD 88	PG	23-06-12	65/35	-26	-15	-33	-27
Cryotech Deicing Technology	Polar Plus®	PG	20-01-13	63/37	-27	-17	-32	-26
Cryotech Deicing Technology	Polar Plus® LT	PG	20-01-26	63/37	-27	-17	-33	-27
Cryotech Deicing Technology	Polar Plus® LT (80)	PG	20-04-12	70/30	-27	-17	-33	-27
Cryotech Deicing Technology	*Polar Plus® (80)*	*PG*	*17-09-12[9]*	*70/30*	*-24.5*	*-12*	*-32.5*	*-27*
Dow Chemical Company	UCAR™ ADF Concentrate	EG	23-03-26	75/25	-36	-33	-45	-49
Dow Chemical Company	UCAR™ ADF XL54[16]	EG	23-03-26	as supplied	-33	-27	-33	-27
Dow Chemical Company	UCAR™ PG ADF Concentrate	PG	23-04-16	65/35	-25	-13	-32	-26
Dow Chemical Company	UCAR™ PG ADF Dilute 55/45[17]	PG	23-04-16	as supplied	-24	-11	-25	-13
DR Energy Group LTD.[11]	*Northern Guard I*	*EG*	*17-06-16[9]*	*65/35*	*Not tested[10]*	*Not tested[10]*	*-39.5*	*-39*
Gansu xiexin huineng Science and technology development Co., Ltd.	XHN-1	PG DEG	19-10-04	75/25	Not tested[10]	Not tested[10]	-36	-33
Heilongjiang Hangjie Aero-chemical Technology Co. Ltd.	HJF-1	EG	21-06-14	65/35	Not tested[10]	Not tested[10]	-42	-44
Heilongjiang Hangjie Aero-chemical Technology Co. Ltd.	*HJF-1A*	*EG*	*16-09-02[9]*	*75/25*	*Not tested[10]*	*Not tested[10]*	*-40.5*	*-41*
HOC Industries	SafeTemp® ES Plus	PG	20-04-12	65/35	-25.5	-14	-29	-20
Inland Technologies	DuraGly-E Type I ADF Concentrate	EG	23-02-08	60/40	-33	-27	-33	-27
Inland Technologies	Inland ADF Concentrate[12] (Multiple Location)	EG	Y-M-D[12]	75/25	-36	-33	-42.5	-45
Inland Technologies	SafeTemp® ES Plus (Multiple Location)	PG	Y-M-D[18]	65/35	-25.5	-14	-31	-24
Kilfrost Limited	Kilfrost DF Plus	PG	23-06-18	69/31	-25.5[13]	-14[13]	-32	-26
Kilfrost Limited	Kilfrost DF Plus (80)	PG	20-05-02	69/31	-26	-15	-31.5	-25
Kilfrost Limited	Kilfrost DF Plus (88)	PG	23-06-05	63/37	-25.5[13]	-14[13]	-32	-26
Kilfrost Limited	Kilfrost DF^{Sustain}	NCG	19-08-06	68/32	-34	-29	-41	-42

TABLE 44 (CONT'D):
TYPE I FLUIDS TESTED FOR ANTI-ICING PERFORMANCE AND AERODYNAMIC ACCEPTANCE

(see cautions and notes on page 60)

COMPANY NAME	FLUID NAME	TYPE OF GLYCOL[1]	EXPIRY[2] (Y-M-D)	LOWEST OPERATIONAL USE TEMPERATURE[3]				
				DILUTION[4,5] (FLUID/WATER)	LOW SPEED AERODYNAMIC TEST[6]		HIGH SPEED AERODYNAMIC TEST[6]	
					°C	°F	°C	°F
LNT Solutions	LNT E188	EG	21-08-22	70/30	-30.5	-23	-41	-42
LNT Solutions	LNT P180	PG	22-02-11	69/31	-26	-15	-32	-26
LNT Solutions	*LNT P188*	*PG*	*18-11-28[13]*	*70/30*	*-24.5*	*-12*	*-31.5*	*-25*
Newave Aerochemical Co. Ltd.	FCY-1A	EG	23-04-08	75/25	-40	-40	-40	-40
Newave Aerochemical Co. Ltd.	FCY-1Bio+	EG	20-07-22	75/25	Not tested[10]	Not tested[10]	-40.5	-41
Oksayd Co. Ltd.	DEFROST EG 88.1	EG	21-04-25	70/30	-40.5	-41	-44.5	-48
Oksayd Co. Ltd.	DEFROST PG 1	PG	19-10-18	70/30	-24.5	-12	-31.5	-25
ROMCHIM PROTECT SRL	ADD-PROTECT Type I	PG	20-12-12	70/30	-25.5	-14	-31	-24
Shaanxi Cleanway Aviation Chemical Co., Ltd	Cleansurface I	EG	21-08-22	75/25	Not tested[10]	Not tested[10]	-40.5	-41
Shaanxi Cleanway Aviation Chemical Co., Ltd	Cleansurface I-BIO	EG	22-05-02	75/25	Not tested[10]	Not tested[10]	-37	-35
Velvana a.s.[11]	*AIRVEL OK 1*	*PG*	*17-01-28[9]*	*70/30*	*-26*	*-15*	*-30*	*-22*
Xinjiang Zhongtian	*Clearice-I Type I*	*EG*	*19-05-24[13]*	*60/40*	*Not tested[10]*	*Not tested[10]*	*-30*	*-22*

TABLE 45:
TYPE II FLUIDS TESTED FOR ANTI-ICING PERFORMANCE AND AERODYNAMIC ACCEPTANCE

(see cautions and notes on page 60)

COMPANY NAME	FLUID NAME	TYPE OF GLYCOL[1]	EXPIRY[2] (Y-M-D)	DILUTION (FLUID/WATER)	LOWEST OPERATIONAL USE TEMPERATURE[3]		LOWEST ON-WING VISCOSITY[7,8] (mPa.s)	
					HIGH SPEED AERODYNAMIC TEST[6]		MANUFACTURER METHOD	AS 9968 METHOD
					°C	°F		
ABAX Industries	*ECOWING 26*	*PG*	*17-04-28[9]*	*100/0*	*-25*	*-13*	*4 900 (f)*	*4 600 (a)*
				75/25	*-14*	*7*	*2 200 (a)*	*2 200 (a)*
				50/50	*-4*	*25*	*50 (a)*	*50 (a)*
ABAX Industries	ECOWING AD-2	PG	21-03-28	100/0	-27	-17	5 750 (a)	5 750 (a)
				75/25	-15	5	12 000 (c)	12 000 (c)
				50/50	-3	27	7 500 (a)	7 500 (a)
Aviation Shaanxi Hi-Tech Physical Chemical Co. Ltd.	Cleanwing II	PG	21-05-22	100/0	-25	-13	4 650 (d)	4 500 (a)
				75/25	-15	5	9 450 (d)	10 000 (a)
				50/50	-4.5	24	10 150 (d)	10 200 (a)
Beijing Yadilite Aviation Advanced Materials Corporation	*YD-102 Type II*	*PG*	*18-02-26[9]*	*100/0*	*-29*	*-20*	*4 500 (a)*	*4 500 (a)*
				75/25	*-14*	*7*	*12 850 (a)*	*12 850 (a)*
				50/50	*-3*	*27*	*820 (a)*	*300 (l)*
Clariant Produkte (Deutschland) GmbH	Safewing MP II FLIGHT	PG	20-02-20	100/0	-29	-20	3 340 (a)	3 340 (a)
				75/25	-14	7	12 900 (c)	12 900 (c)
				50/50	-3.5	26	11 500 (a)	11 500 (a)
Clariant Produkte (Deutschland) GmbH	Safewing MP II FLIGHT PLUS	PG	20-02-26	100/0	-29	-20	3 650 (m)	3 100 (a)
				75/25	-14.5	6	12 400 (m)	10 450 (a)
				50/50	-4	25	7 800 (m)	7 050 (a)
Cryotech Deicing Technology	Polar Guard® II	PG	21-03-21	100/0	-30.5	-23	4 400 (e)	4 050 (a)
				75/25	-14	7	11 600 (e)	9 750 (a)
				50/50	-3.5	26	80 (a)	80 (a)
Kilfrost Limited	ABC-K Plus	PG	20-12-20	100/0	-29	-20	2 850 (d)	2 640 (a)
				75/25	-14.5	6	12 650 (d)	12 650 (c)
				50/50	-3.5	26	4 200 (d)	5 260 (a)
Kilfrost Limited	Ice Clear II	PG	20-06-20	100/0	-24	-11	8 450 (a)	8 450 (a)
				75/25	Dilution Not Applicable		Dilution Not Applicable	
				50/50	Dilution Not Applicable		Dilution Not Applicable	
Newave Aerochemical Co. Ltd.	FCY-2	PG	21-05-13	100/0	-28	-18	7 000 (d)	8 920 (a)
				75/25	-14.5	6	18 550 (d)	18 550 (c)
				50/50	-4.5	24	6 750 (d)	7 030 (a)

TABLE 45 (CONT'D):
TYPE II FLUIDS TESTED FOR ANTI-ICING PERFORMANCE AND AERODYNAMIC ACCEPTANCE

(see cautions and notes on page 60)

COMPANY NAME	FLUID NAME	TYPE OF GLYCOL[1]	EXPIRY[2] (Y-M-D)	DILUTION (FLUID/WATER)	LOWEST OPERATIONAL USE TEMPERATURE[3]		LOWEST ON-WING VISCOSITY[7,8] (mPa.s)	
					HIGH SPEED AERODYNAMIC TEST[6]		MANUFACTURER METHOD	AS 9968 METHOD
					°C	°F		
Newave Aerochemical Co. Ltd.	*FCY-2 Bio+*	*PG*	*19-04-10[13]*	*100/0*	*-28.5*	*-19*	*7 210 (a)*	*7 210 (a)*
				75/25	*-14*	*7*	*21 400 (c)*	*21 400 (c)*
				50/50	*-3*	*27*	*1 900 (a)*	*1 900 (a)*
Oksayd Co. Ltd.	Defrost PG 2	PG	20-06-27	100/0	-27	-17	4 450 (a)	4 450 (a)
				75/25	-16	3	8 000 (a)	8 000 (a)
				50/50	-4	25	17 900 (g)	25 400 (c)
ROMCHIM PROTECT SRL	ADD-PROTECT Type II	PG	21-01-18	100/0	-28	-18	4 000 (a)	4 000 (a)
				75/25	-14	7	7 700 (a)	7 700 (a)
				50/50	-3	27	14 500 (a)	14 500 (a)

TABLE 46:
TYPE III FLUIDS TESTED FOR ANTI-ICING PERFORMANCE AND AERODYNAMIC ACCEPTANCE

(see cautions and notes on page 60)

COMPANY NAME	FLUID NAME	TYPE OF GLYCOL[1]	EXPIRY[2] (Y-M-D)	DILUTION (FLUID/WATER)	LOWEST OPERATIONAL USE TEMPERATURE[3]				LOWEST ON-WING VISCOSITY[7,8] (mPa.s)	
					LOW SPEED AERODYNAMIC TEST[6]		HIGH SPEED AERODYNAMIC TEST[6]		MANUFACTURER METHOD	AS 9968 METHOD
					°C	°F	°C	°F		
AllClear Systems LLC	AeroClear MAX	EG	21-02-25	100/0	-16	3	-35	-31	7 800 (k)	Not Available[15]
				75/25	Dilution Not Applicable		Dilution Not Applicable		Dilution Not Applicable	
				50/50	Dilution Not Applicable		Dilution Not Applicable		Dilution Not Applicable	

TABLE 47:
TYPE IV FLUIDS TESTED FOR ANTI-ICING PERFORMANCE AND AERODYNAMIC ACCEPTANCE

(see cautions and notes on page 60)

Company Name	Fluid Name	Type of Glycol[1]	Expiry[2] (Y-M-D)	Dilution (fluid/water)	Lowest Operational Use Temperature[3]		Lowest On-Wing Viscosity[7,8] (mPa.s)	
					High Speed Aerodynamic Test[6]		Manufacturer Method	AS 9968 Method
					°C	°F		
ABAX Industries	ECOWING AD-49	PG	20-04-25	100/0	-26	-15	12 150 (g)	11 000 (a)
				75/25	Dilution Not Applicable		Dilution Not Applicable	
				50/50	Dilution Not Applicable		Dilution Not Applicable	
AllClear Systems LLC	ClearWing EG	EG	21-01-31	100/0	-29	-20	35 500 (j)	13 350 (a)
				75/25	Dilution Not Applicable		Dilution Not Applicable	
				50/50	Dilution Not Applicable		Dilution Not Applicable	
CHEMCO Inc.	ChemR EG IV	EG	21-04-02	100/0	-27	-17	46 400 (i)	19 450 (c)
				75/25	Dilution Not Applicable		Dilution Not Applicable	
				50/50	Dilution Not Applicable		Dilution Not Applicable	
Clariant Produkte (Deutschland) GmbH	*Max Flight 04*	*PG*	*16-07-23*[9]	*100/0*	*-23.5*	*-10*	*5 540 (b)*	*5 540 (a)*
				75/25	*Dilution Not Applicable*		*Dilution Not Applicable*	
				50/50	*Dilution Not Applicable*		*Dilution Not Applicable*	
Clariant Produkte (Deutschland) GmbH	Max Flight AVIA	EG	20-06-06	100/0	-28.5	-19	1 000 (l)	1 000 (l)
				75/25	Dilution Not Applicable		Dilution Not Applicable	
				50/50	Dilution Not Applicable		Dilution Not Applicable	
Clariant Produkte (Deutschland) GmbH	Max Flight SNEG	PG	20-05-25	100/0	-29	-20	8 700 (n)	8 050 (a)
				75/25	-14	7	20 200 (o)	21 800 (c)
				50/50	-3	27	13 600(o)	15 000 (c)
Clariant Produkte (Deutschland) GmbH	Safewing EG IV NORTH	EG	20-07-13	100/0	-30	-22	830 (l)	830 (l)
				75/25	Dilution Not Applicable		Dilution Not Applicable	
				50/50	Dilution Not Applicable		Dilution Not Applicable	
Clariant Produkte (Deutschland) GmbH	Safewing MP IV LAUNCH	PG	20-03-07	100/0	-28.5	-19	7 550 (a)	7 550 (a)
				75/25	-14	7	18 000 (a)	18 000 (a)
				50/50	-3.5	26	17 800 (a)	17 800 (a)
Clariant Produkte (Deutschland) GmbH	Safewing MP IV LAUNCH PLUS	PG	21-04-01	100/0	-29	-20	8 700 (n)	8 450 (a)
				75/25	-14	7	18 800 (o)	17 200 (c)
				50/50	-3.5	26	9 700 (n)	12 150 (a)
Cryotech Deicing Technology	Polar Guard® Advance	PG	21-01-31	100/0	-30.5	-23	4 400 (e)	4 050 (a)
				75/25	-14	7	11 600 (e)	9 750 (a)
				50/50	-3.5	26	80 (a)	80 (a)

TABLE 47 (CONT'D):
TYPE IV FLUIDS TESTED FOR ANTI-ICING PERFORMANCE AND AERODYNAMIC ACCEPTANCE

(see cautions and notes on page 60)

Company Name	Fluid Name	Type of Glycol[1]	Expiry[2] (Y-M-D)	Dilution (fluid/water)	Lowest Operational Use Temperature[3]		Lowest On-Wing Viscosity[7,8] (mPa.s)	
					High Speed Aerodynamic Test[6]		Manufacturer Method	AS 9968 Method
					°C	°F		
Cryotech Deicing Technology	Polar Guard® Xtend	PG	21-05-15	100/0	-29	-20	6 000 (e)	6 350 (a)
				75/25	Dilution Not Applicable		Dilution Not Applicable	
				50/50	Dilution Not Applicable		Dilution Not Applicable	
Dow Chemical Company	UCAR™ Endurance EG106 De/Anti-Icing Fluid	EG	21-03-01	100/0	-29	-20	24 850 (h)	2 230 (a)
				75/25	Dilution Not Applicable		Dilution Not Applicable	
				50/50	Dilution Not Applicable		Dilution Not Applicable	
Dow Chemical Company	UCAR™ FlightGuard AD-49	PG	21-04-25	100/0	-26	-15	12 150 (g)	11 000 (a)
				75/25	Dilution Not Applicable		Dilution Not Applicable	
				50/50	Dilution Not Applicable		Dilution Not Applicable	
Inland Technologies	*ECO-SHIELD®*	*PG*	20-08-16	*100/0*	*-25.5*	*-14*	*11 050 (a)*	*11 050 (a)*
				75/25	*Dilution Not Applicable*		*Dilution Not Applicable*	
				50/50	*Dilution Not Applicable*		*Dilution Not Applicable*	
Kilfrost Limited	ABC-S Plus	PG	21-06-07	100/0	-28	-18	17 900 (d)	17 900 (c)
				75/25	-14.5	6	18 300 (d)	18 300 (c)
				50/50	-3.5	26	7 500 (d)	7 500 (a)
LNT Solutions	*LNT E450*	*EG*	*17-07-29*[13]	*100/0*	*-22.5*	*-9*	*45 300 (i)*	*Not Available*[15]
				75/25	*Dilution Not Applicable*		*Dilution Not Applicable*	
				50/50	*Dilution Not Applicable*		*Dilution Not Applicable*	
Newave Aerochemical Co. Ltd.	FCY 9311	PG	20-01-23	100/0	-29.5	-21	14 100 (c)	14 100 (c)
				75/25	Dilution Not Applicable		Dilution Not Applicable	
				50/50	Dilution Not Applicable		Dilution Not Applicable	
Oksayd Co. Ltd.	Defrost ECO 4	PG	21-05-24	100/0	-25.5	-14	9 800 (g)	12 350 (a)
				75/25	Dilution Not Applicable		Dilution Not Applicable	
				50/50	Dilution Not Applicable		Dilution Not Applicable	
Oksayd Co. Ltd.	Defrost EG 4	EG	20-05-17	100/0	-26	-15	12 000 (g)	12 950 (a)
				75/25	Dilution Not Applicable		Dilution Not Applicable	
				50/50	Dilution Not Applicable		Dilution Not Applicable	
Shaanxi Cleanway Aviation Chemical Co., Ltd	*Cleansurface IV*	*PG*	*19-02-24*[9]	*100/0*	*-28.5*	*-19*	*15 200 (c)*	*15 200 (c)*
				75/25	*-19*	*-2*	*28 500 (c)*	*28 500 (c)*
				50/50	*-6.5*	*20*	*17 500 (c)*	*17 500 (c)*

CAUTIONS AND NOTES FOR TABLES 44, 45, 46, 47

CAUTIONS

- These tables list fluids that have been tested with respect to endurance time performance (Holdover Times), anti-icing performance (Water Spray Endurance Testing/High Humidity Endurance Testing) and aerodynamic acceptance (Type I: SAE ARP6207 §3.4.1, AMS1424 §3.5.2 and §3.5.3; Type II/ III/ IV: SAE ARP5718 §FOREWARD, AMS1428 §3.2.4 and §3.2.5) only. These tests were conducted by APS Aviation Inc. (www.apsaviation.ca) and Anti-icing Materials International Laboratory (AMIL) (www.uqac.ca/amil). The end user is responsible for contacting the fluid manufacturer to confirm all other SAE AMS1424/1428 technical requirement tests, such as fluid stability, toxicity, materials compatibility, etc. have been conducted. These technical requirement tests are typically conducted by Scientific Material International (SMI) (www.smiinc.com) and AMIL, or any acceptable source.
- LOUT data provided in these tables is based strictly on the manufacturer's data; the end user is responsible for verifying the validity of this data.
- Type I fluids supplied in concentrated form must not be used in that form and must be diluted.

NOTES

1 PG = conventional glycol (propylene glycol); EG = conventional glycol (ethylene glycol); DEG = conventional glycol (diethylene glycol); NCG = non-conventional glycol (organic non-ionic diols and triols, e.g. 1,3-propanediol, glycerine) and mixtures of non-conventional glycol and conventional glycol; NG = non-glycol (e.g. organic salts) and mixtures of non-glycol and glycol.

2 Expiry date is the earlier expiry date of the Aerodynamic Test(s) or Water Spray Endurance Test. Fluids that are tested after the issuance of this list will appear in a later update.

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

a) The lowest temperature at which the fluid meets the aerodynamic acceptance test for a given aircraft type; or
b) The actual freezing point of the fluid plus its freezing point buffer (Type I = 10 °C/18 °F; Type II/III/IV = 7 °C/13 °F).

Note: LOUTs are rounded to the nearest half degree Celsius and the values in degrees Fahrenheit are calculated to the nearest whole degree.

4 The LOUT for Type I fluids that are intended to be diluted is derived from a dilution that provides the lowest operational use temperature. For other Type I dilutions, determine the freezing point of the fluid and add a 10 °C freezing point buffer, as a dilution will usually yield a higher and more restrictive operational use temperature. Consult the fluid manufacturer or fluid documentation for further clarification and guidance on establishing the appropriate operational use temperature of a diluted fluid.

5 Type I concentrate fluids have also been tested at 50/50 (glycol/water) dilution.

6 If uncertain whether the aircraft to be treated conforms to the low speed or the high speed aerodynamic test, consult the aircraft manufacturer. The aerodynamic test is defined in SAE AS5900 (latest version).

7 The viscosity values in this table are those of the fluids provided by the manufacturers for holdover time testing. For the holdover times to be valid, the viscosity of the fluid on the wing shall not be lower than that in this table. The user should periodically ensure that the viscosity of a fluid sample taken from the wing surface is not lower than that listed.

8 The SAE AS9968 viscosity method should only be used for field verification and auditing purposes; when in doubt as to which method is appropriate, use the manufacturer method. Viscosity measurement methods are indicated as letters (in parentheses) beside each viscosity value. Details of each measurement method are shown in the table below. The exact measurement method (spindle, container, fluid volume, temperature, speed, duration) must be used to compare the viscosity of a sample to a viscosity given in this table.

Method	Brookfield Spindle*	Container	Fluid Volume	Temp.**	Speed	Duration
a	LV1 (with guard leg)	600 mL low form (Griffin) beaker	575 mL***	20 °C	0.3 rpm	10.0 minutes
b	LV1 (with guard leg)	600 mL low form (Griffin) beaker	575 mL***	20 °C	0.3 rpm	33.3 minutes
c	LV2-disc (with guard leg)	600 mL low form (Griffin) beaker	425 mL***	20 °C	0.3 rpm	10.0 minutes
d	LV2-disc (with guard leg)	150 mL tall form (Berzelius) beaker	135 mL***	20 °C	0.3 rpm	10.0 minutes
e	SC4-34/13R	small sample adapter	10 mL	20 °C	0.3 rpm	10.0 minutes
f	SC4-34/13R	small sample adapter	10 mL	20 °C	0.3 rpm	30.0 minutes
g	SC4-31/13R	small sample adapter	10 mL	20 °C	0.3 rpm	10.0 minutes
h	SC4-31/13R	small sample adapter	10 mL	0 °C	0.3 rpm	10.0 minutes
i	SC4-31/13R	small sample adapter	9 mL	0 °C	0.3 rpm	10.0 minutes
j	SC4-31/13R	small sample adapter	9 mL	0 °C	0.3 rpm	30.0 minutes
k	SC4-31/13R	small sample adapter	9 mL	0 °C	0.3 rpm	65.0 minutes
l	LV0	ultra low adapter	16 mL	20 °C	0.3 rpm	10.0 minutes
m	LV1	big sample adapter	50 mL	20 °C	0.3 rpm	10.0 minutes
n	LV1	big sample adapter	55 mL	20 °C	0.3 rpm	10.0 minutes
o	LV2-disc	big sample adapter	60 mL	20 °C	0.3 rpm	10.0 minutes

* Spindle must be attached to a Brookfield viscometer model equipped with an LV spring.
** Sample temperature will affect readings; ensure sufficient time is allowed for sample to reach thermal equilibrium before starting test. Use of a cooling bath strongly recommended.
*** If necessary, adjust fluid volume to ensure fluid is level with notch on the spindle shaft.

9 Fluids listed in italics have expired and will be removed from this listing four years after expiry.

10 Manufacturer has indicated fluid was not tested.

11 Manufacturer has not provided fluid information as required in SAE ARP5718A; fluid may be removed from this listing in subsequent revisions.

12 Dow UCAR™ ADF Concentrate, sold under the product name Inland ADF Concentrate, qualified from 2015-09-04.

13 Currently in the test/re-test process.

14 Fluid was not retested for low speed aerodynamics. This data will be removed four years after the expiry of the last low speed test.

15 Measurements using the SAE AS9968 method do not provide stable, reliable results. Use the manufacturer method to evaluate viscosity.

16 For UCAR™ ADF XL54, refer to primary site qualification of UCAR™ ADF Concentrate.

17 For UCAR™ PG ADF Dilute 55/45, refer to primary site qualification of UCAR™ PG ADF Concentrate.

18 Refer to preproduction qualification of SafeTemp® ES Plus submitted by HOC Industries, qualified from 2017-11-20.

TABLE 48: GUIDELINES FOR THE APPLICATION OF SAE TYPE I FLUID

Outside Air Temperature (OAT)[1]	One-Step Procedure De/Anti-icing	Two-Step Procedure	
		First Step: Deicing	Second Step: Anti-icing[2]
0°C (32°F) and above	Heated mix of fluid and water with a freezing point of at least 10°C (18°F) below OAT	Heated water or a heated fluid/water mixture	Heated mix of fluid and water with a freezing point of at least 10°C (18°F) below OAT
Below 0°C (32°F) to LOUT		Heated fluid/water mixture with a freezing point at OAT or below	

NOTES

1 Fluids must not be used at temperatures below their lowest operational use temperature (LOUT).
2 To be applied before first step fluid freezes, typically within 3 minutes. (This time may be higher than 3 minutes in some conditions, but potentially lower in heavy precipitation, colder temperatures, or for critical surfaces constructed of composite materials. If necessary, the second step shall be applied area by area.)

CAUTIONS

- This table is applicable for the use of Type I holdover time guidelines in all conditions, including active frost. If holdover times are not required, a temperature of 60°C (140°F) at the nozzle is desirable.
- If holdover times are required, the temperature of water or fluid/water mixtures shall be at least 60°C (140°F) at the nozzle. Upper temperature limit shall not exceed fluid and aircraft manufacturers' recommendations.
- To use Type I Holdover Times Guidelines in all conditions including active frost, an additional minimum of 1 litre/m^2 (~2 gal./100 sq. ft.) of heated Type I fluid mixture must be applied to the surfaces after all frozen contamination is removed. This application is necessary to heat the surfaces, as heat contributes significantly to the Type I fluid holdover times. The required protection can be provided using a 1-step method by applying more fluid than is strictly needed to just remove all of the frozen contamination (the same additional amount stated above is required).
- The lowest operational use temperature (LOUT) for a given Type I fluid is the higher (warmer) of:
  a) The lowest temperature at which the fluid meets the aerodynamic acceptance test for a given aircraft type; or
  b) The actual freezing point of the fluid plus its freezing point buffer of 10°C (18°F).
- Wing skin temperatures may differ and in some cases may be lower than the OAT. A stronger mix (more glycol) may be needed under these conditions.

TABLE 49: GUIDELINES FOR THE APPLICATION OF SAE TYPE II AND IV FLUID

(FLUID CONCENTRATIONS IN % VOLUME)

Outside Air Temperature (OAT)[1]	One-Step Procedure De/Anti-icing	Two-Step Procedure	
		First Step: Deicing	Second Step: Anti-icing[2]
0°C (32°F) and above	100/0, 75/25 or 50/50 Heated[3] Type II or IV fluid/water mixture	Heated water or a heated Type I, II, III, or IV fluid/water mixture	100/0, 75/25 or 50/50 Heated or unheated Type II or IV fluid/water mixture
Below 0°C (32°F) to -3°C (27°F)	100/0, 75/25 or 50/50 Heated[3] Type II or IV fluid/water mixture	Heated Type I, II, III, or IV fluid/water mixture with a freezing point at OAT or below	100/0, 75/25 or 50/50 Heated or unheated Type II or IV fluid/water mixture
Below -3°C (27°F) to -14°C (7°F)	100/0 or 75/25 Heated[3] Type II or IV fluid/water mixture	Heated Type I, II, III, or IV fluid/water mixture with a freezing point at OAT or below	100/0 or 75/25 Heated or unheated Type II or IV fluid/water mixture
Below -14°C (7°F) to LOUT	100/0 Heated[3] Type II or IV fluid/water mixture	Heated Type I, II, III, or IV fluid/water mixture with a freezing point at OAT or below	100/0 Heated or unheated Type II or IV fluid/water mixture

NOTES

1 One step or second step fluids must not be used at temperatures below their lowest operational use temperature (LOUT). First step fluids must not be used below their freezing points. Consideration should be given to the use of Type I/III fluid when Type II/IV fluid cannot be used due to LOUT limitations (see Table 48 and 50). The LOUT for a given Type II/IV fluid is the higher (warmer) of:

a) The lowest temperature at which the fluid meets the aerodynamic acceptance test for a given aircraft type; or
b) The actual freezing point of the fluid plus its freezing point buffer of 7°C (13°F).

Although some LOUTs are lower than the temperatures stated in the HOT table, holdover times do not apply when anti-icing below the lowest temperature stated in the band.

2 To be applied before first step fluid freezes, typically within 3 minutes. (This time may be longer than 3 minutes in some conditions, but potentially shorter in heavy precipitation, in colder temperatures, or for critical surfaces constructed of composite materials. If necessary, the second step shall be applied area by area.)

3 Clean aircraft may be anti-iced with unheated fluid.

CAUTIONS

- For heated fluids, a fluid temperature not less than 60°C (140°F) at the nozzle is desirable.
- Upper temperature limit shall not exceed fluid and aircraft manufacturers' recommendations.
- Wing skin temperatures may differ and in some cases may be lower than the OAT. A stronger mix (more glycol) may be needed under these conditions.
- Whenever frost or ice occurs on the lower surface of the wing in the area of the fuel tank, indicating a cold soaked wing, the 50/50 dilutions of Type II or IV shall not be used for the anti-icing step because fluid freezing may occur.
- An insufficient amount of anti-icing fluid may cause a substantial loss of holdover time. This is particularly true when using a Type I fluid mixture for the first step in a two-step procedure.

TABLE 50: GUIDELINES FOR THE APPLICATION OF UNHEATED SAE TYPE III FLUID

(FLUID CONCENTRATIONS IN % VOLUME)

Outside Air Temperature (OAT)[1]	One-Step Procedure Anti-icing Only[4]	Two-Step Procedure	
		First Step: Deicing	Second Step: Anti-icing[2]
0°C (32°F) and above	100/0, 75/25 or 50/50 Unheated Type III fluid/water mixture	Heated[3] water or a heated[3] Type I, II, III, or IV fluid/water mixture	100/0, 75/25 or 50/50 Unheated Type III fluid/water mixture
Below 0°C (32°F) to -3°C (27°F)	100/0, 75/25 or 50/50 Unheated Type III fluid/water mixture	Heated[3] Type I, II, III, or IV fluid/water mixture with a freezing point at OAT or below	100/0, 75/25 or 50/50 Unheated Type III fluid/water mixture
Below -3°C (27°F) to -10°C (14°F)	100/0 or 75/25 Unheated Type III fluid/water mixture	Heated[3] Type I, II, III, or IV fluid/water mixture with a freezing point at OAT or below	100/0 or 75/25 Unheated Type III fluid/water mixture
Below -10°C (14°F) to LOUT	100/0 Unheated Type III fluid/water mixture	Heated[3] Type I, II, III, or IV fluid/water mixture with a freezing point at OAT or below	100/0 Unheated Type III fluid/water mixture

NOTES

1 One step or second step fluids must not be used at temperatures below their lowest operational use temperature (LOUT). First step fluids must not be used below their freezing points. Consider the use of Type I when Type III fluid cannot be used (see Table 48). The LOUT for a given Type III fluid is the higher (warmer) of:

   a) The lowest temperature at which the fluid meets the aerodynamic acceptance test for a given aircraft type; or
   b) The actual freezing point of the fluid plus its freezing point buffer of 7°C (13°F).

   Although the LOUTs may be lower than the temperatures stated in the HOT table, holdover times do not apply when anti-icing below the lowest temperature stated in the band.

2 To be applied before first step fluid freezes, typically within 3 minutes. (This time may be longer than 3 minutes in some conditions, but potentially shorter in heavy precipitation, in colder temperatures, or for critical surfaces constructed of composite materials. If necessary, the second step shall be applied area by area.)

3 For heated fluids, a fluid temperature not less than 60°C (140°F) at the nozzle is desirable.

4 One-step procedure with unheated Type III fluid is only possible on a clean aircraft. If deicing is required, a two-step procedure must be used.

CAUTIONS

- Upper temperature limit shall not exceed fluid and aircraft manufacturers' recommendations.
- Wing skin temperatures may differ and in some cases may be lower than the OAT. A stronger mix (more glycol) may be needed under these conditions.
- Whenever frost or ice occurs on the lower surface of the wing in the area of the fuel tank, indicating a cold soaked wing, the 50/50 dilutions of Type III shall not be used for the anti-icing step because fluid freezing may occur.
- An insufficient amount of anti-icing fluid may cause a substantial loss of holdover time. This is particularly true when using a Type I fluid mixture for the first step in a two-step procedure.

APPENDIX A:
ADJUSTED HOLDOVER TIME (HOT) GUIDELINES

These tables are for use when flaps/slats are deployed prior to de/anti-icing. Holdover and allowance times have been adjusted to 76 percent of standard times. Standard holdover and allowance times can be used if flaps and slats are deployed as close to departure as safety allows.

Appendix A: Transport Canada Adjusted HOT Guidelines Winter 2019-2020

ADJUSTED HOLDOVER TIME (HOT) GUIDELINES FOR WINTER 2019-2020

Table ADJ-1: Adjusted Active Frost Holdover Times for SAE Type I, Type II, Type III, and Type IV Fluids A-3
Table ADJ-2: Adjusted Holdover Times for SAE Type I Fluid on Critical Aircraft Surfaces Composed Predominantly of Aluminum A-4
Table ADJ-3: Adjusted Holdover Times for SAE Type I Fluid on Critical Aircraft Surfaces Composed Predominantly of Composites A-5
Table ADJ-4: Adjusted Generic Holdover Times for SAE Type II Fluids A-6
Table ADJ-5: Adjusted Type II Holdover Times for ABAX ECOWING 26 ..... A-7
Table ADJ-6: Adjusted Type II Holdover Times for ABAX ECOWING AD-2 ..... A-8
Table ADJ-7: Adjusted Type II Holdover Times for Aviation Shaanxi Hi-Tech Cleanwing II A-9
Table ADJ-8: Adjusted Type II Holdover Times for Beijing Yadilite Aviation YD-102 Type II A-10
Table ADJ-9: Adjusted Type II Holdover Times for Clariant Safewing MP II FLIGHT A-11
Table ADJ-10: Adjusted Type II Holdover Times for Clariant Safewing MP II FLIGHT PLUS A-12
Table ADJ-11: Adjusted Type II Holdover Times for Cryotech Polar Guard® II A-13
Table ADJ-12: Adjusted Type II Holdover Times for Kilfrost ABC-K Plus A-14
Table ADJ-13: Adjusted Type II Holdover Times for Kilfrost Ice Clear II A-15
Table ADJ-14: Adjusted Type II Holdover Times for Newave Aerochemical FCY-2 ..... A-16
Table ADJ-15: Adjusted Type II Holdover Times for Newave Aerochemical FCY-2 Bio+ A-17
Table ADJ-16: Adjusted Type II Holdover Times for Oksayd Defrost PG 2 ..... A-18
Table ADJ-17: Adjusted Type II Holdover Times for ROMCHIM ADD-PROTECT Type II A-19
Table ADJ-18: Adjusted Type III Holdover Times for AllClear AeroClear MAX Applied Unheated on Low Speed Aircraft A-20
Table ADJ-19: Adjusted Type III Holdover Times for AllClear AeroClear MAX Applied Unheated on High Speed Aircraft A-21
Table ADJ-20: Adjusted Generic Holdover Times for SAE Type IV Fluids A-22
Table ADJ-21: Adjusted Type IV Holdover Times for ABAX ECOWING AD-49 ..... A-23
Table ADJ-22: Adjusted Type IV Holdover Times for AllClear ClearWing EG A-24
Table ADJ-23: Adjusted Type IV Holdover Times for CHEMCO ChemR EG IV A-25
Table ADJ-24: Adjusted Type IV Holdover Times for Clariant Max Flight 04 ..... A-26
Table ADJ-25: Adjusted Type IV Holdover Times for Clariant Max Flight AVIA A-27
Table ADJ-26: Adjusted Type IV Holdover Times for Clariant Max Flight SNEG A-28
Table ADJ-27: Adjusted Type IV Holdover Times for Clariant Safewing EG IV NORTH A-29
Table ADJ-28: Adjusted Type IV Holdover Times for Clariant Safewing MP IV LAUNCH A-30
Table ADJ-29: Adjusted Type IV Holdover Times for Clariant Safewing MP IV LAUNCH PLUS A-31
Table ADJ-30: Adjusted Type IV Holdover Times for Cryotech Polar Guard® Advance A-32
Table ADJ-31: Adjusted Type IV Holdover Times for Cryotech Polar Guard® Xtend A-33
Table ADJ-32: Adjusted Type IV Holdover Times for Dow Chemical UCAR™ Endurance EG106 ..... A-34
Table ADJ-33: Adjusted Type IV Holdover Times for Dow Chemical UCAR™ FlightGuard AD-49 ..... A-35
Table ADJ-34: Adjusted Type IV Holdover Times for Inland Technologies ECO-SHIELD® A-36
Table ADJ-35: Adjusted Type IV Holdover Times for Kilfrost ABC-S Plus A-37
Table ADJ-36: Adjusted Type IV Holdover Times for LNT Solutions E450 ..... A-38
Table ADJ-37: Adjusted Type IV Holdover Times for Newave Aerochemical FCY 9311 ..... A-39
Table ADJ-38: Adjusted Type IV Holdover Times for Oksayd Defrost ECO 4 ..... A-40
Table ADJ-39: Adjusted Type IV Holdover Times for Oksayd Defrost EG 4 ..... A-41
Table ADJ-40: Adjusted Type IV Holdover Times for Shaanxi Cleanway Aviation Cleansurface IV A-42
Table ADJ-41: Adjusted Allowance Times for SAE Type III Fluids A-43
Table ADJ-42: Adjusted Allowance Times for SAE Type IV Fluids A-44

Appendix A: Transport Canada Adjusted HOT Guidelines — Winter 2019-2020

TABLE ADJ-1: ADJUSTED ACTIVE FROST HOLDOVER TIMES FOR SAE TYPE I, TYPE II, TYPE III, AND TYPE IV FLUIDS

Outside Air Temperature[1,2,3]	Type I
-1°C and above (30°F and above)	0:34 *(0:26)*[5]
below -1 to -3°C (below 30 to 27°F)	
below -3 to -10°C (below 27 to 14°F)	
below -10 to -14°C (below 14 to 7°F)	
below -14 to -21°C (below 7 to -6°F)	
below -21 to -25°C (below -6 to -13°F)	
below -25°C to LOUT (below -13°F to LOUT)	

Outside Air Temperature[2,3]	Concentration Fluid/Water By % Volume	Type II	Type III[4]	Type IV
-1°C and above (30°F and above)	100/0	6:04	1:31	9:07
	75/25	3:48	0:45	3:48
	50/50	2:16	0:22	2:16
below -1 to -3°C (below 30 to 27°F)	100/0	6:04	1:31	9:07
	75/25	3:48	0:45	3:48
	50/50	1:08	0:22	2:16
below -3 to -10°C (below 27 to 14°F)	100/0	6:04	1:31	7:36
	75/25	3:48	0:45	3:48
below -10 to -14°C (below 14 to 7°F)	100/0	4:33	1:31	4:33
	75/25	0:45	0:45	0:45
below -14 to -21°C (below 7 to -6°F)	100/0	4:33	1:31	4:33
below -21 to -25°C (below -6 to -13°F)	100/0	1:31	1:31	3:02
below -25°C (below -13°F)	100/0	No Holdover Time Guidelines Exist		

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Type I fluid / water mixture must be selected so that the freezing point of the mixture is at least 10°C (18°F) below outside air temperature.
2 Ensure that the lowest operational use temperature (LOUT) is respected.
3 Changes in outside air temperature (OAT) over the course of longer frost events can be significant; the appropriate holdover time to use is the one provided for the coldest OAT that has occurred in the time between the de/anti-icing fluid application and takeoff.
4 To use the Type III fluid frost holdover times, the fluid brand being used must be known. AllClear AeroClear MAX must be applied unheated.
5 Value in parentheses is for aircraft with critical surfaces that are predominantly or entirely constructed of composite materials.

CAUTIONS

- The responsibility for the application of these data remains with the user.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

Appendix A: Transport Canada Adjusted HOT Guidelines — Winter 2019-2020

TABLE ADJ-2: ADJUSTED HOLDOVER TIMES FOR SAE TYPE I FLUID ON CRITICAL AIRCRAFT SURFACES COMPOSED PREDOMINANTLY OF ALUMINUM

Outside Air Temperature[1,2]	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[3,4]	Light Snow, Snow Grains or Snow Pellets[3,4]	Moderate Snow, Snow Grains or Snow Pellets[3]	Freezing Drizzle[5]	Light Freezing Rain	Rain on Cold Soaked Wing[6]	Other[7]
-3°C and above (27°F and above)	0:08 - 0:13	0:14	0:08 - 0:14	0:05 - 0:08	0:07 - 0:10	0:03 - 0:05	0:02 - 0:04	
below -3 to -6°C (below 27 to 21°F)	0:06 - 0:10	0:11	0:06 - 0:11	0:04 - 0:06	0:04 - 0:07	0:03 - 0:05	CAUTION: No holdover time guidelines exist	
below -6 to -10°C (below 21 to 14°F)	0:05 - 0:08	0:08	0:05 - 0:08	0:03 - 0:05	0:03 - 0:05	0:02 - 0:04		
below -10°C (below 14°F)	0:04 - 0:07	0:05	0:03 - 0:05	0:02 - 0:03				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Type I fluid / water mixture must be selected so that the freezing point of the mixture is at least 10°C (18°F) below outside air temperature.
2 Ensure that the lowest operational use temperature (LOUT) is respected.
3 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
4 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
5 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
6 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
7 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.

CAUTIONS

- These holdover times apply to aircraft with critical surfaces constructed predominantly or entirely of aluminum materials that have demonstrated satisfactory use of these holdover times.
- The responsibility for the application of these data remains with the user.
- Takeoff after the longest applicable holdover time has been exceeded is not permitted for Type I fluids.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

Appendix A: Transport Canada Adjusted HOT Guidelines — Winter 2019-2020

TABLE ADJ-3: ADJUSTED HOLDOVER TIMES FOR SAE TYPE I FLUID ON CRITICAL AIRCRAFT SURFACES COMPOSED PREDOMINANTLY OF COMPOSITES

Outside Air Temperature[1,2]	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[3,4]	Light Snow, Snow Grains or Snow Pellets[3,4]	Moderate Snow, Snow Grains or Snow Pellets[3]	Freezing Drizzle[5]	Light Freezing Rain	Rain on Cold Soaked Wing[6]	Other[7]
-3°C and above (27°F and above)	0:07 - 0:12	0:09	0:05 - 0:09	0:02 - 0:05	0:06 - 0:10	0:03 - 0:05	0:01 - 0:04	
below -3 to -6°C (below 27 to 21°F)	0:05 - 0:06	0:08	0:04 - 0:08	0:02 - 0:04	0:04 - 0:07	0:03 - 0:05	CAUTION: No holdover time guidelines exist	
below -6 to -10°C (below 21 to 14°F)	0:03 - 0:06	0:07	0:04 - 0:07	0:02 - 0:04	0:03 - 0:05	0:02 - 0:04		
below -10°C (below 14°F)	0:03 - 0:05	0:05	0:03 - 0:05	0:02 - 0:03				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Type I Fluid / Water Mixture must be selected so that the freezing point of the mixture is at least 10°C (18°F) below outside air temperature.
2 Ensure that the lowest operational use temperature (LOUT) is respected.
3 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
4 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
5 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
6 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
7 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.

CAUTIONS

- These holdover times apply to newer aircraft with critical surfaces constructed predominantly or entirely of composite materials.
- The responsibility for the application of these data remains with the user.
- Takeoff after the longest applicable holdover time has been exceeded is not permitted for Type I fluids.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

Appendix A: Transport Canada Adjusted HOT Guidelines — Winter 2019-2020

TABLE ADJ-4: ADJUSTED GENERIC HOLDOVER TIMES FOR SAE TYPE II FLUIDS

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets[2,3]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	0:42 - 1:24	0:19 - 0:38	0:23 - 0:46	0:15 - 0:27	0:06 - 0:34	
	75/25	0:19 - 0:42	0:11 - 0:19	0:11 - 0:30	0:08 - 0:15	0:03 - 0:19	
	50/50	0:11 - 0:19	0:04 - 0:08	0:06 - 0:11	0:05 - 0:07	CAUTION: No holdover time guidelines exist	
below -3 to -8°C (below 27 to 18°F)	100/0	0:23 - 0:34	0:15 - 0:27	0:15 - 0:34	0:11 - 0:15		
	75/25	0:19 - 0:38	0:08 - 0:15	0:11 - 0:19	0:06 - 0:11		
below -8 to -14°C (below 18 to 7°F)	100/0	0:23 - 0:34	0:11 - 0:23	0:15 - 0:34[7]	0:11 - 0:15[7]		
	75/25	0:19 - 0:38	0:06 - 0:15	0:11 - 0:19[7]	0:06 - 0:11[7]		
below -14 to -18°C (below 7 to 0°F)	100/0	0:11 - 0:19	0:02 - 0:05				
below -18 to -25°C (below 0 to -13°F)	100/0	0:11 - 0:19[8]	0:01 - 0:02[8]				
below -25°C to LOUT (below -13°F to LOUT)	100/0	0:11 - 0:19[8]	0:00 - 0:01[8]				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10°C (14°F).
8 If the LOUT is unknown, no holdover time guidelines exist below -24°C (-11°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

Appendix A: Transport Canada Adjusted HOT Guidelines — Winter 2019-2020

TABLE ADJ-5: ADJUSTED TYPE II HOLDOVER TIMES FOR ABAX ECOWING 26

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	1:05 - 1:58	1:12	0:46 - 1:12	0:30 - 0:46	0:38 - 1:12	0:30 - 0:38	0:15 - 1:05	
	75/25	0:49 - 1:27	1:01	0:30 - 1:01	0:15 - 0:30	0:34 - 0:49	0:19 - 0:27	0:08 - 0:46	
	50/50	0:23 - 0:34	0:30	0:15 - 0:30	0:05 - 0:15	0:11 - 0:19	0:06 - 0:08	CAUTION: No holdover time guidelines exist	
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:34 - 1:43	1:08	0:42 - 1:08	0:27 - 0:42	0:23 - 0:53	0:11 - 0:27		
	75/25	0:27 - 0:57	0:49	0:27 - 0:49	0:15 - 0:27	0:15 - 0:38	0:11 - 0:19		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:34 - 1:43	1:05	0:42 - 1:05	0:27 - 0:42	0:23 - 0:53[7]	0:11 - 0:27[7]		
	75/25	0:27 - 0:57	0:42	0:23 - 0:42	0:11 - 0:23	0:15 - 0:38[7]	0:11 - 0:19[7]		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:19 - 0:34	0:15	0:05 - 0:15	0:02 - 0:05				
below -18 to -25°C (below 0 to -13°F)	100/0	0:19 - 0:34	0:07	0:02 - 0:07	0:01 - 0:02				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

Appendix A: Transport Canada Adjusted HOT Guidelines — Winter 2019-2020

TABLE ADJ-6: ADJUSTED TYPE II HOLDOVER TIMES FOR ABAX ECOWING AD-2

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	1:01 - 2:17	1:50	0:57 - 1:50	0:30 - 0:57	0:30 - 1:16	0:23 - 0:34	0:07 - 1:05	
	75/25	0:57 - 1:05	1:20	0:42 - 1:20	0:19 - 0:42	0:27 - 0:49	0:15 - 0:23	0:03 - 0:38	
	50/50	0:11 - 0:23	0:27	0:11 - 0:27	0:05 - 0:11	0:07 - 0:11	0:05 - 0:07	CAUTION: No holdover time guidelines exist	
below -3 to -8°C (below 27 to 18°F)	100/0	0:34 - 1:54	1:31	0:46 - 1:31	0:23 - 0:46	0:19 - 0:53	0:15 - 0:23		
	75/25	0:27 - 1:27	1:16	0:38 - 1:16	0:19 - 0:38	0:11 - 0:42	0:15 - 0:27		
below -8 to -14°C (below 18 to 7°F)	100/0	0:34 - 1:54	1:20	0:42 - 1:20	0:23 - 0:42	0:19 - 0:53[7]	0:15 - 0:23[7]		
	75/25	0:27 - 1:27	1:12	0:38 - 1:12	0:19 - 0:38	0:11 - 0:42[7]	0:15 - 0:27[7]		
below -14 to -18°C (below 7 to 0°F)	100/0	0:11 - 0:30	0:15	0:05 - 0:15	0:02 - 0:05				
below -18 to -25°C (below 0 to -13°F)	100/0	0:11 - 0:30	0:07	0:02 - 0:07	0:01 - 0:02				
below -25 to -27°C (below -13 to -17°F)	100/0	0:11 - 0:30	0:04	0:01 - 0:04	0:00 - 0:01				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE ADJ-7: ADJUSTED TYPE II HOLDOVER TIMES FOR AVIATION SHAANXI HI-TECH CLEANWING II

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets[2,3]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	0:42 - 1:24	0:23 - 0:42	0:27 - 0:49	0:19 - 0:27	0:08 - 0:42	
	75/25	0:38 - 1:01	0:19 - 0:34	0:27 - 0:46	0:15 - 0:23	0:05 - 0:38	
	50/50	0:27 - 0:46	0:11 - 0:23	0:15 - 0:30	0:08 - 0:15	CAUTION: No holdover time guidelines exist	
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:34 - 1:24	0:23 - 0:42	0:23 - 0:42	0:15 - 0:19		
	75/25	0:30 - 1:20	0:19 - 0:34	0:27 - 0:30	0:15 - 0:19		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:34 - 1:24	0:23 - 0:42	0:23 - 0:42[7]	0:15 - 0:19[7]		
	75/25	0:30 - 1:20	0:19 - 0:34	0:27 - 0:30[7]	0:15 - 0:19[7]		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:15 - 0:38	0:02 - 0:05				
below -18 to -25°C (below 0 to -13°F)	100/0	0:15 - 0:38	0:01 - 0:02				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE ADJ-8: ADJUSTED TYPE II HOLDOVER TIMES FOR BEIJING YADILITE AVIATION YD-102 TYPE II

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	0:53 - 1:31	1:16	0:38 - 1:16	0:19 - 0:38	0:30 - 0:57	0:27 - 0:30	0:08 - 0:46	
	75/25	0:19 - 0:42	0:38	0:19 - 0:38	0:11 - 0:19	0:11 - 0:30	0:08 - 0:15	0:03 - 0:19	
	50/50	0:11 - 0:19	0:19	0:08 - 0:19	0:04 - 0:08	0:06 - 0:11	0:05 - 0:07	CAUTION: No holdover time guidelines exist	
below -3 to -8°C (below 27 to 18°F)	100/0	0:34 - 1:08	0:57	0:27 - 0:57	0:15 - 0:27	0:27 - 0:38	0:19 - 0:19		
	75/25	0:23 - 0:38	0:30	0:15 - 0:30	0:08 - 0:15	0:11 - 0:19	0:07 - 0:11		
below -8 to -14°C (below 18 to 7°F)	100/0	0:34 - 1:08	0:46	0:23 - 0:46	0:11 - 0:23	0:27 - 0:38[7]	0:19 - 0:19[7]		
	75/25	0:23 - 0:38	0:27	0:15 - 0:27	0:06 - 0:15	0:11 - 0:19[7]	0:07 - 0:11[7]		
below -14 to -18°C (below 7 to 0°F)	100/0	0:15 - 0:34	0:15	0:05 - 0:15	0:02 - 0:05				
below -18 to -25°C (below 0 to -13°F)	100/0	0:15 - 0:34	0:07	0:02 - 0:07	0:01 - 0:02				
below -25 to -29°C (below -13 to -20°F)	100/0	0:15 - 0:34	0:04	0:01 - 0:04	0:00 - 0:01				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE ADJ-9: ADJUSTED TYPE II HOLDOVER TIMES FOR CLARIANT SAFEWING MP II FLIGHT

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	2:40 - 3:02	1:58	1:12 - 1:58	0:46 - 1:12	1:01 - 1:31	0:34 - 1:05	0:08 - 1:08	
	75/25	1:24 - 2:05	1:58	1:01 - 1:58	0:30 - 1:01	0:53 - 1:08	0:23 - 0:42	0:05 - 0:38	
	50/50	0:42 - 1:20	0:34	0:19 - 0:34	0:08 - 0:19	0:15 - 0:23	0:08 - 0:11		
below -3 to -8°C (below 27 to 18°F)	100/0	0:42 - 1:20	1:35	0:57 - 1:35	0:34 - 0:57	0:27 - 1:08	0:19 - 0:34		
	75/25	0:19 - 0:49	1:20	0:42 - 1:20	0:23 - 0:42	0:19 - 0:53	0:15 - 0:27		
below -8 to -14°C (below 18 to 7°F)	100/0	0:42 - 1:20	1:24	0:49 - 1:24	0:30 - 0:49	0:27 - 1:08[7]	0:19 - 0:34[7]		
	75/25	0:19 - 0:49	1:01	0:30 - 1:01	0:15 - 0:30	0:19 - 0:53[7]	0:15 - 0:27[7]	CAUTION: No holdover time guidelines exist	
below -14 to -18°C (below 7 to 0°F)	100/0	0:23 - 0:38	0:53	0:19 - 0:53	0:06 - 0:19				
below -18 to -25°C (below 0 to -13°F)	100/0	0:23 - 0:38	0:23	0:08 - 0:23	0:02 - 0:08				
below -25 to -29°C (below -13 to -20°F)	100/0	0:23 - 0:38	0:15	0:05 - 0:15	0:02 - 0:05				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE ADJ-10: ADJUSTED TYPE II HOLDOVER TIMES FOR CLARIANT SAFEWING MP II FLIGHT PLUS

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets[2,3]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	2:02 - 3:02	0:38 - 1:24	1:05 - 1:31	0:34 - 0:46	0:11 - 1:31	
	75/25	1:58 - 3:02	0:46 - 1:20	1:12 - 1:31	0:38 - 0:57	0:11 - 0:57	
	50/50	0:49 - 1:46	0:11 - 0:19	0:23 - 0:49	0:11 - 0:15	CAUTION: No holdover time guidelines exist	
below -3 to -8°C (below 27 to 18°F)	100/0	0:30 - 1:46	0:30 - 1:08	0:27 - 1:05	0:27 - 0:42		
	75/25	0:23 - 1:20	0:46 - 1:16	0:19 - 0:53	0:23 - 0:34		
below -8 to -14°C (below 18 to 7°F)	100/0	0:30 - 1:46	0:27 - 0:57	0:27 - 1:05[7]	0:27 - 0:42[7]		
	75/25	0:23 - 1:20	0:42 - 1:16	0:19 - 0:53[7]	0:23 - 0:34[7]		
below -14 to -18°C (below 7 to 0°F)	100/0	0:15 - 0:30	0:02 - 0:05				
below -18 to -25°C (below 0 to -13°F)	100/0	0:15 - 0:30	0:01 - 0:02				
below -25 to -29°C (below -13 to -20°F)	100/0	0:15 - 0:30	0:00 - 0:01				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE ADJ-11: ADJUSTED TYPE II HOLDOVER TIMES FOR CRYOTECH POLAR GUARD® II

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	2:09 - 3:02	2:00	1:27 - 2:00	0:49 - 1:27	1:12 - 1:31	0:57 - 1:08	0:11 - 1:31	
	75/25	1:54 - 3:02	2:00	1:05 - 2:00	0:30 - 1:05	1:16 - 1:31	0:30 - 0:53	0:07 - 1:16	
	50/50	0:38 - 1:05	0:53	0:19 - 0:53	0:08 - 0:19	0:15 - 0:34	0:07 - 0:15	CAUTION: No holdover time guidelines exist	
below -3 to -8°C (below 27 to 18°F)	100/0	0:42 - 1:54	1:50	1:05 - 1:50	0:38 - 1:05	0:27 - 1:12	0:27 - 0:34		
	75/25	0:30 - 1:08	1:46	0:49 - 1:46	0:23 - 0:49	0:19 - 0:49	0:27 - 0:34		
below -8 to -14°C (below 18 to 7°F)	100/0	0:42 - 1:54	1:31	0:53 - 1:31	0:30 - 0:53	0:27 - 1:12[7]	0:27 - 0:34[7]		
	75/25	0:30 - 1:08	1:31	0:42 - 1:31	0:19 - 0:42	0:19 - 0:49[7]	0:27 - 0:34[7]		
below -14 to -18°C (below 7 to 0°F)	100/0	0:19 - 0:38	1:12	0:27 - 1:12	0:08 - 0:27				
below -18 to -25°C (below 0 to -13°F)	100/0	0:19 - 0:38	0:30	0:11 - 0:30	0:03 - 0:11				
below -25 to -30.5°C (below -13 to -23°F)	100/0	0:19 - 0:38	0:19	0:05 - 0:19	0:02 - 0:05				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE ADJ-12: ADJUSTED TYPE II HOLDOVER TIMES FOR KILFROST ABC-K PLUS

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets[2,3]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	1:43 - 2:51	0:46 - 1:16	1:24 - 1:31	0:46 - 1:05	0:15 - 1:31	
	75/25	1:16 - 1:54	0:27 - 0:53	1:05 - 1:31	0:38 - 0:53	0:11 - 1:31	
	50/50	0:27 - 0:49	0:05 - 0:11	0:15 - 0:23	0:08 - 0:11	CAUTION: No holdover time guidelines exist	
below -3 to -8°C (below 27 to 18°F)	100/0	0:23 - 0:49	0:42 - 1:08	0:19 - 0:46	0:11 - 0:27		
	75/25	0:19 - 1:05	0:27 - 0:49	0:15 - 0:42	0:07 - 0:23		
below -8 to -14°C (below 18 to 7°F)	100/0	0:23 - 0:49	0:38 - 1:05	0:19 - 0:46[7]	0:11 - 0:27[7]		
	75/25	0:19 - 1:05	0:27 - 0:49	0:15 - 0:42[7]	0:07 - 0:23[7]		
below -14 to -18°C (below 7 to 0°F)	100/0	0:23 - 0:42	0:02 - 0:05				
below -18 to -25°C (below 0 to -13°F)	100/0	0:23 - 0:42	0:01 - 0:02				
below -25 to -29°C (below -13 to -20°F)	100/0	0:23 - 0:42	0:00 - 0:01				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE ADJ-13: ADJUSTED TYPE II HOLDOVER TIMES FOR KILFROST ICE CLEAR II

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	0:49 - 1:31	1:31	0:49 - 1:31	0:27 - 0:49	0:27 - 0:46	0:19 - 0:30	0:08 - 0:49	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A		
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:42 - 1:27	1:20	0:42 - 1:20	0:23 - 0:42	0:30 - 0:46	0:19 - 0:23		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:42 - 1:27	1:16	0:42 - 1:16	0:23 - 0:42	0:30 - 0:46[7]	0:19 - 0:23[7]	CAUTION: No holdover time guidelines exist	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:23 - 0:42	0:15	0:05 - 0:15	0:02 - 0:05				
below -18 to -24°C (below 0 to -11°F)	100/0	0:23 - 0:42	0:07	0:02 - 0:07	0:01 - 0:02				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE ADJ-14: ADJUSTED TYPE II HOLDOVER TIMES FOR NEWAVE AEROCHEMICAL FCY-2

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets[2,3]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	0:57 - 1:50	0:23 - 0:42	0:27 - 0:49	0:19 - 0:27	0:06 - 0:34	
	75/25	0:38 - 1:08	0:15 - 0:30	0:19 - 0:34	0:11 - 0:19	0:04 - 0:19	
	50/50	0:19 - 0:27	0:11 - 0:19	0:08 - 0:15	0:05 - 0:08	CAUTION: No holdover time guidelines exist	
below -3 to -8°C (below 27 to 18°F)	100/0	0:34 - 1:08	0:15 - 0:30	0:15 - 0:34	0:11 - 0:15		
	75/25	0:23 - 0:49	0:11 - 0:19	0:11 - 0:23	0:06 - 0:11		
below -8 to -14°C (below 18 to 7°F)	100/0	0:34 - 1:08	0:11 - 0:23	0:15 - 0:34[7]	0:11 - 0:15[7]		
	75/25	0:23 - 0:49	0:08 - 0:15	0:11 - 0:23[7]	0:06 - 0:11[7]		
below -14 to -18°C (below 7 to 0°F)	100/0	0:19 - 0:27	0:02 - 0:05				
below -18 to -25°C (below 0 to -13°F)	100/0	0:19 - 0:27	0:01 - 0:02				
below -25 to -28°C (below -13 to -18°F)	100/0	0:19 - 0:27	0:00 - 0:01				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE ADJ-15: ADJUSTED TYPE II HOLDOVER TIMES FOR NEWAVE AEROCHEMICAL FCY-2 BIO+

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	1:05 - 1:54	1:46	0:49 - 1:46	0:23 - 0:49	0:38 - 1:01	0:19 - 0:34	0:06 - 0:57	
	75/25	0:34 - 1:01	1:01	0:30 - 1:01	0:15 - 0:30	0:19 - 0:38	0:11 - 0:19	0:05 - 0:27	
	50/50	0:11 - 0:23	0:19	0:11 - 0:19	0:06 - 0:11	0:08 - 0:15	0:06 - 0:08	CAUTION: No holdover time guidelines exist	
below -3 to -8°C (below 27 to 18°F)	100/0	0:30 - 1:08	1:05	0:30 - 1:05	0:15 - 0:30	0:27 - 0:49	0:11 - 0:23		
	75/25	0:23 - 0:49	0:38	0:19 - 0:38	0:08 - 0:19	0:15 - 0:27	0:11 - 0:15		
below -8 to -14°C (below 18 to 7°F)	100/0	0:30 - 1:08	0:46	0:23 - 0:46	0:11 - 0:23	0:27 - 0:49[7]	0:11 - 0:23[7]		
	75/25	0:23 - 0:49	0:27	0:15 - 0:27	0:06 - 0:15	0:15 - 0:27[7]	0:11 - 0:15[7]		
below -14 to -18°C (below 7 to 0°F)	100/0	0:15 - 0:46	0:15	0:05 - 0:15	0:02 - 0:05				
below -18 to -25°C (below 0 to -13°F)	100/0	0:15 - 0:46	0:07	0:02 - 0:07	0:01 - 0:02				
below -25 to -28.5°C (below -13 to -19°F)	100/0	0:15 - 0:46	0:04	0:01 - 0:04	0:00 - 0:01				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

Appendix A: Transport Canada Adjusted HOT Guidelines — Winter 2019-2020

TABLE ADJ-16: ADJUSTED TYPE II HOLDOVER TIMES FOR OKSAYD DEFROST PG 2

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	0:42 - 1:24	1:24	0:42 - 1:24	0:23 - 0:42	0:23 - 0:46	0:15 - 0:27	0:08 - 1:01	
	75/25	0:49 - 1:31	1:20	0:34 - 1:20	0:15 - 0:34	0:19 - 0:38	0:11 - 0:23	0:05 - 0:27	
	50/50	0:46 - 1:24	1:39	0:46 - 1:39	0:23 - 0:46	0:23 - 0:38	0:11 - 0:23	CAUTION: No holdover time guidelines exist	
below -3 to -8°C (below 27 to 18°F)	100/0	0:42 - 1:05	1:05	0:34 - 1:05	0:19 - 0:34	0:27 - 0:38	0:15 - 0:23		
	75/25	0:30 - 1:01	0:53	0:23 - 0:53	0:11 - 0:23	0:19 - 0:30	0:11 - 0:15		
below -8 to -14°C (below 18 to 7°F)	100/0	0:42 - 1:05	0:57	0:30 - 0:57	0:15 - 0:30	0:27 - 0:38[7]	0:15 - 0:23[7]		
	75/25	0:30 - 1:01	0:42	0:19 - 0:42	0:08 - 0:19	0:19 - 0:30[7]	0:11 - 0:15[7]		
below -14 to -18°C (below 7 to 0°F)	100/0	0:27 - 0:49	0:15	0:05 - 0:15	0:02 - 0:05				
below -18 to -25°C (below 0 to -13°F)	100/0	0:27 - 0:49	0:07	0:02 - 0:07	0:01 - 0:02				
below -25 to -27°C (below -13 to -17°F)	100/0	0:27 - 0:49	0:04	0:01 - 0:04	0:00 - 0:01				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE ADJ-17: ADJUSTED TYPE II HOLDOVER TIMES FOR ROMCHIM ADD-PROTECT TYPE II

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	1:16 - 2:40	1:27	0:46 - 1:27	0:23 - 0:46	0:30 - 1:12	0:19 - 0:34	0:07 - 0:38	
	75/25	0:30 - 0:53	0:46	0:23 - 0:46	0:11 - 0:23	0:19 - 0:30	0:11 - 0:19	0:04 - 0:19	
	50/50	0:15 - 0:27	0:23	0:11 - 0:23	0:07 - 0:11	0:08 - 0:23	0:06 - 0:08	CAUTION: No holdover time guidelines exist	
below -3 to -8°C (below 27 to 18°F)	100/0	0:23 - 0:34	1:01	0:30 - 1:01	0:15 - 0:30	0:19 - 0:38	0:15 - 0:23		
	75/25	0:23 - 0:42	0:30	0:19 - 0:30	0:08 - 0:19	0:15 - 0:23	0:11 - 0:15		
below -8 to -14°C (below 18 to 7°F)	100/0	0:23 - 0:34	0:49	0:27 - 0:49	0:11 - 0:27	0:19 - 0:38[7]	0:15 - 0:23[7]		
	75/25	0:23 - 0:42	0:27	0:15 - 0:27	0:07 - 0:15	0:15 - 0:23[7]	0:11 - 0:15[7]		
below -14 to -18°C (below 7 to 0°F)	100/0	0:11 - 0:19	0:15	0:05 - 0:15	0:02 - 0:05				
below -18 to -25°C (below 0 to -13°F)	100/0	0:11 - 0:19	0:07	0:02 - 0:07	0:01 - 0:02				
below -25 to -28°C (below -13 to -18°F)	100/0	0:11 - 0:19	0:04	0:01 - 0:04	0:00 - 0:01				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE ADJ-18: ADJUSTED TYPE III HOLDOVER TIMES FOR ALLCLEAR AEROCLEAR MAX APPLIED UNHEATED ON LOW SPEED AIRCRAFT[1]

Outside Air Temperature[2]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[3,4]	Light Snow, Snow Grains or Snow Pellets[3,4]	Moderate Snow, Snow Grains or Snow Pellets[3]	Freezing Drizzle[5]	Light Freezing Rain	Rain on Cold Soaked Wing[6]	Other[7]
-3°C and above (27°F and above)	100/0	0:34 - 1:27	1:01	0:30 - 1:01	0:14 - 0:30	0:19 - 0:38	0:11 - 0:19	0:04 - 0:30	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A	CAUTION: No holdover time guidelines exist	
below -3 to -10°C (below 27 to 14°F)	100/0	0:38 - 1:16	1:01	0:30 - 1:01	0:14 - 0:30	0:19 - 0:34	0:11 - 0:19		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -10 to -16°C (below 14 to 3°F)	100/0	0:30 - 1:20	1:01	0:30 - 1:01	0:14 - 0:30				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 These holdover times are for aircraft conforming to the SAE AS5900 low speed aerodynamic test criterion. Fluid must be applied unheated to use these holdover times. No holdover times exist for this fluid applied heated.
2 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type III fluid cannot be used.
3 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
4 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
5 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
6 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
7 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE ADJ-19: ADJUSTED TYPE III HOLDOVER TIMES FOR ALLCLEAR AEROCLEAR MAX APPLIED UNHEATED ON HIGH SPEED AIRCRAFT[1]

Outside Air Temperature[2]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[3,4]	Light Snow, Snow Grains or Snow Pellets[3,4]	Moderate Snow, Snow Grains or Snow Pellets[3]	Freezing Drizzle[5]	Light Freezing Rain	Rain on Cold Soaked Wing[6]	Other[7]
-3°C and above (27°F and above)	100/0	0:34 - 1:27	1:01	0:30 - 1:01	0:14 - 0:30	0:19 - 0:38	0:11 - 0:19	0:04 - 0:30	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A	CAUTION: No holdover time guidelines exist	
below -3 to -10°C (below 27 to 14°F)	100/0	0:38 - 1:16	1:01	0:30 - 1:01	0:14 - 0:30	0:19 - 0:34	0:11 - 0:19		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -10 to -25°C (below 14 to -13°F)	100/0	0:30 - 1:20	1:01	0:30 - 1:01	0:14 - 0:30				
below -25 to -35°C (below -13 to -31°F)	100/0	0:19 - 0:46	0:34	0:15 - 0:34	0:08 - 0:15				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 These holdover times are for aircraft conforming to the SAE AS5900 high speed aerodynamic test criterion. Fluid must be applied unheated to use these holdover times. No holdover times exist for this fluid applied heated.
2 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type III fluid cannot be used.
3 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
4 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
5 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
6 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
7 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table ADJ-41 provides allowance times for ice pellets and small hail for SAE Type III fluids, applied unheated).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

Appendix A: Transport Canada Adjusted HOT Guidelines — Winter 2019-2020

TABLE ADJ-20: ADJUSTED GENERIC HOLDOVER TIMES FOR SAE TYPE IV FLUIDS

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	0:57 - 2:02	1:46	0:53 - 1:46	0:27 - 0:53	0:30 - 1:08	0:19 - 0:30	0:06 - 0:53	
	75/25	1:05 - 2:02	1:35	0:57 - 1:35	0:30 - 0:57	0:38 - 1:01	0:23 - 0:34	0:07 - 0:57	
	50/50	0:23 - 0:42	0:46	0:19 - 0:46	0:08 - 0:19	0:11 - 0:30	0:07 - 0:15		
below -3 to -8°C (below 27 to 18°F)	100/0	0:15 - 1:12	1:24	0:42 - 1:24	0:23 - 0:42	0:19 - 1:01	0:15 - 0:19		
	75/25	0:23 - 1:01	1:24	0:46 - 1:24	0:23 - 0:46	0:15 - 0:49	0:11 - 0:19		
below -8 to -14°C (below 18 to 7°F)	100/0	0:15 - 1:12	1:01	0:34 - 1:01	0:19 - 0:34	0:19 - 1:01[7]	0:15 - 0:19[7]		
	75/25	0:23 - 1:01	1:16	0:34 - 1:16	0:15 - 0:34	0:15 - 0:49[7]	0:11 - 0:19[7]	CAUTION: No holdover time guidelines exist	
below -14 to -18°C (below 7 to 0°F)	100/0	0:15 - 0:30	0:23	0:07 - 0:23	0:02 - 0:07				
below -18 to -25°C (below 0 to -13°F)	100/0	0:15 - 0:30[8]	0:08[8]	0:02 - 0:08[8]	0:01 - 0:02[8]				
below -25°C to LOUT (below -13°F to LOUT)	100/0	0:15 - 0:30[8]	0:05[8]	0:02 - 0:05[8]	0:00 - 0:02[8]				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table ADJ-42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10°C (14°F).
8 If the LOUT is unknown, no holdover time guidelines exist below -22.5°C (-8.5°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE ADJ-21: ADJUSTED TYPE IV HOLDOVER TIMES FOR ABAX ECOWING AD-49

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	2:32 - 3:02	2:00	1:27 - 2:00	0:46 - 1:27	1:05 - 1:31	0:46 - 1:05	0:08 - 1:27	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A		
below -3 to -8°C (below 27 to 18°F)	100/0	0:15 - 1:12	2:00	1:08 - 2:00	0:34 - 1:08	0:19 - 1:05	0:15 - 0:19		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14°C (below 18 to 7°F)	100/0	0:15 - 1:12	1:50	0:57 - 1:50	0:30 - 0:57	0:19 - 1:05[7]	0:15 - 0:19[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18°C (below 7 to 0°F)	100/0	0:19 - 0:30	0:23	0:07 - 0:23	0:02 - 0:07				
below -18 to -25°C (below 0 to -13°F)	100/0	0:19 - 0:30	0:08	0:02 - 0:08	0:01 - 0:02				
below -25 to -26°C (below -13 to -15°F)	100/0	0:19 - 0:30	0:05	0:02 - 0:05	0:00 - 0:02				

CAUTION: No holdover time guidelines exist

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table ADJ-42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE ADJ-22: ADJUSTED TYPE IV HOLDOVER TIMES FOR ALLCLEAR CLEARWING EG

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	1:24 - 2:28	2:00	1:01 - 2:00	0:30 - 1:01	0:53 - 1:12	0:23 - 0:46	0:08 - 1:08	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A	CAUTION: No holdover time guidelines exist	
below -3 to -8°C (below 27 to 18°F)	100/0	1:12 - 2:51	1:50	0:53 - 1:50	0:27 - 0:53	0:49 - 1:08	0:23 - 0:46		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14°C (below 18 to 7°F)	100/0	1:12 - 2:51	1:43	0:49 - 1:43	0:23 - 0:49	0:49 - 1:08[7]	0:23 - 0:46[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18°C (below 7 to 0°F)	100/0	0:42 - 1:31	0:38	0:19 - 0:38	0:08 - 0:19				
below -18 to -25°C (below 0 to -13°F)	100/0	0:42 - 1:31	0:30	0:11 - 0:30	0:04 - 0:11				
below -25 to -29°C (below -13 to -20°F)	100/0	0:42 - 1:31	0:19	0:06 - 0:19	0:02 - 0:06				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table ADJ-42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE ADJ-23: ADJUSTED TYPE IV HOLDOVER TIMES FOR CHEMCO CHEMR EG IV

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	1:35 - 2:43	2:00	0:57 - 2:00	0:27 - 0:57	0:34 - 1:16	0:19 - 0:30	0:07 - 1:20	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A		
below -3 to -8°C (below 27 to 18°F)	100/0	1:05 - 2:47	2:00	0:57 - 2:00	0:27 - 0:57	0:46 - 1:12	0:27 - 0:38		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14°C (below 18 to 7°F)	100/0	1:05 - 2:47	2:00	0:57 - 2:00	0:27 - 0:57	0:46 - 1:12[7]	0:27 - 0:38[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18°C (below 7 to 0°F)	100/0	0:30 - 1:05	0:38	0:19 - 0:38	0:08 - 0:19				
below -18 to -25°C (below 0 to -13°F)	100/0	0:30 - 1:05	0:30	0:11 - 0:30	0:04 - 0:11				
below -25 to -27°C (below -13 to -17°F)	100/0	0:30 - 1:05	0:19	0:06 - 0:19	0:02 - 0:06				

CAUTION: No holdover time guidelines exist

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table ADJ-42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE ADJ-24: ADJUSTED TYPE IV HOLDOVER TIMES FOR CLARIANT MAX FLIGHT 04

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	2:02 - 3:02	2:00	2:00 - 2:00	1:05 - 2:00	1:31 - 1:31	0:53 - 1:08	0:15 - 1:31	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A		
below -3 to -8°C (below 27 to 18°F)	100/0	0:38 - 1:54	2:00	1:16 - 2:00	0:38 - 1:16	0:19 - 1:08	0:15 - 0:30		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14°C (below 18 to 7°F)	100/0	0:38 - 1:54	1:46	0:53 - 1:46	0:27 - 0:53	0:19 - 1:08[7]	0:15 - 0:30[7]	CAUTION: No holdover time guidelines exist	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18°C (below 7 to 0°F)	100/0	0:15 - 0:34	0:23	0:07 - 0:23	0:02 - 0:07				
below -18 to -23.5°C (below 0 to -10°F)	100/0	0:15 - 0:34	0:08	0:02 - 0:08	0:01 - 0:02				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table ADJ-42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE ADJ-25: ADJUSTED TYPE IV HOLDOVER TIMES FOR CLARIANT MAX FLIGHT AVIA

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	2:21 - 3:02	2:00	1:20 - 2:00	0:46 - 1:20	1:05 - 1:31	0:42 - 0:53	0:07 - 1:31	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A		
below -3 to -8°C (below 27 to 18°F)	100/0	1:20 - 2:59	1:54	1:05 - 1:54	0:38 - 1:05	0:53 - 1:31	0:42 - 1:08		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14°C (below 18 to 7°F)	100/0	1:20 - 2:59	1:39	0:57 - 1:39	0:30 - 0:57	0:53 - 1:31[7]	0:42 - 1:08[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18°C (below 7 to 0°F)	100/0	0:27 - 1:05	0:38	0:19 - 0:38	0:08 - 0:19				
below -18 to -25°C (below 0 to -13°F)	100/0	0:27 - 1:05	0:30	0:11 - 0:30	0:04 - 0:11				
below -25 to -28.5°C (below -13 to -19°F)	100/0	0:27 - 1:05	0:19	0:06 - 0:19	0:02 - 0:06				

CAUTION: No holdover time guidelines exist

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table ADJ-42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE ADJ-26: ADJUSTED TYPE IV HOLDOVER TIMES FOR CLARIANT MAX FLIGHT SNEG

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	1:50 - 3:02	2:00	1:16 - 2:00	0:42 - 1:16	1:31 - 1:31	0:38 - 1:16	0:15 - 1:08	
	75/25	3:02 - 3:02	1:50	1:08 - 1:50	0:42 - 1:08	1:08 - 1:31	0:49 - 1:01	0:11 - 1:20	
	50/50	1:08 - 2:40	1:20	0:34 - 1:20	0:15 - 0:34	0:27 - 0:53	0:11 - 0:23	CAUTION: No holdover time guidelines exist	
below -3 to -8°C (below 27 to 18°F)	100/0	0:34 - 1:46	1:50	1:01 - 1:50	0:34 - 1:01	0:23 - 1:05	0:19 - 0:30		
	75/25	0:23 - 1:05	1:27	0:53 - 1:27	0:34 - 0:53	0:15 - 0:49	0:15 - 0:30		
below -8 to -14°C (below 18 to 7°F)	100/0	0:34 - 1:46	1:35	0:53 - 1:35	0:30 - 0:53	0:23 - 1:05[7]	0:19 - 0:30[7]		
	75/25	0:23 - 1:05	1:16	0:46 - 1:16	0:30 - 0:46	0:15 - 0:49[7]	0:15 - 0:30[7]		
below -14 to -18°C (below 7 to 0°F)	100/0	0:15 - 0:38	0:23	0:07 - 0:23	0:02 - 0:07				
below -18 to -25°C (below 0 to -13°F)	100/0	0:15 - 0:38	0:08	0:02 - 0:08	0:01 - 0:02				
below -25 to -29°C (below -13 to -20°F)	100/0	0:15 - 0:38	0:05	0:02 - 0:05	0:00 - 0:02				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table ADJ-42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE ADJ-27: ADJUSTED TYPE IV HOLDOVER TIMES FOR CLARIANT SAFEWING EG IV NORTH

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	1:46 - 2:59	2:00	1:16 - 2:00	0:38 - 1:16	1:08 - 1:31	0:38 - 0:42	0:06 - 1:31	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A		
below -3 to -8°C (below 27 to 18°F)	100/0	1:20 - 3:02	2:00	1:08 - 2:00	0:38 - 1:08	0:49 - 1:24	0:42 - 1:05		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14°C (below 18 to 7°F)	100/0	1:20 - 3:02	2:00	1:08 - 2:00	0:38 - 1:08	0:49 - 1:24[7]	0:42 - 1:05[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18°C (below 7 to 0°F)	100/0	0:30 - 1:01	0:38	0:19 - 0:38	0:08 - 0:19				
below -18 to -25°C (below 0 to -13°F)	100/0	0:30 - 1:01	0:30	0:11 - 0:30	0:04 - 0:11				
below -25 to -30°C (below -13 to -22°F)	100/0	0:30 - 1:01	0:19	0:06 - 0:19	0:02 - 0:06				

CAUTION: No holdover time guidelines exist

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table ADJ-42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE ADJ-28: ADJUSTED TYPE IV HOLDOVER TIMES FOR CLARIANT SAFEWING MP IV LAUNCH

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	3:02 - 3:02	2:00	1:20 - 2:00	0:49 - 1:20	1:08 - 1:31	0:46 - 1:16	0:11 - 1:16	
	75/25	2:47 - 3:02	2:00	1:20 - 2:00	0:46 - 1:20	1:16 - 1:31	0:34 - 0:57	0:08 - 1:20	
	50/50	1:05 - 2:05	1:05	0:34 - 1:05	0:19 - 0:34	0:23 - 0:38	0:15 - 0:19	CAUTION: No holdover time guidelines exist	
below -3 to -8°C (below 27 to 18°F)	100/0	0:46 - 1:27	1:50	1:08 - 1:50	0:42 - 1:08	0:27 - 1:16	0:19 - 0:34		
	75/25	0:30 - 1:01	2:00	1:08 - 2:00	0:38 - 1:08	0:19 - 0:53	0:19 - 0:34		
below -8 to -14°C (below 18 to 7°F)	100/0	0:46 - 1:27	1:39	1:01 - 1:39	0:38 - 1:01	0:27 - 1:16[7]	0:19 - 0:34[7]		
	75/25	0:30 - 1:01	1:50	1:05 - 1:50	0:34 - 1:05	0:19 - 0:53[7]	0:19 - 0:34[7]		
below -14 to -18°C (below 7 to 0°F)	100/0	0:23 - 0:38	0:57	0:15 - 0:57	0:05 - 0:15				
below -18 to -25°C (below 0 to -13°F)	100/0	0:23 - 0:38	0:23	0:07 - 0:23	0:02 - 0:07				
below -25 to -28.5°C (below -13 to -19°F)	100/0	0:23 - 0:38	0:15	0:05 - 0:15	0:01 - 0:05				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table ADJ-42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE ADJ-29: ADJUSTED TYPE IV HOLDOVER TIMES FOR CLARIANT SAFEWING MP IV LAUNCH PLUS

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	2:59 - 3:02	2:00	1:35 - 2:00	0:42 - 1:35	1:31 - 1:31	0:46 - 1:31	0:15 - 1:31	
	75/25	2:59 - 3:02	2:00	1:27 - 2:00	0:38 - 1:27	1:31 - 1:31	1:01 - 1:05	0:15 - 1:24	
	50/50	0:57 - 1:24	1:12	0:34 - 1:12	0:15 - 0:34	0:19 - 0:46	0:11 - 0:15	CAUTION: No holdover time guidelines exist	
below -3 to -8°C (below 27 to 18°F)	100/0	0:42 - 1:43	2:00	1:16 - 2:00	0:34 - 1:16	0:19 - 1:12	0:19 - 0:30		
	75/25	0:30 - 1:31	2:00	1:08 - 2:00	0:27 - 1:08	0:15 - 0:49	0:15 - 0:23		
below -8 to -14°C (below 18 to 7°F)	100/0	0:42 - 1:43	2:00	1:05 - 2:00	0:30 - 1:05	0:19 - 1:12[7]	0:19 - 0:30[7]		
	75/25	0:30 - 1:31	2:00	0:57 - 2:00	0:23 - 0:57	0:15 - 0:49[7]	0:15 - 0:23[7]		
below -14 to -18°C (below 7 to 0°F)	100/0	0:19 - 0:38	0:57	0:19 - 0:57	0:05 - 0:19				
below -18 to -25°C (below 0 to -13°F)	100/0	0:19 - 0:38	0:23	0:07 - 0:23	0:02 - 0:07				
below -25 to -29°C (below -13 to -20°F)	100/0	0:19 - 0:38	0:15	0:05 - 0:15	0:02 - 0:05				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table ADJ-42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE ADJ-30: ADJUSTED TYPE IV HOLDOVER TIMES FOR CRYOTECH POLAR GUARD® ADVANCE

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	2:09 - 3:02	2:00	1:27 - 2:00	0:49 - 1:27	1:12 - 1:31	0:57 - 1:08	0:11 - 1:31	
	75/25	1:54 - 3:02	2:00	1:05 - 2:00	0:30 - 1:05	1:16 - 1:31	0:30 - 0:53	0:07 - 1:16	
	50/50	0:38 - 1:05	0:53	0:19 - 0:53	0:08 - 0:19	0:15 - 0:34	0:07 - 0:15	CAUTION: No holdover time guidelines exist	
below -3 to -8°C (below 27 to 18°F)	100/0	0:42 - 1:54	1:50	1:05 - 1:50	0:38 - 1:05	0:27 - 1:12	0:27 - 0:34		
	75/25	0:30 - 1:08	1:46	0:49 - 1:46	0:23 - 0:49	0:19 - 0:49	0:27 - 0:34		
below -8 to -14°C (below 18 to 7°F)	100/0	0:42 - 1:54	1:31	0:53 - 1:31	0:30 - 0:53	0:27 - 1:12[7]	0:27 - 0:34[7]		
	75/25	0:30 - 1:08	1:31	0:42 - 1:31	0:19 - 0:42	0:19 - 0:49[7]	0:27 - 0:34[7]		
below -14 to -18°C (below 7 to 0°F)	100/0	0:19 - 0:38	1:12	0:27 - 1:12	0:08 - 0:27				
below -18 to -25°C (below 0 to -13°F)	100/0	0:19 - 0:38	0:30	0:11 - 0:30	0:03 - 0:11				
below -25 to -30.5°C (below -13 to -22°F)	100/0	0:19 - 0:38	0:19	0:05 - 0:19	0:02 - 0:05				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table ADJ-42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE ADJ-31: ADJUSTED TYPE IV HOLDOVER TIMES FOR CRYOTECH POLAR GUARD® XTEND

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	1:54 - 3:02	2:00	1:31 - 2:00	0:49 - 1:31	1:31 - 1:31	0:46 - 1:24	0:15 - 1:20	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A	CAUTION: No holdover time guidelines exist	
below -3 to -8°C (below 27 to 18°F)	100/0	0:46 - 1:24	2:00	1:12 - 2:00	0:38 - 1:12	0:27 - 1:16	0:38 - 0:42		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14°C (below 18 to 7°F)	100/0	0:46 - 1:24	1:50	1:01 - 1:50	0:34 - 1:01	0:27 - 1:16[7]	0:38 - 0:42[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18°C (below 7 to 0°F)	100/0	0:19 - 0:30	0:23	0:07 - 0:23	0:02 - 0:07				
below -18 to -25°C (below 0 to -13°F)	100/0	0:19 - 0:30	0:08	0:02 - 0:08	0:01 - 0:02				
below -25 to -29°C (below -13 to -20°F)	100/0	0:19 - 0:30	0:05	0:02 - 0:05	0:00 - 0:02				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table ADJ-42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE ADJ-32: ADJUSTED TYPE IV HOLDOVER TIMES FOR DOW CHEMICAL UCAR™ ENDURANCE EG106

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	1:35 - 2:24	2:00	1:01 - 2:00	0:30 - 1:01	0:53 - 1:31	0:38 - 0:57	0:15 - 1:31	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A	CAUTION: No holdover time guidelines exist	
below -3 to -8°C (below 27 to 18°F)	100/0	1:24 - 2:32	1:50	0:53 - 1:50	0:27 - 0:53	0:42 - 1:24	0:34 - 0:53		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14°C (below 18 to 7°F)	100/0	1:24 - 2:32	1:39	0:49 - 1:39	0:23 - 0:49	0:42 - 1:24[7]	0:34 - 0:53[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18°C (below 7 to 0°F)	100/0	0:23 - 0:49	1:20	0:38 - 1:20	0:19 - 0:38				
below -18 to -25°C (below 0 to -13°F)	100/0	0:23 - 0:49	1:08	0:30 - 1:08	0:15 - 0:30				
below -25 to -29°C (below -13 to -20°F)	100/0	0:23 - 0:49	1:01	0:30 - 1:01	0:15 - 0:30				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table ADJ-42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE ADJ-33: ADJUSTED TYPE IV HOLDOVER TIMES FOR DOW CHEMICAL UCAR™ FLIGHTGUARD AD-49

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	2:32 - 3:02	2:00	1:27 - 2:00	0:46 - 1:27	1:05 - 1:31	0:46 - 1:05	0:08 - 1:27	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A		
below -3 to -8°C (below 27 to 18°F)	100/0	0:15 - 1:12	2:00	1:08 - 2:00	0:34 - 1:08	0:19 - 1:05	0:15 - 0:19		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14°C (below 18 to 7°F)	100/0	0:15 - 1:12	1:50	0:57 - 1:50	0:30 - 0:57	0:19 - 1:05[7]	0:15 - 0:19[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18°C (below 7 to 0°F)	100/0	0:19 - 0:30	0:23	0:07 - 0:23	0:02 - 0:07				
below -18 to -25°C (below 0 to -13°F)	100/0	0:19 - 0:30	0:08	0:02 - 0:08	0:01 - 0:02				
below -25 to -26°C (below -13 to -15°F)	100/0	0:19 - 0:30	0:05	0:02 - 0:05	0:00 - 0:02				

CAUTION: No holdover time guidelines exist

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table ADJ-42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE ADJ-34: ADJUSTED TYPE IV HOLDOVER TIMES FOR INLAND TECHNOLOGIES ECO-SHIELD®

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	0:57 - 2:02	1:50	1:01 - 1:50	0:34 - 1:01	0:30 - 1:08	0:27 - 0:30	0:11 - 1:12	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A		
below -3 to -8°C (below 27 to 18°F)	100/0	0:53 - 1:58	1:35	0:53 - 1:35	0:30 - 0:53	0:38 - 1:05	0:23 - 0:30		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14°C (below 18 to 7°F)	100/0	0:53 - 1:58	1:27	0:49 - 1:27	0:27 - 0:49	0:38 - 1:05[7]	0:23 - 0:30[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18°C (below 7 to 0°F)	100/0	0:23 - 0:46	0:23	0:07 - 0:23	0:02 - 0:07				
below -18 to -25°C (below 0 to -13°F)	100/0	0:23 - 0:46	0:08	0:02 - 0:08	0:01 - 0:02				
below -25 to -25.5°C (below -13 to -14°F)	100/0	0:23 - 0:46	0:05	0:02 - 0:05	0:00 - 0:02				

CAUTION: No holdover time guidelines exist

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table ADJ-42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE ADJ-35: ADJUSTED TYPE IV HOLDOVER TIMES FOR KILFROST ABC-S PLUS

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	1:39 - 3:02	2:00	1:35 - 2:00	0:57 - 1:35	1:24 - 1:31	0:49 - 1:31	0:19 - 1:31	
	75/25	1:05 - 2:02	1:35	0:57 - 1:35	0:34 - 0:57	0:46 - 1:01	0:23 - 0:38	0:08 - 1:01	
	50/50	0:23 - 0:42	0:46	0:23 - 0:46	0:11 - 0:23	0:11 - 0:30	0:11 - 0:15		
below -3 to -8°C (below 27 to 18°F)	100/0	0:42 - 2:40	2:00	1:24 - 2:00	0:49 - 1:24	0:19 - 1:12	0:15 - 0:23		
	75/25	0:34 - 1:24	1:24	0:49 - 1:24	0:30 - 0:49	0:15 - 0:53	0:11 - 0:19		
below -8 to -14°C (below 18 to 7°F)	100/0	0:42 - 2:40	2:00	1:20 - 2:00	0:46 - 1:20	0:19 - 1:12[7]	0:15 - 0:23[7]		
	75/25	0:34 - 1:24	1:20	0:46 - 1:20	0:27 - 0:46	0:15 - 0:53[7]	0:11 - 0:19[7]		
below -14 to -18°C (below 7 to 0°F)	100/0	0:30 - 0:46	0:23	0:07 - 0:23	0:02 - 0:07				
below -18 to -25°C (below 0 to -13°F)	100/0	0:30 - 0:46	0:08	0:02 - 0:08	0:01 - 0:02				
below -25 to -28°C (below -13 to -18°F)	100/0	0:30 - 0:46	0:05	0:02 - 0:05	0:00 - 0:02				

CAUTION: No holdover time guidelines exist

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table ADJ-42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE ADJ-36: ADJUSTED TYPE IV HOLDOVER TIMES FOR LNT SOLUTIONS E450

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	1:24 - 2:13	1:50	1:12 - 1:50	0:46 - 1:12	1:12 - 1:31	0:42 - 1:01	0:19 - 1:31	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A		
below -3 to -8°C (below 27 to 18°F)	100/0	1:08 - 2:59	1:35	1:01 - 1:35	0:38 - 1:01	1:20 - 1:31	0:49 - 1:16		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14°C (below 18 to 7°F)	100/0	1:08 - 2:59	1:24	0:53 - 1:24	0:34 - 0:53	1:20 - 1:31[7]	0:49 - 1:16[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18°C (below 7 to 0°F)	100/0	0:27 - 0:49	2:00	0:49 - 2:00	0:15 - 0:49				
below -18 to -25°C[8] (below 0 to -13°F)[8]	100/0	0:27 - 0:49	1:12	0:23 - 1:12	0:08 - 0:23				
below -25 to -32.5°C[8] (below -13 to -26°F)[8]	100/0	0:19 - 0:46	0:30	0:11 - 0:30	0:03 - 0:11				

CAUTION: No holdover time guidelines exist

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table ADJ-42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10°C (14°F).
8 Use LOUT of -22.5°C (-9°F) unless indicated otherwise by fluid manufacturer.

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE ADJ-37: ADJUSTED TYPE IV HOLDOVER TIMES FOR NEWAVE AEROCHEMICAL FCY 9311

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	1:27 - 3:02	1:46	0:53 - 1:46	0:27 - 0:53	0:53 - 1:31	0:30 - 0:49	0:11 - 1:05	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A		
below -3 to -8°C (below 27 to 18°F)	100/0	0:27 - 1:35	1:24	0:42 - 1:24	0:23 - 0:42	0:27 - 1:01	0:15 - 0:27		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14°C (below 18 to 7°F)	100/0	0:27 - 1:35	1:12	0:38 - 1:12	0:19 - 0:38	0:27 - 1:01[7]	0:15 - 0:27[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18°C (below 7 to 0°F)	100/0	0:23 - 0:42	0:23	0:07 - 0:23	0:02 - 0:07				
below -18 to -25°C (below 0 to -13°F)	100/0	0:23 - 0:42	0:08	0:02 - 0:08	0:01 - 0:02				
below -25 to -29.5°C (below -13 to -21°F)	100/0	0:23 - 0:42	0:05	0:02 - 0:05	0:00 - 0:02				

CAUTION: No holdover time guidelines exist

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table ADJ-42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE ADJ-38: ADJUSTED TYPE IV HOLDOVER TIMES FOR OKSAYD DEFROST ECO 4

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	1:08 - 2:02	1:54	0:57 - 1:54	0:27 - 0:57	0:49 - 1:08	0:30 - 0:49	0:11 - 0:53	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A		
below -3 to -8°C (below 27 to 18°F)	100/0	0:42 - 1:58	1:43	0:49 - 1:43	0:27 - 0:49	0:38 - 1:01	0:27 - 0:38		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14°C (below 18 to 7°F)	100/0	0:42 - 1:58	1:35	0:46 - 1:35	0:23 - 0:46	0:38 - 1:01[7]	0:27 - 0:38[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18°C (below 7 to 0°F)	100/0	0:23 - 0:38	0:23	0:07 - 0:23	0:02 - 0:07				
below -18 to -25°C (below 0 to -13°F)	100/0	0:23 - 0:38	0:08	0:02 - 0:08	0:01 - 0:02				
below -25 to -25.5°C (below -13 to -14°F)	100/0	0:23 - 0:38	0:05	0:02 - 0:05	0:00 - 0:02				

CAUTION: No holdover time guidelines exist

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table ADJ-42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE ADJ-39: ADJUSTED TYPE IV HOLDOVER TIMES FOR OKSAYD DEFROST EG 4

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	2:05 - 3:02	2:00	1:50 - 2:00	1:05 - 1:50	1:31 - 1:31	0:46 - 1:20	0:15 - 1:31	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A	CAUTION: No holdover time guidelines exist	
below -3 to -8°C (below 27 to 18°F)	100/0	1:46 - 3:02	2:00	1:35 - 2:00	0:57 - 1:35	0:46 - 1:31	1:01 - 1:24		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14°C (below 18 to 7°F)	100/0	1:46 - 3:02	2:00	1:27 - 2:00	0:53 - 1:27	0:46 - 1:31[7]	1:01 - 1:24[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18°C (below 7 to 0°F)	100/0	0:34 - 1:50	0:38	0:19 - 0:38	0:08 - 0:19				
below -18 to -25°C (below 0 to -13°F)	100/0	0:34 - 1:50	0:30	0:11 - 0:30	0:04 - 0:11				
below -25 to -26°C (below -13 to -15°F)	100/0	0:34 - 1:50	0:19	0:06 - 0:19	0:02 - 0:06				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table ADJ-42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE ADJ-40: ADJUSTED TYPE IV HOLDOVER TIMES FOR SHAANXI CLEANWAY AVIATION CLEANSURFACE IV

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3°C and above (27°F and above)	100/0	2:09 - 3:02	2:00	1:27 - 2:00	0:46 - 1:27	1:31 - 1:31	1:05 - 1:08	0:11 - 1:31	
	75/25	1:58 - 3:02	2:00	1:12 - 2:00	0:34 - 1:12	0:38 - 1:31	0:27 - 0:34	0:07 - 0:57	
	50/50	0:49 - 1:50	1:16	0:30 - 1:16	0:11 - 0:30	0:19 - 0:38	0:11 - 0:15	CAUTION: No holdover time guidelines exist	
below -3 to -8°C (below 27 to 18°F)	100/0	0:46 - 2:21	1:31	0:49 - 1:31	0:27 - 0:49	0:27 - 1:20	0:15 - 0:27		
	75/25	0:38 - 1:27	1:43	0:46 - 1:43	0:23 - 0:46	0:23 - 1:01	0:19 - 0:30		
below -8 to -14°C (below 18 to 7°F)	100/0	0:46 - 2:21	1:01	0:34 - 1:01	0:19 - 0:34	0:27 - 1:20[7]	0:15 - 0:27[7]		
	75/25	0:38 - 1:27	1:16	0:34 - 1:16	0:15 - 0:34	0:23 - 1:01[7]	0:19 - 0:30[7]		
below -14 to -18°C (below 7 to 0°F)	100/0	0:23 - 0:38	0:23	0:07 - 0:23	0:02 - 0:07				
below -18 to -25°C (below 0 to -13°F)	100/0	0:23 - 0:38	0:08	0:02 - 0:08	0:01 - 0:02				
below -25 to -28.5°C (below -13 to -19°F)	100/0	0:23 - 0:38	0:05	0:02 - 0:05	0:00 - 0:02				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table ADJ-42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10°C (14°F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable table cell.
- The time of protection will be shortened in heavy weather conditions, heavy precipitation rates, or high moisture content. High wind velocity or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.

TABLE ADJ-41: ADJUSTED ALLOWANCE TIMES FOR SAE TYPE III FLUIDS[1]

Precipitation Type	Outside Air Temperature		
	-5°C and above	Below -5 to -10°C	Below -10°C[2]
Light Ice Pellets	8 minutes	8 minutes	**Caution: No allowance times currently exist**
Light Ice Pellets Mixed with Snow	8 minutes	8 minutes	
Light Ice Pellets Mixed with Freezing Drizzle	5 minutes	4 minutes	
Light Ice Pellets Mixed with Freezing Rain	5 minutes	4 minutes	
Light Ice Pellets Mixed with Rain	5 minutes[3]		
Moderate Ice Pellets (or Small Hail)[4]	4 minutes	4 minutes	

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. ALLOWANCE TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 These allowance times are for use with undiluted (100/0) fluids applied unheated on aircraft with rotation speeds of 100 knots or greater.
2 Ensure that the lowest operational use temperature (LOUT) is respected.
3 No allowance times exist in this condition for temperatures below 0°C; consider use of light ice pellets mixed with freezing rain.
4 If no intensity is reported with small hail, use the “moderate ice pellets or small hail” allowance times. If an intensity is reported with small hail, the ice pellet condition with the equivalent intensity can be used, e.g. if light small hail is reported, the “light ice pellets” allowance times can be used. This also applies in mixed conditions, e.g. if light small hail mixed with snow is reported, use the “light ice pellets mixed with snow” allowance times.

CAUTIONS

- The responsibility for the application of these data remains with the user.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- Allowance time cannot be extended by an inspection of the aircraft critical surfaces.
- Takeoff is allowed up to 90 minutes after start of fluid application if the precipitation stops at or before the allowance time expires and does not restart. The OAT must not decrease during the 90 minutes to use this guidance in conditions of light ice pellets mixed with either: freezing drizzle, freezing rain or rain.

Appendix A: Transport Canada Adjusted HOT Guidelines Winter 2019-2020

TABLE ADJ-42: ADJUSTED ALLOWANCE TIMES FOR SAE TYPE IV FLUIDS[1]

<table>
<tr><th rowspan="2">Precipitation Type</th><th colspan="4">Outside Air Temperature</th></tr>
<tr><th>-5°C and above</th><th>Below -5 to -10°C</th><th>Below -10 to -16°C</th><th>Below -16 to -22°C[2]</th></tr>
<tr><td>Light Ice Pellets</td><td>38 minutes</td><td>23 minutes</td><td>23 minutes[3]</td><td>23 minutes[3]</td></tr>
<tr><td>Light Ice Pellets Mixed with Snow</td><td>30 minutes</td><td>11 minutes</td><td>11 minutes[3]</td><td rowspan="4"></td></tr>
<tr><td>Light Ice Pellets Mixed with Freezing Drizzle</td><td>19 minutes</td><td>8 minutes</td><td colspan="2" rowspan="3">Caution:
No allowance times currently exist</td></tr>
<tr><td>Light Ice Pellets Mixed with Freezing Rain</td><td>19 minutes</td><td>8 minutes</td></tr>
<tr><td>Light Ice Pellets Mixed with Rain</td><td>19 minutes[4]</td><td></td></tr>
<tr><td>Moderate Ice Pellets (or Small Hail)[5]</td><td>19 minutes[6]</td><td>8 minutes</td><td>8 minutes[3]</td><td>8 minutes[7]</td></tr>
<tr><td>Moderate Ice Pellets (or Small Hail)[5] Mixed with Freezing Drizzle</td><td>8 minutes</td><td>5 minutes</td><td colspan="2" rowspan="2">Caution:
No allowance times currently exist</td></tr>
<tr><td>Moderate Ice Pellets (or Small Hail)[5] Mixed with Rain</td><td>8 minutes[8]</td><td></td></tr>
</table>

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. ALLOWANCE TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 These allowance times are for use with undiluted (100/0) fluids applied on aircraft with rotation speeds of 100 knots or greater. All Type IV fluids are propylene glycol based with the exception of AllClear ClearWing EG, CHEMCO ChemR EG IV, Clariant Max Flight AVIA, Clariant Safewing EG IV NORTH, Dow EG106, LNT Solutions E450 and Oksayd Defrost EG 4, which are ethylene glycol based.
2 Ensure that the lowest operational use temperature (LOUT) is respected.
3 No allowance times exist for propylene glycol (PG) fluids when used on aircraft with rotation speeds less than 115 knots. If the glycol type is unknown, no allowance times exist for aircraft with rotation speeds of less than 115 knots.
4 No allowance times exist in this condition for temperatures below 0°C; consider use of light ice pellets mixed with freezing rain.
5 If no intensity is reported with small hail, use the “moderate ice pellets or small hail” allowance times. If an intensity is reported with small hail, the ice pellet condition with the equivalent intensity can be used, e.g. if light small hail is reported, the “light ice pellets” allowance times can be used. This also applies in mixed conditions, e.g. if light small hail mixed with snow is reported, use the “light ice pellets mixed with snow” allowance times.
6 Allowance time is 14 minutes for propylene glycol (PG) fluids or when the fluid type is unknown.
7 No allowance times exist for propylene glycol (PG) fluids in this condition for temperatures below -16°C.
8 No allowance times exist in this condition for temperatures below 0°C.

CAUTIONS

- The responsibility for the application of these data remains with the user.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- Allowance time cannot be extended by an inspection of the aircraft critical surfaces.
- Takeoff is allowed up to 90 minutes after start of fluid application if the precipitation stops at or before the allowance time expires and does not restart. The OAT must not decrease during the 90 minutes to use this guidance in conditions of light ice pellets mixed with either: freezing drizzle, freezing rain or rain.

APPENDIX B:
TESTING LABORATORIES

TESTING LABORATORIES

The following laboratories are known to provide testing for de/anti-icing fluids given they verifiably adhere to internationally accepted standards and recommended practices that are associated with the holdover times published by Transport Canada.

Please enquire directly with the laboratories for a full list of testing available.

- **Anti-icing Materials International Laboratory (AMIL):** 555, boulevard de l'Université, Chicoutimi, Québec, G7H 2B1, Canada, 418-545-5011 ext. 2406, www.amillaboratory.ca. Provides testing for anti-icing performance (described in AMS1424, AMS1428, and AS5901), aerodynamic acceptance (described in AMS1424, AMS1428 and AS5900), physical properties including fluid stability (described in AMS1424 and AMS1428), environmental information (described in AMS1424 and AMS1428) and most of tests to evaluate materials compatibility (described in AMS1424 and AMS1428).

- **APS Aviation Inc.:** 6700, chemin de la Côte-de-Liesse, Suite 102, Saint-Laurent, Quebec, H4T 2B5, Canada, 514-878-4388, www.apsaviation.ca. Provides endurance time testing (described in ARP5485 and ARP5945).

- **Scientific Material International (SMI):** 12219 SW 131st Avenue, Miami, Florida, USA 33186-6401; 305-971-7047, www.smiinc.com. Provides testing for physical properties including fluid stability (described in AMS1424 and AMS1428), environmental information (described in AMS1424 and AMS1428) and most of tests to evaluate materials compatibility (described in AMS1424 and AMS1428).

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FAA
HOLDOVER TIME GUIDELINES
WINTER 2019-2020

FAA
HOLDOVER TIME GUIDELINES

WINTER 2019-2020
REVISION 1.0: AUGUST 19, 2019

The information contained in this document serves as the official FAA guidance, Holdover Times and Allowance Times for use during the 2019-2020 winter season.

Questions concerning FAA aircraft ground de/anti-icing requirements or Flight Standards policies should be addressed to charles.j.enders@faa.gov or 202-267-4557.

Questions on the technical content of the holdover time tables should be addressed to warren.underwood@faa.gov or 404-305-7267.

Questions regarding editorial content or web access issues should be addressed to sung.shin@faa.gov or 202-267-8086.

This document is designed to be used in conjunction with the FAA N 8900 series notice "Revised FAA-Approved Deicing Program Updates, Winter 2019-2020."

CHANGE CONTROL RECORDS

This page indicates any changes made to individual pages within the document. Changed pages have the appropriate revision date in the footer. Sidebars are shown to assist in identifying where significant changes have been made on these pages.

It is the responsibility of the end user to periodically check the following website for updates: https://www.faa.gov/other_visit/aviation_industry/airline_operators/airline_safety/deicing/.

REVISION	DATE	DESCRIPTION OF CHANGES	AFFECTED PAGES	AUTHOR
1.0	August 19, 2019	1. Invalid references to note 8 have been removed on pages A-23, A-26, A-28, A-35, A-36, A-37, A-39, A-40 & A-42. 2. Correction to note numbering on Table ADJ-31 on page A-33.	A-23, A-26, A-28, A-35, A-36, A-37, A-39, A-40 & A-42 A-33	FAA

TABLE OF CONTENTS

Change Control Records **2**
Table of Contents **3**
How to Use This Document **4**
Highlights and Changes for Winter 2019-2020 ..... **5**
Holdover Time (HOT) Guidelines for Winter 2019-2020 ..... **6**
Table 1: Active Frost Holdover Times for SAE Type I, Type II, Type III, and Type IV Fluids 7
Table 2: Holdover Times for SAE Type I Fluid on Critical Aircraft Surfaces Composed Predominantly of Aluminum 8
Table 3: Holdover Times for SAE Type I Fluid on Critical Aircraft Surfaces Composed Predominantly of Composites 9
Table 4: Generic Holdover Times for SAE Type II Fluids 10
Table 5: Type II Holdover Times for ABAX ECOWING 26 11
Table 6: Type II Holdover Times for ABAX ECOWING AD-2 12
Table 7: Type II Holdover Times for Aviation Shaanxi Hi-Tech Cleanwing II 13
Table 8: Type II Holdover Times for Beijing Yadilite Aviation YD-102 Type II 14
Table 9: Type II Holdover Times for Clariant Safewing MP II FLIGHT 15
Table 10: Type II Holdover Times for Clariant Safewing MP II FLIGHT PLUS 16
Table 11: Type II Holdover Times for Cryotech Polar Guard® II 17
Table 12: Type II Holdover Times for Kilfrost ABC-K Plus 18
Table 13: Type II Holdover Times for Kilfrost Ice Clear II 19
Table 14: Type II Holdover Times for Newave Aerochemical FCY-2 20
Table 15: Type II Holdover Times for Newave Aerochemical FCY-2 Bio+ 21
Table 16: Type II Holdover Times for Oksayd Defrost PG 2 22
Table 17: Type II Holdover Times for ROMCHIM ADD-PROTECT Type II 23
Table 18: Type III Holdover Times for AllClear AeroClear MAX Applied Unheated on Low Speed Aircraft 24
Table 19: Type III Holdover Times for AllClear AeroClear MAX Applied Unheated on High Speed Aircraft 25
Table 20: Generic Holdover Times for SAE Type IV Fluids 26
Table 21: Type IV Holdover Times for ABAX ECOWING AD-49 27
Table 22: Type IV Holdover Times for AllClear ClearWing EG 28
Table 23: Type IV Holdover Times for CHEMCO ChemR EG IV 29
Table 24: Type IV Holdover Times for Clariant Max Flight 04 30
Table 25: Type IV Holdover Times for Clariant Max Flight AVIA 31
Table 26: Type IV Holdover Times for Clariant Max Flight SNEG 32
Table 27: Type IV Holdover Times for Clariant Safewing EG IV NORTH 33
Table 28: Type IV Holdover Times for Clariant Safewing MP IV LAUNCH 34
Table 29: Type IV Holdover Times for Clariant Safewing MP IV LAUNCH PLUS 35
Table 30: Type IV Holdover Times for Cryotech Polar Guard® Advance 36
Table 31: Type IV Holdover Times for Cryotech Polar Guard® Xtend 37
Table 32: Type IV Holdover Times for Dow Chemical UCAR™ Endurance EG106 38
Table 33: Type IV Holdover Times for Dow Chemical UCAR™ FlightGuard AD-49 39
Table 34: Type IV Holdover Times for Inland Technologies ECO-SHIELD® 40
Table 35: Type IV Holdover Times for Kilfrost ABC-S Plus 41
Table 36: Type IV Holdover Times for LNT Solutions E450 42
Table 37: Type IV Holdover Times for Newave Aerochemical FCY 9311 43
Table 38: Type IV Holdover Times for Oksayd Defrost ECO 4 44
Table 39: Type IV Holdover Times for Oksayd Defrost EG 4 45
Table 40: Type IV Holdover Times for Shaanxi Cleanway Aviation Cleansurface IV 46
Allowance Times Tables for Winter 2019-2020 ..... **47**
Table 41: Allowance Times for SAE Type III Fluids 48
Table 42: Allowance Times for SAE Type IV Fluids 49
Supplemental Guidance for Winter 2019-2020 ..... **50**
Table 43: Snowfall Intensities as a Function of Prevailing Visibility 51
Table 44: Type I Fluids Tested for Anti-Icing Performance and Aerodynamic Acceptance 52
Table 45: Type II Fluids Tested for Anti-Icing Performance and Aerodynamic Acceptance 55
Table 46: Type III Fluids Tested for Anti-Icing Performance and Aerodynamic Acceptance 57
Table 47: Type IV Fluids Tested for Anti-Icing Performance and Aerodynamic Acceptance 58
Table 48: Guidelines for the Application of SAE Type I Fluid 61
Table 49: Guidelines for the Application of SAE Type II and IV Fluid 62
Table 50: Guidelines for the Application of Unheated SAE Type III Fluid 63
Appendix A: Adjusted Holdover Time (HOT) Guidelines **A-1**
Appendix B: Testing Laboratories **B-1**

HOW TO USE THIS DOCUMENT

Complementary Document

This document is designed to be used in conjunction with the FAA N 8900 series notice "Revised FAA-Approved Deicing Program Updates, Winter 2019-2020." The two documents complement each other and should be used together for a thorough understanding of the subject matter.

Applicability

A new version of this document is published for each winter operating season, typically early in the August preceding the winter operating season. Updates to the winter's document may be published any time after the Original Issue document is published. When a new document is published, either mid-season or each new season, the previous document becomes obsolete. It is the responsibility of the end user to periodically check for document updates on the following website:
https://www.faa.gov/other_visit/aviation_industry/airline_operators/airline_safety/deicing/.

Main Document Structure and Content

This document is divided into several sections.

- Change Control Records: Provides details of any changes made to the document in mid-season document updates.
- Table of Contents: Provides a list of sections, tables, and appendices in the document.
- How to Use This Document: Provides top level guidance on how to use the document.
- Highlights and Changes for Winter 2019-2020: Describes key changes made to the document for the current winter operating season.
- Holdover Time Guidelines: Series of tables which provide estimated holdover times (in hh:mm). Fluids are divided by fluid type (Type I, II, III, and IV), aircraft construction materials (Type I only), fluid brand (Type II, III, IV), aircraft rotation speed (Type III only), and fluid application temperature (Type III only). Columns in the tables divide the information by precipitation type; rows in the tables divide the information by temperature and fluid dilution.
- Allowance Times Tables: Tables which provide allowance times (in minutes) for Type III and Type IV fluids. Rows in the tables divide the information by precipitation type; columns in the tables divide the information by temperature.
- Supplementary Guidance: Series of tables which provide supplementary information for using the holdover time guidelines and allowance times tables. Includes a table for estimating snowfall intensity from prevailing visibility, tables of fluid information (one table per fluid type), and tables of fluid application guidance (by fluid type).

Appendices

The appendices contain complementary content.

- Appendix A: Provides adjusted holdover time guidelines (holdover time guidelines and allowance times tables) for operations when flaps and slats are deployed prior to de/anti-icing.
- Appendix B: Provides information on laboratories involved in testing de/anti-icing fluids.

HIGHLIGHTS AND CHANGES FOR WINTER 2019-2020

CHANGED FROM PREVIOUS YEAR

The principal changes from the previous year are briefly indicated herein.

Holdover Time Tables

- Fluid-specific HOT guidelines have been created for three new fluids: ROMCHIM ADD-PROTECT Type II (Type II), AllClear ClearWing EG (Type IV), and Cryotech Polar Guard® Xtend (Type IV).
- Minor decreases have been made to the Type II generic holdover times as a result of the new fluids and data.
- Minor decreases have been made to the Type IV generic holdover times as a result of the new fluids and data.
- The analysis methodology used to determine HOTs for very cold snow (below -14°C) for Type II and Type IV fluids which do not have fluid-specific very cold snow data was updated this year. As a result, HOTs for very cold snow for all Type II/IV fluids which do not have fluid-specific data have been updated (primarily reductions). Note that the updated values are different for Type II vs. Type IV fluids and for propylene glycol vs. ethylene glycol based fluids. Fluids which are not affected by this change include: Clariant Safewing MP II FLIGHT, Clariant Safewing MP IV LAUNCH, Clariant Safewing MP IV LAUNCH PLUS, Cryotech Polar Guard® II, Cryotech Polar Guard® Advance, Dow Endurance EG106, and LNT Solutions E450.
- The protocol used to determine fluid-specific HOTs for snow below -29°C was finalized this year. This resulted in minor changes to the snow HOTs in the "below -25°C to LOUT" temperature band for Cryotech Polar Guard® II and Cryotech Polar Guard® Advance.

Allowance Times Tables

- The third note in the Type IV allowance time tables has been modified to clarify that if the glycol type is unknown, no allowance times exist for aircraft with rotation speeds of less than 115 knots.

Supplemental Guidance

- The list of fluids (Tables 44, 45, 46 and 47) has been updated to reflect the latest information available on all de/anti-icing fluids.
- The table for the application of Heated Type III fluid has been removed as there are currently no Type III fluids with HOTs for heated applications.
- The first note in the Type II/III/IV fluid application table has been modified to make clear that HOTs do not exist below the lowest temperatures stated in the HOT table bands.

UNCHANGED FROM PREVIOUS YEAR

Holdover Time Tables

- The active frost holdover time (HOT) guidelines are unchanged.
- The Type I HOT guidelines are unchanged.

Allowance Times Tables

- The Type III allowance times tables are unchanged.

Supplemental Guidance

- The Type I and Type III Unheated fluid application tables are unchanged.

HOLDOVER TIME (HOT) GUIDELINES FOR WINTER 2019-2020

TABLE 1: ACTIVE FROST HOLDOVER TIMES FOR SAE TYPE I, TYPE II, TYPE III, AND TYPE IV FLUIDS

Outside Air Temperature[1,2,3]	Type I
-1 °C and above (30 °F and above)	0:45 *(0:35)*[5]
below -1 to -3 °C (below 30 to 27 °F)	
below -3 to -10 °C (below 27 to 14 °F)	
below -10 to -14 °C (below 14 to 7 °F)	
below -14 to -21 °C (below 7 to -6 °F)	
below -21 to -25 °C (below -6 to -13 °F)	
below -25 °C to LOUT (below -13 °F to LOUT)	

Outside Air Temperature[2,3]	Concentration Fluid/Water By % Volume	Type II	Type III[4]	Type IV
-1 °C and above (30 °F and above)	100/0	8:00	2:00	12:00
	75/25	5:00	1:00	5:00
	50/50	3:00	0:30	3:00
below -1 to -3 °C (below 30 to 27 °F)	100/0	8:00	2:00	12:00
	75/25	5:00	1:00	5:00
	50/50	1:30	0:30	3:00
below -3 to -10 °C (below 27 to 14 °F)	100/0	8:00	2:00	10:00
	75/25	5:00	1:00	5:00
below -10 to -14 °C (below 14 to 7 °F)	100/0	6:00	2:00	6:00
	75/25	1:00	1:00	1:00
below -14 to -21 °C (below 7 to -6 °F)	100/0	6:00	2:00	6:00
below -21 to -25 °C (below -6 to -13 °F)	100/0	2:00	2:00	4:00
below -25 °C (below -13 °F)	100/0	No Holdover Time Guidelines Exist		

NOTES

1 Type I Fluid / Water Mixture must be selected so that the freezing point of the mixture is at least 10 °C (18 °F) below outside air temperature.
2 Ensure that the lowest operational use temperature (LOUT) is respected.
3 Changes in outside air temperature (OAT) over the course of longer frost events can be significant; the appropriate holdover time to use is the one provided for the coldest OAT that has occurred in the time between the de/anti-icing fluid application and takeoff.
4 To use the Type III fluid frost holdover times, the fluid brand being used must be known. AllClear AeroClear MAX must be applied unheated.
5 Value in parentheses is for aircraft with critical surfaces that are predominantly or entirely constructed of composite materials.

CAUTIONS

- The responsibility for the application of these data remains with the user.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

TABLE 2: HOLDOVER TIMES FOR SAE TYPE I FLUID ON CRITICAL AIRCRAFT SURFACES COMPOSED PREDOMINANTLY OF ALUMINUM

Outside Air Temperature[1,2]	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[3,4]	Light Snow, Snow Grains or Snow Pellets[3,4]	Moderate Snow, Snow Grains or Snow Pellets[3]	Freezing Drizzle[5]	Light Freezing Rain	Rain on Cold Soaked Wing[6]	Other[7]
-3 °C and above (27 °F and above)	0:11 - 0:17	0:18 - 0:22	0:11 - 0:18	0:06 - 0:11	0:09 - 0:13	0:02 - 0:05	0:02 - 0:05	
below -3 to -6 °C (below 27 to 21 °F)	0:08 - 0:13	0:14 - 0:17	0:08 - 0:14	0:05 - 0:08	0:05 - 0:09	0:02 - 0:05	CAUTION: No holdover time guidelines exist	
below -6 to -10 °C (below 21 to 14 °F)	0:06 - 0:10	0:11 - 0:13	0:06 - 0:11	0:04 - 0:06	0:04 - 0:07	0:02 - 0:05		
below -10 °C (below 14 °F)	0:05 - 0:09	0:07 - 0:08	0:04 - 0:07	0:02 - 0:04				

NOTES

1 Type I fluid / water mixture must be selected so that the freezing point of the mixture is at least 10 °C (18 °F) below outside air temperature.
2 Ensure that the lowest operational use temperature (LOUT) is respected.
3 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
4 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
5 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
6 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
7 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

TABLE 3: HOLDOVER TIMES FOR SAE TYPE I FLUID ON CRITICAL AIRCRAFT SURFACES COMPOSED PREDOMINANTLY OF COMPOSITES

Outside Air Temperature[1,2]	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[3,4]	Light Snow, Snow Grains or Snow Pellets[3,4]	Moderate Snow, Snow Grains or Snow Pellets[3]	Freezing Drizzle[5]	Light Freezing Rain	Rain on Cold Soaked Wing[6]	Other[7]
-3 °C and above (27 °F and above)	0:09 - 0:16	0:12 - 0:15	0:06 - 0:12	0:03 - 0:06	0:08 - 0:13	0:02 - 0:05	0:01 - 0:05	
below -3 to -6 °C (below 27 to 21 °F)	0:06 - 0:08	0:11 - 0:13	0:05 - 0:11	0:02 - 0:05	0:05 - 0:09	0:02 - 0:05	CAUTION: No holdover time guidelines exist	
below -6 to -10 °C (below 21 to 14 °F)	0:04 - 0:08	0:09 - 0:12	0:05 - 0:09	0:02 - 0:05	0:04 - 0:07	0:02 - 0:05		
below -10 °C (below 14 °F)	0:04 - 0:07	0:07 - 0:08	0:04 - 0:07	0:02 - 0:04				

NOTES

1 Type I fluid / water mixture must be selected so that the freezing point of the mixture is at least 10 °C (18 °F) below outside air temperature.
2 Ensure that the lowest operational use temperature (LOUT) is respected.
3 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
4 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
5 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
6 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
7 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

TABLE 4: GENERIC HOLDOVER TIMES FOR SAE TYPE II FLUIDS

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets[2,3]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	0:55 - 1:50	0:25 - 0:50	0:30 - 1:00	0:20 - 0:35	0:08 - 0:45	
	75/25	0:25 - 0:55	0:15 - 0:25	0:15 - 0:40	0:10 - 0:20	0:04 - 0:25	
	50/50	0:15 - 0:25	0:05 - 0:10	0:08 - 0:15	0:06 - 0:09	CAUTION: No holdover time guidelines exist	
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:30 - 0:45	0:20 - 0:35	0:20 - 0:45	0:15 - 0:20		
	75/25	0:25 - 0:50	0:10 - 0:20	0:15 - 0:25	0:08 - 0:15		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:30 - 0:45	0:15 - 0:30	0:20 - 0:45[7]	0:15 - 0:20[7]		
	75/25	0:25 - 0:50	0:08 - 0:20	0:15 - 0:25[7]	0:08 - 0:15[7]		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:15 - 0:25	0:02 - 0:07				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:15 - 0:25[8]	0:01 - 0:03[8]				
below -25 °C to LOUT (below -13 °F to LOUT)	100/0	0:15 - 0:25[8]	0:00 - 0:01[8]				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).
8 If the LOUT is unknown, no holdover time guidelines exist below -24 °C (-11 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

TABLE 5: TYPE II HOLDOVER TIMES FOR ABAX ECOWING 26

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	1:25 - 2:35	1:35 - 1:50	1:00 - 1:35	0:40 - 1:00	0:50 - 1:35	0:40 - 0:50	0:20 - 1:25	
	75/25	1:05 - 1:55	1:20 - 1:40	0:40 - 1:20	0:20 - 0:40	0:45 - 1:05	0:25 - 0:35	0:10 - 1:00	
	50/50	0:30 - 0:45	0:40 - 0:50	0:20 - 0:40	0:07 - 0:20	0:15 - 0:25	0:08 - 0:10	CAUTION: No holdover time guidelines exist	
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:45 - 2:15	1:30 - 1:45	0:55 - 1:30	0:35 - 0:55	0:30 - 1:10	0:15 - 0:35		
	75/25	0:35 - 1:15	1:05 - 1:20	0:35 - 1:05	0:20 - 0:35	0:20 - 0:50	0:15 - 0:25		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:45 - 2:15	1:25 - 1:40	0:55 - 1:25	0:35 - 0:55	0:30 - 1:10[7]	0:15 - 0:35[7]		
	75/25	0:35 - 1:15	0:55 - 1:10	0:30 - 0:55	0:15 - 0:30	0:20 - 0:50[7]	0:15 - 0:25[7]		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:25 - 0:45	0:20 - 0:30	0:07 - 0:20	0:02 - 0:07				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:25 - 0:45	0:09 - 0:15	0:03 - 0:09	0:01 - 0:03				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

TABLE 6: TYPE II HOLDOVER TIMES FOR ABAX ECOWING AD-2

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	1:20 - 3:00	2:25 - 2:55	1:15 - 2:25	0:40 - 1:15	0:40 - 1:40	0:30 - 0:45	0:09 - 1:25	
	75/25	1:15 - 1:25	1:45 - 2:10	0:55 - 1:45	0:25 - 0:55	0:35 - 1:05	0:20 - 0:30	0:04 - 0:50	
	50/50	0:15 - 0:30	0:35 - 0:40	0:15 - 0:35	0:07 - 0:15	0:09 - 0:15	0:06 - 0:09	CAUTION: No holdover time guidelines exist	
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:45 - 2:30	2:00 - 2:25	1:00 - 2:00	0:30 - 1:00	0:25 - 1:10	0:20 - 0:30		
	75/25	0:35 - 1:55	1:40 - 2:05	0:50 - 1:40	0:25 - 0:50	0:15 - 0:55	0:20 - 0:35		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:45 - 2:30	1:45 - 2:05	0:55 - 1:45	0:30 - 0:55	0:25 - 1:10[7]	0:20 - 0:30[7]		
	75/25	0:35 - 1:55	1:35 - 2:00	0:50 - 1:35	0:25 - 0:50	0:15 - 0:55[7]	0:20 - 0:35[7]		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:15 - 0:40	0:20 - 0:30	0:07 - 0:20	0:02 - 0:07				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:15 - 0:40	0:09 - 0:15	0:03 - 0:09	0:01 - 0:03				
below -25 to -27 °C (below -13 to -17 °F)	100/0	0:15 - 0:40	0:05 - 0:07	0:01 - 0:05	0:00 - 0:01				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

TABLE 7: TYPE II HOLDOVER TIMES FOR AVIATION SHAANXI HI-TECH CLEANWING II

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets[2,3]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	0:55 - 1:50	0:30 - 0:55	0:35 - 1:05	0:25 - 0:35	0:10 - 0:55	
	75/25	0:50 - 1:20	0:25 - 0:45	0:35 - 1:00	0:20 - 0:30	0:07 - 0:50	
	50/50	0:35 - 1:00	0:15 - 0:30	0:20 - 0:40	0:10 - 0:20	CAUTION: No holdover time guidelines exist	
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:45 - 1:50	0:30 - 0:55	0:30 - 0:55	0:20 - 0:25		
	75/25	0:40 - 1:45	0:25 - 0:45	0:35 - 0:40	0:20 - 0:25		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:45 - 1:50	0:30 - 0:55	0:30 - 0:55[7]	0:20 - 0:25[7]		
	75/25	0:40 - 1:45	0:25 - 0:45	0:35 - 0:40[7]	0:20 - 0:25[7]		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:20 - 0:50	0:02 - 0:07				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:20 - 0:50	0:01 - 0:03				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

TABLE 8: TYPE II HOLDOVER TIMES FOR BEIJING YADILITE AVIATION YD-102 TYPE II

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	1:10 - 2:00	1:40 - 2:00	0:50 - 1:40	0:25 - 0:50	0:40 - 1:15	0:35 - 0:40	0:10 - 1:00	
	75/25	0:25 - 0:55	0:50 - 1:05	0:25 - 0:50	0:15 - 0:25	0:15 - 0:40	0:10 - 0:20	0:04 - 0:25	
	50/50	0:15 - 0:25	0:25 - 0:30	0:10 - 0:25	0:05 - 0:10	0:08 - 0:15	0:07 - 0:09	CAUTION: No holdover time guidelines exist	
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:45 - 1:30	1:15 - 1:30	0:35 - 1:15	0:20 - 0:35	0:35 - 0:50	0:25 - 0:25		
	75/25	0:30 - 0:50	0:40 - 0:50	0:20 - 0:40	0:10 - 0:20	0:15 - 0:25	0:09 - 0:15		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:45 - 1:30	1:00 - 1:15	0:30 - 1:00	0:15 - 0:30	0:35 - 0:50[7]	0:25 - 0:25[7]		
	75/25	0:30 - 0:50	0:35 - 0:45	0:20 - 0:35	0:08 - 0:20	0:15 - 0:25[7]	0:09 - 0:15[7]		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:20 - 0:45	0:20 - 0:30	0:07 - 0:20	0:02 - 0:07				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:20 - 0:45	0:09 - 0:15	0:03 - 0:09	0:01 - 0:03				
below -25 to -29 °C (below -13 to -20 °F)	100/0	0:20 - 0:45	0:05 - 0:07	0:01 - 0:05	0:00 - 0:01				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

TABLE 9: TYPE II HOLDOVER TIMES FOR CLARIANT SAFEWING MP II FLIGHT

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	3:30 - 4:00	2:35 - 3:00	1:35 - 2:35	1:00 - 1:35	1:20 - 2:00	0:45 - 1:25	0:10 - 1:30	
	75/25	1:50 - 2:45	2:35 - 3:00	1:20 - 2:35	0:40 - 1:20	1:10 - 1:30	0:30 - 0:55	0:06 - 0:50	
	50/50	0:55 - 1:45	0:45 - 0:55	0:25 - 0:45	0:10 - 0:25	0:20 - 0:30	0:10 - 0:15	CAUTION: No holdover time guidelines exist	
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:55 - 1:45	2:05 - 2:30	1:15 - 2:05	0:45 - 1:15	0:35 - 1:30	0:25 - 0:45		
	75/25	0:25 - 1:05	1:45 - 2:10	0:55 - 1:45	0:30 - 0:55	0:25 - 1:10	0:20 - 0:35		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:55 - 1:45	1:50 - 2:10	1:05 - 1:50	0:40 - 1:05	0:35 - 1:30[7]	0:25 - 0:45[7]		
	75/25	0:25 - 1:05	1:20 - 1:40	0:40 - 1:20	0:20 - 0:40	0:25 - 1:10[7]	0:20 - 0:35[7]		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:30 - 0:50	1:10 - 1:40	0:25 - 1:10	0:08 - 0:25				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:30 - 0:50	0:30 - 0:40	0:10 - 0:30	0:03 - 0:10				
below -25 to -29 °C (below -13 to -20 °F)	100/0	0:30 - 0:50	0:20 - 0:30	0:07 - 0:20	0:02 - 0:07				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

TABLE 10: TYPE II HOLDOVER TIMES FOR CLARIANT SAFEWING MP II FLIGHT PLUS

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets[2,3]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	2:40 - 4:00	0:50 - 1:50	1:25 - 2:00	0:45 - 1:00	0:15 - 2:00	
	75/25	2:35 - 4:00	1:00 - 1:45	1:35 - 2:00	0:50 - 1:15	0:15 - 1:15	
	50/50	1:05 - 2:20	0:15 - 0:25	0:30 - 1:05	0:15 - 0:20	CAUTION: No holdover time guidelines exist	
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:40 - 2:20	0:40 - 1:30	0:35 - 1:25	0:35 - 0:55		
	75/25	0:30 - 1:45	1:00 - 1:40	0:25 - 1:10	0:30 - 0:45		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:40 - 2:20	0:35 - 1:15	0:35 - 1:25[7]	0:35 - 0:55[7]		
	75/25	0:30 - 1:45	0:55 - 1:40	0:25 - 1:10[7]	0:30 - 0:45[7]		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:20 - 0:40	0:02 - 0:07				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:20 - 0:40	0:01 - 0:03				
below -25 to -29 °C (below -13 to -20 °F)	100/0	0:20 - 0:40	0:00 - 0:01				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

TABLE 11: TYPE II HOLDOVER TIMES FOR CRYOTECH POLAR GUARD® II

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	2:50 - 4:00	3:00 - 3:00	1:55 - 3:00	1:05 - 1:55	1:35 - 2:00	1:15 - 1:30	0:15 - 2:00	
	75/25	2:30 - 4:00	3:00 - 3:00	1:25 - 3:00	0:40 - 1:25	1:40 - 2:00	0:40 - 1:10	0:09 - 1:40	
	50/50	0:50 - 1:25	1:10 - 1:35	0:25 - 1:10	0:10 - 0:25	0:20 - 0:45	0:09 - 0:20	CAUTION: No holdover time guidelines exist	
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:55 - 2:30	2:25 - 2:50	1:25 - 2:25	0:50 - 1:25	0:35 - 1:35	0:35 - 0:45		
	75/25	0:40 - 1:30	2:20 - 3:00	1:05 - 2:20	0:30 - 1:05	0:25 - 1:05	0:35 - 0:45		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:55 - 2:30	2:00 - 2:20	1:10 - 2:00	0:40 - 1:10	0:35 - 1:35[7]	0:35 - 0:45[7]		
	75/25	0:40 - 1:30	2:00 - 2:30	0:55 - 2:00	0:25 - 0:55	0:25 - 1:05[7]	0:35 - 0:45[7]		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:25 - 0:50	1:35 - 2:15	0:35 - 1:35	0:10 - 0:35				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:25 - 0:50	0:40 - 0:55	0:15 - 0:40	0:04 - 0:15				
below -25 to -30.5 °C (below -13 to -23 °F)	100/0	0:25 - 0:50	0:25 - 0:30	0:07 - 0:25	0:02 - 0:07				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

TABLE 12: TYPE II HOLDOVER TIMES FOR KILFROST ABC-K PLUS

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets[2,3]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	2:15 - 3:45	1:00 - 1:40	1:50 - 2:00	1:00 - 1:25	0:20 - 2:00	
	75/25	1:40 - 2:30	0:35 - 1:10	1:25 - 2:00	0:50 - 1:10	0:15 - 2:00	
	50/50	0:35 - 1:05	0:07 - 0:15	0:20 - 0:30	0:10 - 0:15	CAUTION: No holdover time guidelines exist	
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:30 - 1:05	0:55 - 1:30	0:25 - 1:00	0:15 - 0:35		
	75/25	0:25 - 1:25	0:35 - 1:05	0:20 - 0:55	0:09 - 0:30		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:30 - 1:05	0:50 - 1:25	0:25 - 1:00[7]	0:15 - 0:35[7]		
	75/25	0:25 - 1:25	0:35 - 1:05	0:20 - 0:55[7]	0:09 - 0:30[7]		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:30 - 0:55	0:02 - 0:07				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:30 - 0:55	0:01 - 0:03				
below -25 to -29 °C (below -13 to -20 °F)	100/0	0:30 - 0:55	0:00 - 0:01				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

TABLE 13: TYPE II HOLDOVER TIMES FOR KILFROST ICE CLEAR II

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	1:05 - 2:00	2:00 - 2:25	1:05 - 2:00	0:35 - 1:05	0:35 - 1:00	0:25 - 0:40	0:10 - 1:05	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A		
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:55 - 1:55	1:45 - 2:10	0:55 - 1:45	0:30 - 0:55	0:40 - 1:00	0:25 - 0:30		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:55 - 1:55	1:40 - 2:00	0:55 - 1:40	0:30 - 0:55	0:40 - 1:00[7]	0:25 - 0:30[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:30 - 0:55	0:20 - 0:30	0:07 - 0:20	0:02 - 0:07				
below -18 to -24 °C (below 0 to -11 °F)	100/0	0:30 - 0:55	0:09 - 0:15	0:03 - 0:09	0:01 - 0:03				

CAUTION: No holdover time guidelines exist

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

TABLE 14: TYPE II HOLDOVER TIMES FOR NEWAVE AEROCHEMICAL FCY-2

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets[2,3]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	1:15 - 2:25	0:30 - 0:55	0:35 - 1:05	0:25 - 0:35	0:08 - 0:45	
	75/25	0:50 - 1:30	0:20 - 0:40	0:25 - 0:45	0:15 - 0:25	0:05 - 0:25	
	50/50	0:25 - 0:35	0:15 - 0:25	0:10 - 0:20	0:07 - 0:10	CAUTION: No holdover time guidelines exist	
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:45 - 1:30	0:20 - 0:40	0:20 - 0:45	0:15 - 0:20		
	75/25	0:30 - 1:05	0:15 - 0:25	0:15 - 0:30	0:08 - 0:15		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:45 - 1:30	0:15 - 0:30	0:20 - 0:45[7]	0:15 - 0:20[7]		
	75/25	0:30 - 1:05	0:10 - 0:20	0:15 - 0:30[7]	0:08 - 0:15[7]		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:25 - 0:35	0:02 - 0:07				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:25 - 0:35	0:01 - 0:03				
below -25 to -28 °C (below -13 to -18 °F)	100/0	0:25 - 0:35	0:00 - 0:01				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

TABLE 15: TYPE II HOLDOVER TIMES FOR NEWAVE AEROCHEMICAL FCY-2 BIO+

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	1:25 - 2:30	2:20 - 2:55	1:05 - 2:20	0:30 - 1:05	0:50 - 1:20	0:25 - 0:45	0:08 - 1:15	
	75/25	0:45 - 1:20	1:20 - 1:40	0:40 - 1:20	0:20 - 0:40	0:25 - 0:50	0:15 - 0:25	0:06 - 0:35	
	50/50	0:15 - 0:30	0:25 - 0:30	0:15 - 0:25	0:08 - 0:15	0:10 - 0:20	0:08 - 0:10	CAUTION: No holdover time guidelines exist	
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:40 - 1:30	1:25 - 1:50	0:40 - 1:25	0:20 - 0:40	0:35 - 1:05	0:15 - 0:30		
	75/25	0:30 - 1:05	0:50 - 1:05	0:25 - 0:50	0:10 - 0:25	0:20 - 0:35	0:15 - 0:20		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:40 - 1:30	1:00 - 1:15	0:30 - 1:00	0:15 - 0:30	0:35 - 1:05[7]	0:15 - 0:30[7]		
	75/25	0:30 - 1:05	0:35 - 0:45	0:20 - 0:35	0:08 - 0:20	0:20 - 0:35[7]	0:15 - 0:20[7]		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:20 - 1:00	0:20 - 0:30	0:07 - 0:20	0:02 - 0:07				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:20 - 1:00	0:09 - 0:15	0:03 - 0:09	0:01 - 0:03				
below -25 to -28.5 °C (below -13 to -19 °F)	100/0	0:20 - 1:00	0:05 - 0:07	0:01 - 0:05	0:00 - 0:01				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

TABLE 16: TYPE II HOLDOVER TIMES FOR OKSAYD DEFROST PG 2

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	0:55 - 1:50	1:50 - 2:15	0:55 - 1:50	0:30 - 0:55	0:30 - 1:00	0:20 - 0:35	0:10 - 1:20	
	75/25	1:05 - 2:00	1:45 - 2:15	0:45 - 1:45	0:20 - 0:45	0:25 - 0:50	0:15 - 0:30	0:06 - 0:35	
	50/50	1:00 - 1:50	2:10 - 2:40	1:00 - 2:10	0:30 - 1:00	0:30 - 0:50	0:15 - 0:30	CAUTION: No holdover time guidelines exist	
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:55 - 1:25	1:25 - 1:45	0:45 - 1:25	0:25 - 0:45	0:35 - 0:50	0:20 - 0:30		
	75/25	0:40 - 1:20	1:10 - 1:30	0:30 - 1:10	0:15 - 0:30	0:25 - 0:40	0:15 - 0:20		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:55 - 1:25	1:15 - 1:30	0:40 - 1:15	0:20 - 0:40	0:35 - 0:50[7]	0:20 - 0:30[7]		
	75/25	0:40 - 1:20	0:55 - 1:05	0:25 - 0:55	0:10 - 0:25	0:25 - 0:40[7]	0:15 - 0:20[7]		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:35 - 1:05	0:20 - 0:30	0:07 - 0:20	0:02 - 0:07				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:35 - 1:05	0:09 - 0:15	0:03 - 0:09	0:01 - 0:03				
below -25 to -27 °C (below -13 to -17 °F)	100/0	0:35 - 1:05	0:05 - 0:07	0:01 - 0:05	0:00 - 0:01				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

TABLE 17: TYPE II HOLDOVER TIMES FOR ROMCHIM ADD-PROTECT TYPE II

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	1:40 - 3:30	1:55 - 2:25	1:00 - 1:55	0:30 - 1:00	0:40 - 1:35	0:25 - 0:45	0:09 - 0:50	
	75/25	0:40 - 1:10	1:00 - 1:10	0:30 - 1:00	0:15 - 0:30	0:25 - 0:40	0:15 - 0:25	0:05 - 0:25	
	50/50	0:20 - 0:35	0:30 - 0:35	0:15 - 0:30	0:09 - 0:15	0:10 - 0:30	0:08 - 0:10	CAUTION: No holdover time guidelines exist	
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:30 - 0:45	1:20 - 1:40	0:40 - 1:20	0:20 - 0:40	0:25 - 0:50	0:20 - 0:30		
	75/25	0:30 - 0:55	0:40 - 0:50	0:25 - 0:40	0:10 - 0:25	0:20 - 0:30	0:15 - 0:20		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:30 - 0:45	1:05 - 1:20	0:35 - 1:05	0:15 - 0:35	0:25 - 0:50[7]	0:20 - 0:30[7]		
	75/25	0:30 - 0:55	0:35 - 0:40	0:20 - 0:35	0:09 - 0:20	0:20 - 0:30[7]	0:15 - 0:20[7]		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:15 - 0:25	0:20 - 0:30	0:07 - 0:20	0:02 - 0:07				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:15 - 0:25	0:09 - 0:15	0:03 - 0:09	0:01 - 0:03				
below -25 to -28 °C (below -13 to -18 °F)	100/0	0:15 - 0:25	0:05 - 0:07	0:01 - 0:05	0:00 - 0:01				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

TABLE 18: TYPE III HOLDOVER TIMES FOR ALLCLEAR AEROCLEAR MAX APPLIED UNHEATED ON LOW SPEED AIRCRAFT[1]

Outside Air Temperature[2]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[3,4]	Light Snow, Snow Grains or Snow Pellets[3,4]	Moderate Snow, Snow Grains or Snow Pellets[3]	Freezing Drizzle[5]	Light Freezing Rain	Rain on Cold Soaked Wing[6]	Other[7]
-3 °C and above (27 °F and above)	100/0	0:45 - 1:55	1:20 - 1:45	0:40 - 1:20	0:18 - 0:40	0:25 - 0:50	0:14 - 0:25	0:05 - 0:40	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A	CAUTION: No holdover time guidelines exist	
below -3 to -10 °C (below 27 to 14 °F)	100/0	0:50 - 1:40	1:20 - 1:45	0:40 - 1:20	0:18 - 0:40	0:25 - 0:45	0:15 - 0:25		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -10 to -16 °C (below 14 to 3 °F)	100/0	0:40 - 1:45	1:20 - 1:45	0:40 - 1:20	0:18 - 0:40				

NOTES

1 These holdover times are for aircraft conforming to the SAE AS5900 low speed aerodynamic test criterion. Fluid must be applied unheated to use these holdover times. No holdover times exist for this fluid applied heated.
2 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type III fluid cannot be used.
3 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
4 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
5 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
6 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
7 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

TABLE 19: TYPE III HOLDOVER TIMES FOR ALLCLEAR AEROCLEAR MAX APPLIED UNHEATED ON HIGH SPEED AIRCRAFT[1]

Outside Air Temperature[2]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[3,4]	Light Snow, Snow Grains or Snow Pellets[3,4]	Moderate Snow, Snow Grains or Snow Pellets[3]	Freezing Drizzle[5]	Light Freezing Rain	Rain on Cold Soaked Wing[6]	Other[7]
-3 °C and above (27 °F and above)	100/0	0:45 - 1:55	1:20 - 1:45	0:40 - 1:20	0:18 - 0:40	0:25 - 0:50	0:14 - 0:25	0:05 - 0:40	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A		
below -3 to -10 °C (below 27 to 14 °F)	100/0	0:50 - 1:40	1:20 - 1:45	0:40 - 1:20	0:18 - 0:40	0:25 - 0:45	0:15 - 0:25		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -10 to -25 °C (below 14 to -13 °F)	100/0	0:40 - 1:45	1:20 - 1:45	0:40 - 1:20	0:18 - 0:40			CAUTION: No holdover time guidelines exist	
below -25 to -35 °C (below -13 to -31 °F)	100/0	0:25 - 1:00	0:45 - 1:00	0:20 - 0:45	0:10 - 0:20				

NOTES

1 These holdover times are for aircraft conforming to the SAE AS5900 high speed aerodynamic test criterion. Fluid must be applied unheated to use these holdover times. No holdover times exist for this fluid applied heated.
2 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type III fluid cannot be used.
3 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
4 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
5 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
6 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
7 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table 41 provides allowance times for ice pellets and small hail for SAE Type III fluids, applied unheated).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

TABLE 20: GENERIC HOLDOVER TIMES FOR SAE TYPE IV FLUIDS

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	1:15 - 2:40	2:20 - 2:45	1:10 - 2:20	0:35 - 1:10	0:40 - 1:30	0:25 - 0:40	0:08 - 1:10	
	75/25	1:25 - 2:40	2:05 - 2:25	1:15 - 2:05	0:40 - 1:15	0:50 - 1:20	0:30 - 0:45	0:09 - 1:15	
	50/50	0:30 - 0:55	1:00 - 1:10	0:25 - 1:00	0:10 - 0:25	0:15 - 0:40	0:09 - 0:20		
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:20 - 1:35	1:50 - 2:20	0:55 - 1:50	0:30 - 0:55	0:25 - 1:20	0:20 - 0:25		
	75/25	0:30 - 1:20	1:50 - 2:10	1:00 - 1:50	0:30 - 1:00	0:20 - 1:05	0:15 - 0:25		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:20 - 1:35	1:20 - 1:40	0:45 - 1:20	0:25 - 0:45	0:25 - 1:20[7]	0:20 - 0:25[7]		
	75/25	0:30 - 1:20	1:40 - 2:00	0:45 - 1:40	0:20 - 0:45	0:20 - 1:05[7]	0:15 - 0:25[7]		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:20 - 0:40	0:30 - 0:45	0:09 - 0:30	0:02 - 0:09				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:20 - 0:40[8]	0:10 - 0:20[8]	0:03 - 0:10[8]	0:01 - 0:03[8]				
below -25 °C to LOUT (below -13 °F to LOUT)	100/0	0:20 - 0:40[8]	0:07 - 0:10[8]	0:02 - 0:07[8]	0:00 - 0:02[8]				

CAUTION: No holdover time guidelines exist

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table 42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).
8 If the LOUT is unknown, no holdover time guidelines exist below -22.5 °C (-8.5 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

TABLE 21: TYPE IV HOLDOVER TIMES FOR ABAX ECOWING AD-49

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	3:20 - 4:00	3:00 - 3:00	1:55 - 3:00	1:00 - 1:55	1:25 - 2:00	1:00 - 1:25	0:10 - 1:55	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A	CAUTION: No holdover time guidelines exist	
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:20 - 1:35	2:55 - 3:00	1:30 - 2:55	0:45 - 1:30	0:25 - 1:25	0:20 - 0:25		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:20 - 1:35	2:25 - 3:00	1:15 - 2:25	0:40 - 1:15	0:25 - 1:25[7]	0:20 - 0:25[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:25 - 0:40	0:30 - 0:45	0:09 - 0:30	0:02 - 0:09				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:25 - 0:40	0:10 - 0:20	0:03 - 0:10	0:01 - 0:03				
below -25 to -26 °C (below -13 to -15 °F)	100/0	0:25 - 0:40	0:07 - 0:10	0:02 - 0:07	0:00 - 0:02				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table 42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

TABLE 22: TYPE IV HOLDOVER TIMES FOR ALLCLEAR CLEARWING EG

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	1:50 - 3:15	2:40 - 3:00	1:20 - 2:40	0:40 - 1:20	1:10 - 1:35	0:30 - 1:00	0:10 - 1:30	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A		
below -3 to -8 °C (below 27 to 18 °F)	100/0	1:35 - 3:45	2:25 - 3:00	1:10 - 2:25	0:35 - 1:10	1:05 - 1:30	0:30 - 1:00		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14 °C (below 18 to 7 °F)	100/0	1:35 - 3:45	2:15 - 2:45	1:05 - 2:15	0:30 - 1:05	1:05 - 1:30[7]	0:30 - 1:00[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:55 - 2:00	0:50 - 1:05	0:25 - 0:50	0:10 - 0:25				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:55 - 2:00	0:40 - 0:55	0:15 - 0:40	0:05 - 0:15				
below -25 to -29 °C (below -13 to -20 °F)	100/0	0:55 - 2:00	0:25 - 0:35	0:08 - 0:25	0:02 - 0:08				

CAUTION: No holdover time guidelines exist

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table 42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

TABLE 23: TYPE IV HOLDOVER TIMES FOR CHEMCO CHEMR EG IV

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	2:05 - 3:35	3:00 - 3:00	1:15 - 3:00	0:35 - 1:15	0:45 - 1:40	0:25 - 0:40	0:09 - 1:45	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A	CAUTION: No holdover time guidelines exist	
below -3 to -8 °C (below 27 to 18 °F)	100/0	1:25 - 3:40	3:00 - 3:00	1:15 - 3:00	0:35 - 1:15	1:00 - 1:35	0:35 - 0:50		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14 °C (below 18 to 7 °F)	100/0	1:25 - 3:40	3:00 - 3:00	1:15 - 3:00	0:35 - 1:15	1:00 - 1:35[7]	0:35 - 0:50[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:40 - 1:25	0:50 - 1:05	0:25 - 0:50	0:10 - 0:25				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:40 - 1:25	0:40 - 0:55	0:15 - 0:40	0:05 - 0:15				
below -25 to -27 °C (below -13 to -17 °F)	100/0	0:40 - 1:25	0:25 - 0:35	0:08 - 0:25	0:02 - 0:08				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table 42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

TABLE 24: TYPE IV HOLDOVER TIMES FOR CLARIANT MAX FLIGHT 04

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	2:40 - 4:00	3:00 - 3:00	2:45 - 3:00	1:25 - 2:45	2:00 - 2:00	1:10 - 1:30	0:20 - 2:00	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A	CAUTION: No holdover time guidelines exist	
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:50 - 2:30	3:00 - 3:00	1:40 - 3:00	0:50 - 1:40	0:25 - 1:30	0:20 - 0:40		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:50 - 2:30	2:20 - 2:50	1:10 - 2:20	0:35 - 1:10	0:25 - 1:30[7]	0:20 - 0:40[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:20 - 0:45	0:30 - 0:45	0:09 - 0:30	0:02 - 0:09				
below -18 to -23.5 °C (below 0 to -10 °F)	100/0	0:20 - 0:45	0:10 - 0:20	0:03 - 0:10	0:01 - 0:03				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table 42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

TABLE 25: TYPE IV HOLDOVER TIMES FOR CLARIANT MAX FLIGHT AVIA

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	3:05 - 4:00	3:00 - 3:00	1:45 - 3:00	1:00 - 1:45	1:25 - 2:00	0:55 - 1:10	0:09 - 2:00	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A	CAUTION: No holdover time guidelines exist	
below -3 to -8 °C (below 27 to 18 °F)	100/0	1:45 - 3:55	2:30 - 3:00	1:25 - 2:30	0:50 - 1:25	1:10 - 2:00	0:55 - 1:30		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14 °C (below 18 to 7 °F)	100/0	1:45 - 3:55	2:10 - 2:35	1:15 - 2:10	0:40 - 1:15	1:10 - 2:00[7]	0:55 - 1:30[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:35 - 1:25	0:50 - 1:05	0:25 - 0:50	0:10 - 0:25				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:35 - 1:25	0:40 - 0:55	0:15 - 0:40	0:05 - 0:15				
below -25 to -28.5 °C (below -13 to -19 °F)	100/0	0:35 - 1:25	0:25 - 0:35	0:08 - 0:25	0:02 - 0:08				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table 42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

TABLE 26: TYPE IV HOLDOVER TIMES FOR CLARIANT MAX FLIGHT SNEG

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	2:25 - 4:00	3:00 - 3:00	1:40 - 3:00	0:55 - 1:40	2:00 - 2:00	0:50 - 1:40	0:20 - 1:30	
	75/25	4:00 - 4:00	2:25 - 2:50	1:30 - 2:25	0:55 - 1:30	1:30 - 2:00	1:05 - 1:20	0:15 - 1:45	
	50/50	1:30 - 3:30	1:45 - 2:20	0:45 - 1:45	0:20 - 0:45	0:35 - 1:10	0:15 - 0:30	CAUTION: No holdover time guidelines exist	
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:45 - 2:20	2:25 - 2:55	1:20 - 2:25	0:45 - 1:20	0:30 - 1:25	0:25 - 0:40		
	75/25	0:30 - 1:25	1:55 - 2:15	1:10 - 1:55	0:45 - 1:10	0:20 - 1:05	0:20 - 0:40		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:45 - 2:20	2:05 - 2:30	1:10 - 2:05	0:40 - 1:10	0:30 - 1:25[7]	0:25 - 0:40[7]		
	75/25	0:30 - 1:25	1:40 - 2:00	1:00 - 1:40	0:40 - 1:00	0:20 - 1:05[7]	0:20 - 0:40[7]		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:20 - 0:50	0:30 - 0:45	0:09 - 0:30	0:02 - 0:09				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:20 - 0:50	0:10 - 0:20	0:03 - 0:10	0:01 - 0:03				
below -25 to -29 °C (below -13 to -20 °F)	100/0	0:20 - 0:50	0:07 - 0:10	0:02 - 0:07	0:00 - 0:02				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table 42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

TABLE 27: TYPE IV HOLDOVER TIMES FOR CLARIANT SAFEWING EG IV NORTH

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	2:20 - 3:55	3:00 - 3:00	1:40 - 3:00	0:50 - 1:40	1:30 - 2:00	0:50 - 0:55	0:08 - 2:00	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A		
below -3 to -8 °C (below 27 to 18 °F)	100/0	1:45 - 4:00	2:50 - 3:00	1:30 - 2:50	0:50 - 1:30	1:05 - 1:50	0:55 - 1:25		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14 °C (below 18 to 7 °F)	100/0	1:45 - 4:00	2:45 - 3:00	1:30 - 2:45	0:50 - 1:30	1:05 - 1:50[7]	0:55 - 1:25[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:40 - 1:20	0:50 - 1:05	0:25 - 0:50	0:10 - 0:25			CAUTION: No holdover time guidelines exist	
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:40 - 1:20	0:40 - 0:55	0:15 - 0:40	0:05 - 0:15				
below -25 to -30 °C (below -13 to -22 °F)	100/0	0:40 - 1:20	0:25 - 0:35	0:08 - 0:25	0:02 - 0:08				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table 42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

TABLE 28: TYPE IV HOLDOVER TIMES FOR CLARIANT SAFEWING MP IV LAUNCH

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	4:00 - 4:00	2:50 - 3:00	1:45 - 2:50	1:05 - 1:45	1:30 - 2:00	1:00 - 1:40	0:15 - 1:40	
	75/25	3:40 - 4:00	3:00 - 3:00	1:45 - 3:00	1:00 - 1:45	1:40 - 2:00	0:45 - 1:15	0:10 - 1:45	
	50/50	1:25 - 2:45	1:25 - 1:40	0:45 - 1:25	0:25 - 0:45	0:30 - 0:50	0:20 - 0:25	CAUTION: No holdover time guidelines exist	
below -3 to -8 °C (below 27 to 18 °F)	100/0	1:00 - 1:55	2:25 - 2:50	1:30 - 2:25	0:55 - 1:30	0:35 - 1:40	0:25 - 0:45		
	75/25	0:40 - 1:20	2:40 - 3:00	1:30 - 2:40	0:50 - 1:30	0:25 - 1:10	0:25 - 0:45		
below -8 to -14 °C (below 18 to 7 °F)	100/0	1:00 - 1:55	2:10 - 2:30	1:20 - 2:10	0:50 - 1:20	0:35 - 1:40[7]	0:25 - 0:45[7]		
	75/25	0:40 - 1:20	2:25 - 2:55	1:25 - 2:25	0:45 - 1:25	0:25 - 1:10[7]	0:25 - 0:45[7]		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:30 - 0:50	1:15 - 1:45	0:20 - 1:15	0:06 - 0:20				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:30 - 0:50	0:30 - 0:45	0:09 - 0:30	0:02 - 0:09				
below -25 to -28.5 °C (below -13 to -19 °F)	100/0	0:30 - 0:50	0:20 - 0:30	0:06 - 0:20	0:01 - 0:06				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table 42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

TABLE 29: TYPE IV HOLDOVER TIMES FOR CLARIANT SAFEWING MP IV LAUNCH PLUS

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	3:55 - 4:00	3:00 - 3:00	2:05 - 3:00	0:55 - 2:05	2:00 - 2:00	1:00 - 2:00	0:20 - 2:00	
	75/25	3:55 - 4:00	3:00 - 3:00	1:55 - 3:00	0:50 - 1:55	2:00 - 2:00	1:20 - 1:25	0:20 - 1:50	
	50/50	1:15 - 1:50	1:35 - 2:00	0:45 - 1:35	0:20 - 0:45	0:25 - 1:00	0:15 - 0:20	CAUTION: No holdover time guidelines exist	
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:55 - 2:15	3:00 - 3:00	1:40 - 3:00	0:45 - 1:40	0:25 - 1:35	0:25 - 0:40		
	75/25	0:40 - 2:00	3:00 - 3:00	1:30 - 3:00	0:35 - 1:30	0:20 - 1:05	0:20 - 0:30		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:55 - 2:15	3:00 - 3:00	1:25 - 3:00	0:40 - 1:25	0:25 - 1:35[7]	0:25 - 0:40[7]		
	75/25	0:40 - 2:00	2:55 - 3:00	1:15 - 2:55	0:30 - 1:15	0:20 - 1:05[7]	0:20 - 0:30[7]		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:25 - 0:50	1:15 - 1:50	0:25 - 1:15	0:07 - 0:25				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:25 - 0:50	0:30 - 0:45	0:09 - 0:30	0:03 - 0:09				
below -25 to -29 °C (below -13 to -20 °F)	100/0	0:25 - 0:50	0:20 - 0:30	0:06 - 0:20	0:02 - 0:06				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table 42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

TABLE 30: TYPE IV HOLDOVER TIMES FOR CRYOTECH POLAR GUARD® ADVANCE

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	2:50 - 4:00	3:00 - 3:00	1:55 - 3:00	1:05 - 1:55	1:35 - 2:00	1:15 - 1:30	0:15 - 2:00	
	75/25	2:30 - 4:00	3:00 - 3:00	1:25 - 3:00	0:40 - 1:25	1:40 - 2:00	0:40 - 1:10	0:09 - 1:40	
	50/50	0:50 - 1:25	1:10 - 1:35	0:25 - 1:10	0:10 - 0:25	0:20 - 0:45	0:09 - 0:20	CAUTION: No holdover time guidelines exist	
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:55 - 2:30	2:25 - 2:50	1:25 - 2:25	0:50 - 1:25	0:35 - 1:35	0:35 - 0:45		
	75/25	0:40 - 1:30	2:20 - 3:00	1:05 - 2:20	0:30 - 1:05	0:25 - 1:05	0:35 - 0:45		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:55 - 2:30	2:00 - 2:20	1:10 - 2:00	0:40 - 1:10	0:35 - 1:35[7]	0:35 - 0:45[7]		
	75/25	0:40 - 1:30	2:00 - 2:30	0:55 - 2:00	0:25 - 0:55	0:25 - 1:05[7]	0:35 - 0:45[7]		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:25 - 0:50	1:35 - 2:15	0:35 - 1:35	0:10 - 0:35				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:25 - 0:50	0:40 - 0:55	0:15 - 0:40	0:04 - 0:15				
below -25 to -30.5 °C (below -13 to -23 °F)	100/0	0:25 - 0:50	0:25 - 0:30	0:07 - 0:25	0:02 - 0:07				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table 42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

TABLE 31: TYPE IV HOLDOVER TIMES FOR CRYOTECH POLAR GUARD® XTEND

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	2:30 - 4:00	3:00 - 3:00	2:00 - 3:00	1:05 - 2:00	2:00 - 2:00	1:00 - 1:50	0:20 - 1:45	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A	CAUTION: No holdover time guidelines exist	
below -3 to -8 °C (below 27 to 18 °F)	100/0	1:00 - 1:50	2:50 - 3:00	1:35 - 2:50	0:50 - 1:35	0:35 - 1:40	0:50 - 0:55		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14 °C (below 18 to 7 °F)	100/0	1:00 - 1:50	2:25 - 2:55	1:20 - 2:25	0:45 - 1:20	0:35 - 1:40[7]	0:50 - 0:55[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:25 - 0:40	0:30 - 0:45	0:09 - 0:30	0:02 - 0:09				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:25 - 0:40	0:10 - 0:20	0:03 - 0:10	0:01 - 0:03				
below -25 to -29 °C (below -13 to -20 °F)	100/0	0:25 - 0:40	0:07 - 0:10	0:02 - 0:07	0:00 - 0:02				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table 42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

TABLE 32: TYPE IV HOLDOVER TIMES FOR DOW CHEMICAL UCAR™ ENDURANCE EG106

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	2:05 - 3:10	2:45 - 3:00	1:20 - 2:45	0:40 - 1:20	1:10 - 2:00	0:50 - 1:15	0:20 - 2:00	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A		
below -3 to -8 °C (below 27 to 18 °F)	100/0	1:50 - 3:20	2:25 - 3:00	1:10 - 2:25	0:35 - 1:10	0:55 - 1:50	0:45 - 1:10		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14 °C (below 18 to 7 °F)	100/0	1:50 - 3:20	2:10 - 2:45	1:05 - 2:10	0:30 - 1:05	0:55 - 1:50[7]	0:45 - 1:10[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:30 - 1:05	1:45 - 2:15	0:50 - 1:45	0:25 - 0:50				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:30 - 1:05	1:30 - 1:55	0:40 - 1:30	0:20 - 0:40				
below -25 to -29 °C (below -13 to -20 °F)	100/0	0:30 - 1:05	1:20 - 1:45	0:40 - 1:20	0:20 - 0:40				

CAUTION: No holdover time guidelines exist

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table 42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

TABLE 33: TYPE IV HOLDOVER TIMES FOR DOW CHEMICAL UCAR™ FLIGHTGUARD AD-49

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	3:20 - 4:00	3:00 - 3:00	1:55 - 3:00	1:00 - 1:55	1:25 - 2:00	1:00 - 1:25	0:10 - 1:55	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A		
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:20 - 1:35	2:55 - 3:00	1:30 - 2:55	0:45 - 1:30	0:25 - 1:25	0:20 - 0:25		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:20 - 1:35	2:25 - 3:00	1:15 - 2:25	0:40 - 1:15	0:25 - 1:25[7]	0:20 - 0:25[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:25 - 0:40	0:30 - 0:45	0:09 - 0:30	0:02 - 0:09				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:25 - 0:40	0:10 - 0:20	0:03 - 0:10	0:01 - 0:03				
below -25 to -26 °C (below -13 to -15 °F)	100/0	0:25 - 0:40	0:07 - 0:10	0:02 - 0:07	0:00 - 0:02				

CAUTION: No holdover time guidelines exist

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table 42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

TABLE 34: TYPE IV HOLDOVER TIMES FOR INLAND TECHNOLOGIES ECO-SHIELD®

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	1:15 - 2:40	2:25 - 2:50	1:20 - 2:25	0:45 - 1:20	0:40 - 1:30	0:35 - 0:40	0:15 - 1:35	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A		
below -3 to -8 °C (below 27 to 18 °F)	100/0	1:10 - 2:35	2:05 - 2:30	1:10 - 2:05	0:40 - 1:10	0:50 - 1:25	0:30 - 0:40		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14 °C (below 18 to 7 °F)	100/0	1:10 - 2:35	1:55 - 2:15	1:05 - 1:55	0:35 - 1:05	0:50 - 1:25[7]	0:30 - 0:40[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:30 - 1:00	0:30 - 0:45	0:09 - 0:30	0:02 - 0:09				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:30 - 1:00	0:10 - 0:20	0:03 - 0:10	0:01 - 0:03				
below -25 to -25.5 °C (below -13 to -14 °F)	100/0	0:30 - 1:00	0:07 - 0:10	0:02 - 0:07	0:00 - 0:02				

CAUTION: No holdover time guidelines exist

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table 42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

TABLE 35: TYPE IV HOLDOVER TIMES FOR KILFROST ABC-S PLUS

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	2:10 - 4:00	3:00 - 3:00	2:05 - 3:00	1:15 - 2:05	1:50 - 2:00	1:05 - 2:00	0:25 - 2:00	
	75/25	1:25 - 2:40	2:05 - 2:25	1:15 - 2:05	0:45 - 1:15	1:00 - 1:20	0:30 - 0:50	0:10 - 1:20	
	50/50	0:30 - 0:55	1:00 - 1:10	0:30 - 1:00	0:15 - 0:30	0:15 - 0:40	0:15 - 0:20	CAUTION: No holdover time guidelines exist	
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:55 - 3:30	3:00 - 3:00	1:50 - 3:00	1:05 - 1:50	0:25 - 1:35	0:20 - 0:30		
	75/25	0:45 - 1:50	1:50 - 2:10	1:05 - 1:50	0:40 - 1:05	0:20 - 1:10	0:15 - 0:25		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:55 - 3:30	2:55 - 3:00	1:45 - 2:55	1:00 - 1:45	0:25 - 1:35[7]	0:20 - 0:30[7]		
	75/25	0:45 - 1:50	1:45 - 2:00	1:00 - 1:45	0:35 - 1:00	0:20 - 1:10[7]	0:15 - 0:25[7]		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:40 - 1:00	0:30 - 0:45	0:09 - 0:30	0:02 - 0:09				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:40 - 1:00	0:10 - 0:20	0:03 - 0:10	0:01 - 0:03				
below -25 to -28 °C (below -13 to -18 °F)	100/0	0:40 - 1:00	0:07 - 0:10	0:02 - 0:07	0:00 - 0:02				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table 42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

TABLE 36: TYPE IV HOLDOVER TIMES FOR LNT SOLUTIONS E450

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	1:50 - 2:55	2:25 - 2:45	1:35 - 2:25	1:00 - 1:35	1:35 - 2:00	0:55 - 1:20	0:25 - 2:00	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A		
below -3 to -8 °C (below 27 to 18 °F)	100/0	1:30 - 3:55	2:05 - 2:20	1:20 - 2:05	0:50 - 1:20	1:45 - 2:00	1:05 - 1:40		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14 °C (below 18 to 7 °F)	100/0	1:30 - 3:55	1:50 - 2:05	1:10 - 1:50	0:45 - 1:10	1:45 - 2:00[7]	1:05 - 1:40[7]	CAUTION: No holdover time guidelines exist	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:35 - 1:05	3:00 - 3:00	1:05 - 3:00	0:20 - 1:05				
below -18 to -25 °C[8] (below 0 to -13 °F)[8]	100/0	0:35 - 1:05	1:35 - 2:15	0:30 - 1:35	0:10 - 0:30				
below -25 to -32.5°C[8] (below -13 to -26°F)[8]	100/0	0:25 - 1:00	0:40 - 1:00	0:15 - 0:40	0:04 - 0:15				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table 42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).
8 Use LOUT of -22.5 °C (-9 °F) unless indicated otherwise by fluid manufacturer.

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

TABLE 37: TYPE IV HOLDOVER TIMES FOR NEWAVE AEROCHEMICAL FCY 9311

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	1:55 - 4:00	2:20 - 2:55	1:10 - 2:20	0:35 - 1:10	1:10 - 2:00	0:40 - 1:05	0:15 - 1:25	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A		
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:35 - 2:05	1:50 - 2:20	0:55 - 1:50	0:30 - 0:55	0:35 - 1:20	0:20 - 0:35		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:35 - 2:05	1:35 - 2:00	0:50 - 1:35	0:25 - 0:50	0:35 - 1:20[7]	0:20 - 0:35[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:30 - 0:55	0:30 - 0:45	0:09 - 0:30	0:02 - 0:09				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:30 - 0:55	0:10 - 0:20	0:03 - 0:10	0:01 - 0:03				
below -25 to -29.5 °C (below -13 to -21 °F)	100/0	0:30 - 0:55	0:07 - 0:10	0:02 - 0:07	0:00 - 0:02				

CAUTION: No holdover time guidelines exist

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table 42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

TABLE 38: TYPE IV HOLDOVER TIMES FOR OKSAYD DEFROST ECO 4

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	1:30 - 2:40	2:30 - 3:00	1:15 - 2:30	0:35 - 1:15	1:05 - 1:30	0:40 - 1:05	0:15 - 1:10	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A	CAUTION: No holdover time guidelines exist	
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:55 - 2:35	2:15 - 2:45	1:05 - 2:15	0:35 - 1:05	0:50 - 1:20	0:35 - 0:50		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:55 - 2:35	2:05 - 2:35	1:00 - 2:05	0:30 - 1:00	0:50 - 1:20[7]	0:35 - 0:50[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:30 - 0:50	0:30 - 0:45	0:09 - 0:30	0:02 - 0:09				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:30 - 0:50	0:10 - 0:20	0:03 - 0:10	0:01 - 0:03				
below -25 to -25.5 °C (below -13 to -14 °F)	100/0	0:30 - 0:50	0:07 - 0:10	0:02 - 0:07	0:00 - 0:02				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table 42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

TABLE 39: TYPE IV HOLDOVER TIMES FOR OKSAYD DEFROST EG 4

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	2:45 - 4:00	3:00 - 3:00	2:25 - 3:00	1:25 - 2:25	2:00 - 2:00	1:00 - 1:45	0:20 - 2:00	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A		
below -3 to -8 °C (below 27 to 18 °F)	100/0	2:20 - 4:00	3:00 - 3:00	2:05 - 3:00	1:15 - 2:05	1:00 - 2:00	1:20 - 1:50		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14 °C (below 18 to 7 °F)	100/0	2:20 - 4:00	3:00 - 3:00	1:55 - 3:00	1:10 - 1:55	1:00 - 2:00[7]	1:20 - 1:50[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:45 - 2:25	0:50 - 1:05	0:25 - 0:50	0:10 - 0:25				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:45 - 2:25	0:40 - 0:55	0:15 - 0:40	0:05 - 0:15				
below -25 to -26 °C (below -13 to -15 °F)	100/0	0:45 - 2:25	0:25 - 0:35	0:08 - 0:25	0:02 - 0:08				

CAUTION: No holdover time guidelines exist

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table 42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

TABLE 40: TYPE IV HOLDOVER TIMES FOR SHAANXI CLEANWAY AVIATION CLEANSURFACE IV

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	2:50 - 4:00	3:00 - 3:00	1:55 - 3:00	1:00 - 1:55	2:00 - 2:00	1:25 - 1:30	0:15 - 2:00	
	75/25	2:35 - 4:00	3:00 - 3:00	1:35 - 3:00	0:45 - 1:35	0:50 - 2:00	0:35 - 0:45	0:09 - 1:15	
	50/50	1:05 - 2:25	1:40 - 2:20	0:40 - 1:40	0:15 - 0:40	0:25 - 0:50	0:15 - 0:20	CAUTION: No holdover time guidelines exist	
below -3 to -8 °C (below 27 to 18 °F)	100/0	1:00 - 3:05	2:00 - 2:25	1:05 - 2:00	0:35 - 1:05	0:35 - 1:45	0:20 - 0:35		
	75/25	0:50 - 1:55	2:15 - 2:55	1:00 - 2:15	0:30 - 1:00	0:30 - 1:20	0:25 - 0:40		
below -8 to -14 °C (below 18 to 7 °F)	100/0	1:00 - 3:05	1:20 - 1:40	0:45 - 1:20	0:25 - 0:45	0:35 - 1:45[7]	0:20 - 0:35[7]		
	75/25	0:50 - 1:55	1:40 - 2:10	0:45 - 1:40	0:20 - 0:45	0:30 - 1:20[7]	0:25 - 0:40[7]		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:30 - 0:50	0:30 - 0:45	0:09 - 0:30	0:02 - 0:09				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:30 - 0:50	0:10 - 0:20	0:03 - 0:10	0:01 - 0:03				
below -25 to -28.5 °C (below -13 to -19 °F)	100/0	0:30 - 0:50	0:07 - 0:10	0:02 - 0:07	0:00 - 0:02				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table 42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

ALLOWANCE TIMES TABLES FOR WINTER 2019-2020

TABLE 41: ALLOWANCE TIMES FOR SAE TYPE III FLUIDS[1]

Precipitation Type	Outside Air Temperature		
	-5 °C and above	Below -5 to -10 °C	Below -10 °C[2]
Light Ice Pellets	10 minutes	10 minutes	**Caution: No allowance times currently exist**
Light Ice Pellets Mixed with Snow	10 minutes	10 minutes	
Light Ice Pellets Mixed with Freezing Drizzle	7 minutes	5 minutes	
Light Ice Pellets Mixed with Freezing Rain	7 minutes	5 minutes	
Light Ice Pellets Mixed with Rain	7 minutes[3]		
Moderate Ice Pellets (or Small Hail)[4]	5 minutes	5 minutes	

NOTES

1 These allowance times are for use with undiluted (100/0) fluids applied unheated on aircraft with rotation speeds of 100 knots or greater.
2 Ensure that the lowest operational use temperature (LOUT) is respected.
3 No allowance times exist in this condition for temperatures below 0 °C; consider use of light ice pellets mixed with freezing rain.
4 If no intensity is reported with small hail, use the “moderate ice pellets or small hail” allowance times. If an intensity is reported with small hail, the ice pellet condition with the equivalent intensity can be used, e.g. if light small hail is reported, the “light ice pellets” allowance times can be used. This also applies in mixed conditions, e.g. if light small hail mixed with snow is reported, use the “light ice pellets mixed with snow” allowance times.

CAUTIONS

- The responsibility for the application of these data remains with the user.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.
- Allowance time cannot be extended by an inspection of the aircraft critical surfaces.
- Takeoff is allowed up to 90 minutes after start of fluid application if the precipitation stops at or before the allowance time expires and does not restart. The OAT must not decrease during the 90 minutes to use this guidance in conditions of light ice pellets mixed with either: freezing drizzle, freezing rain, or rain.

TABLE 42: ALLOWANCE TIMES FOR SAE TYPE IV FLUIDS[1]

Precipitation Type	Outside Air Temperature			
	-5 °C and above	Below -5 to -10 °C	Below -10 to -16 °C	Below -16 to -22 °C[2]
Light Ice Pellets	50 minutes	30 minutes	30 minutes[3]	30 minutes[3]
Light Ice Pellets Mixed with Snow	40 minutes	15 minutes	15 minutes[3]	
Light Ice Pellets Mixed with Freezing Drizzle	25 minutes	10 minutes	**Caution: No allowance times currently exist**	
Light Ice Pellets Mixed with Freezing Rain	25 minutes	10 minutes		
Light Ice Pellets Mixed with Rain	25 minutes[4]			
Moderate Ice Pellets (or Small Hail)[5]	25 minutes[6]	10 minutes	10 minutes[3]	10 minutes[7]
Moderate Ice Pellets (or Small Hail)[5] Mixed with Freezing Drizzle	10 minutes	7 minutes	**Caution: No allowance times currently exist**	
Moderate Ice Pellets (or Small Hail)[5] Mixed with Rain	10 minutes[8]			

NOTES

1 These allowance times are for use with undiluted (100/0) fluids applied on aircraft with rotation speeds of 100 knots or greater. All Type IV fluids are propylene glycol based with the exception of AllClear ClearWing EG, CHEMCO ChemR EG IV, Clariant Max Flight AVIA, Clariant Safewing EG IV NORTH, Dow EG106, LNT Solutions E450 and Oksayd Defrost EG 4, which are ethylene glycol based.
2 Ensure that the lowest operational use temperature (LOUT) is respected.
3 No allowance times exist for propylene glycol (PG) fluids when used on aircraft with rotation speeds less than 115 knots. If the glycol type is unknown, no allowance times exist for aircraft with rotation speeds of less than 115 knots.
4 No allowance times exist in this condition for temperatures below 0 °C; consider use of light ice pellets mixed with freezing rain.
5 If no intensity is reported with small hail, use the “moderate ice pellets or small hail” allowance times. If an intensity is reported with small hail, the ice pellet condition with the equivalent intensity can be used, e.g. if light small hail is reported, the “light ice pellets” allowance times can be used. This also applies in mixed conditions, e.g. if light small hail mixed with snow is reported, use the “light ice pellets mixed with snow” allowance times.
6 Allowance time is 15 minutes for propylene glycol (PG) fluids or when the fluid type is unknown.
7 No allowance times exist for propylene glycol (PG) fluids in this condition for temperatures below -16 °C.
8 No allowance times exist in this condition for temperatures below 0 °C.

CAUTIONS

- The responsibility for the application of these data remains with the user.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.
- Allowance time cannot be extended by an inspection of the aircraft critical surfaces.
- Takeoff is allowed up to 90 minutes after start of fluid application if the precipitation stops at or before the allowance time expires and does not restart. The OAT must not decrease during the 90 minutes to use this guidance in conditions of light ice pellets mixed with either: freezing drizzle, freezing rain or rain.

SUPPLEMENTAL GUIDANCE FOR WINTER 2019-2020

TABLE 43: SNOWFALL INTENSITIES AS A FUNCTION OF PREVAILING VISIBILITY

Time of Day	Temp.		Visibility in Statute Miles (Meters)									
	Degrees Celsius	Degrees Fahrenheit	≥ 2 1/2 (≥ 4000)	2 (3200)	1 3/4 (2800)	1 1/2 (2400)	1 1/4 (2000)	1 (1600)	3/4 (1200)	1/2 (800)	≤ 1/4 (≤ 400)	Snowfall Intensity
Day	colder/equal -1	colder/equal 30	Very Light	Very Light	Very Light	Light	Light	Light	Moderate	Moderate	**Heavy**	
	warmer than -1	warmer than 30	Very Light	Light	Light	Light	Light	Moderate	Moderate	**Heavy**	**Heavy**	
Night	colder/equal -1	colder/equal 30	Very Light	Light	Light	Moderate	Moderate	Moderate	Moderate	**Heavy**	**Heavy**	
	warmer than -1	warmer than 30	Very Light	Light	Moderate	Moderate	Moderate	Moderate	**Heavy**	**Heavy**	**Heavy**	

NOTE 1: This table is for estimating snowfall intensity. It is based upon the technical report, "The Estimation of Snowfall Rate Using Visibility," Rasmussen, et al., Journal of Applied Meteorology, October 1999 and additional in situ data.

NOTE 2: This table is to be used with Type I, II, III, and IV fluid guidelines.

NOTE 3: The use of Runway Visual Range (RVR) is not permitted for determining visibility used with the holdover tables.

NOTE 4: Some METARS contain tower visibility as well as surface visibility. Whenever surface visibility is available from an official source, such as a METAR, in either the main body of the METAR or in the Remarks ("RMK") section, the preferred action is to use the surface visibility value.

NOTE 5: If visibility from a source other than the METAR is used, round to the nearest visibility in the table, rounding down if it is right in between two values. For example, .6 and .625 (5/8) would both be rounded to .5 (1/2).

HEAVY = Caution—No Holdover Time Guidelines Exist

During snow conditions alone, the use of Table 43 in determining snowfall intensities does not require pilot company coordination or company reporting procedures since this table is more conservative than the visibility table used by official weather observers in determining snowfall intensities.

Because the FAA Snowfall Intensities Table, like the FMH-1 Table, uses visibility to determine snowfall intensities, if the visibility is being reduced by snow along with other forms of obscuration such as fog, haze, smoke, etc., the FAA Snowfall Intensities Table does not need to be used to estimate the snowfall intensity for HOT determination during the presence of these obscurations. Use of the FAA Snowfall Intensities as a Function of Prevailing Visibility Table under these conditions may needlessly overestimate the actual snowfall intensity. Therefore, the snowfall intensity being reported by the weather observer or automated surface observing system (ASOS), from the FMH-1 Table, may be used.

TABLE 44:
TYPE I FLUIDS TESTED FOR ANTI-ICING PERFORMANCE AND AERODYNAMIC ACCEPTANCE

(see cautions and notes on page 60)

COMPANY NAME	FLUID NAME	TYPE OF GLYCOL[1]	EXPIRY[2] (Y-M-D)	LOWEST OPERATIONAL USE TEMPERATURE[3]				
				DILUTION[4,5] (FLUID/WATER)	LOW SPEED AERODYNAMIC TEST[6]		HIGH SPEED AERODYNAMIC TEST[6]	
					°C	°F	°C	°F
ABAX Industries	DE-950	PG	22-04-25	71/29	-26	-15	-31	-24
ADDCON EUROPE GmbH	IceFree I.80	PG	21-03-14	70/30	-26	-15	-32	-26
ALAB Industries	WDF 1	EG	22-03-02	70/30	-40	-40	-45	-49
AllClear Systems LLC	Lift-Off E-188	EG	22-05-15	70/30	-40	-40	-41.5	-43
AllClear Systems LLC	Lift-Off P-88	PG	22-05-15	70/30	-24.5	-12	-29.5	-21
Arcton Ltd.	Arctica DG ready-to-use	DEG	22-03-26	as supplied	-26	-15	-26	-15
Arcton Ltd.	*Arctica DG 91 Concentrate*	*DEG*	*17-07-16[9]*	*75/25*	*Not tested[10]*	*Not tested[10]*	*-25*	*-13*
AVIAFLUID International Ltd.	AVIAFLO EG	EG	21-06-19	70/30	-40.5	-41	-44	-47
Aviation Shaanxi Hi-Tech Physical Chemical Co. Ltd.	Cleanwing I	PG	19-09-30	75/25	Not tested[10]	Not tested[10]	-39.5	-39
Aviation Xi'an High-Tech Physical Chemical Co. Ltd.	KHF-1	PG	23-05-24	75/25	Not tested[10]	Not tested[10]	-38.5	-37
Beijing Wangye Aviation Chemical Product Co Ltd.	KLA-1	EG	19-09-08	60/40	Not tested[10]	Not tested[10]	-30.5	-23
Beijing Wangye Aviation Chemical Product Co Ltd.	KLA-1A	EG	22-05-22	60/40	Not tested[10]	Not tested[10]	-32	-26
Beijing Yadilite Aviation Advanced Materials Corporation	YD-101 Type I	PG	21-03-07	60/40	Not tested[10]	Not tested[10]	-30	-22
Beijing Yadilite Aviation Advanced Materials Corporation	YD-101A Type I	EG	21-03-07	70/30	Not tested[10]	Not tested[10]	-38	-36
Boryszew S.A.	*Borygo Plane I*	*PG*	*17-12-04[9]*	*75/25*	*-25*	*-13*	*-30*	*-22*
CHEMCO Inc.	CHEMR EG I	EG	20-04-01	70/30	-37	-35	-43	-45
CHEMCO Inc.	CHEMR REG I	EG	22-05-25	75/25	-36.5	-34	-43.5	-46
Clariant Produkte (Deutschland) GmbH	Octaflo EF Concentrate	PG	22-03-28	65/35	-25	-13	-33	-27
Clariant Produkte (Deutschland) GmbH	*Octaflo EG Concentrate*	*EG*	*17-07-23[9]*	*70/30*	*-40.5*	*-41*	*-44*	*-47*
Clariant Produkte (Deutschland) GmbH	Octaflo LYOD	EG	20-03-16	70/30	-40	-40	-45.5	-50
Clariant Produkte (Deutschland) GmbH	Safewing EG I 1996 (88)	EG	19-10-15	70/30	-39.5	-39	-41.5	-43
Clariant Produkte (Deutschland) GmbH	Safewing MP I 1938 ECO	PG	20-05-11	65/35	-25.5	-14	-32	-26
Clariant Produkte (Deutschland) GmbH	Safewing MP I 1938 ECO (80)	PG	20-05-20	71/29	-25	-13	-32.5	-27
Clariant Produkte (Deutschland) GmbH	Safewing MP I 1938 ECO (80) Premix 55% i.g. ready-to-use	PG	21-02-24	as supplied	Not tested[10]	Not tested[10]	-19	-2

TABLE 44 (CONT'D): TYPE I FLUIDS TESTED FOR ANTI-ICING PERFORMANCE AND AERODYNAMIC ACCEPTANCE

(see cautions and notes on page 60)

COMPANY NAME	FLUID NAME	TYPE OF GLYCOL[1]	EXPIRY[2] (Y-M-D)	LOWEST OPERATIONAL USE TEMPERATURE[3]				
				DILUTION[4,5] (FLUID/WATER)	LOW SPEED AERODYNAMIC TEST[6]		HIGH SPEED AERODYNAMIC TEST[6]	
					°C	°F	°C	°F
Clariant Produkte (Deutschland) GmbH	Safewing MP I ECO PLUS (80)	PG	23-04-12	71/29	-25	-13	-33	-27
Clariant Produkte (Deutschland) GmbH	Safewing MP I LFD 80	PG	21-04-29	71/29	Not tested[10]	Not tested[10]	-33	-27
Clariant Produkte (Deutschland) GmbH	Safewing MP I LFD 88	PG	23-06-12	65/35	-26	-15	-33	-27
Cryotech Deicing Technology	Polar Plus®	PG	20-01-13	63/37	-27	-17	-32	-26
Cryotech Deicing Technology	Polar Plus® LT	PG	20-01-26	63/37	-27	-17	-33	-27
Cryotech Deicing Technology	Polar Plus® LT (80)	PG	20-04-12	70/30	-27	-17	-33	-27
Cryotech Deicing Technology	*Polar Plus® (80)*	*PG*	*17-09-12[9]*	*70/30*	*-24.5*	*-12*	*-32.5*	*-27*
Dow Chemical Company	UCAR™ ADF Concentrate	EG	23-03-26	75/25	-36	-33	-45	-49
Dow Chemical Company	UCAR™ ADF XL54[16]	EG	23-03-26	as supplied	-33	-27	-33	-27
Dow Chemical Company	UCAR™ PG ADF Concentrate	PG	23-04-16	65/35	-25	-13	-32	-26
Dow Chemical Company	UCAR™ PG ADF Dilute 55/45[17]	PG	23-04-16	as supplied	-24	-11	-25	-13
DR Energy Group LTD.[11]	*Northern Guard I*	*EG*	*17-06-16[9]*	*65/35*	*Not tested[10]*	*Not tested[10]*	*-39.5*	*-39*
Gansu xiexin huineng Science and technology development Co., Ltd.	XHN-1	PG DEG	19-10-04	75/25	Not tested[10]	Not tested[10]	-36	-33
Heilongjiang Hangjie Aero-chemical Technology Co. Ltd.	HJF-1	EG	21-06-14	65/35	Not tested[10]	Not tested[10]	-42	-44
Heilongjiang Hangjie Aero-chemical Technology Co. Ltd.	*HJF-1A*	*EG*	*16-09-02[9]*	*75/25*	*Not tested[10]*	*Not tested[10]*	*-40.5*	*-41*
HOC Industries	SafeTemp® ES Plus	PG	20-04-12	65/35	-25.5	-14	-29	-20
Inland Technologies	DuraGly-E Type I ADF Concentrate	EG	23-02-08	60/40	-33	-27	-33	-27
Inland Technologies	Inland ADF Concentrate[12] (Multiple Location)	EG	Y-M-D[12]	75/25	-36	-33	-42.5	-45
Inland Technologies	SafeTemp® ES Plus (Multiple Location)	PG	Y-M-D[18]	65/35	-25.5	-14	-31	-24
Kilfrost Limited	Kilfrost DF Plus	PG	23-06-18	69/31	-25.5[13]	-14[13]	-32	-26
Kilfrost Limited	Kilfrost DF Plus (80)	PG	20-05-02	69/31	-26	-15	-31.5	-25
Kilfrost Limited	Kilfrost DF Plus (88)	PG	23-06-05	63/37	-25.5[13]	-14[13]	-32	-26
Kilfrost Limited	Kilfrost DF^{Sustain}	NCG	19-08-06	68/32	-34	-29	-41	-42

TABLE 44 (CONT'D):
TYPE I FLUIDS TESTED FOR ANTI-ICING PERFORMANCE AND AERODYNAMIC ACCEPTANCE

(see cautions and notes on page 60)

COMPANY NAME	FLUID NAME	TYPE OF GLYCOL[1]	EXPIRY[2] (Y-M-D)	LOWEST OPERATIONAL USE TEMPERATURE[3]				
				DILUTION[4,5] (FLUID/WATER)	LOW SPEED AERODYNAMIC TEST[6]		HIGH SPEED AERODYNAMIC TEST[6]	
					°C	°F	°C	°F
LNT Solutions	LNT E188	EG	21-08-22	70/30	-30.5	-23	-41	-42
LNT Solutions	LNT P180	PG	22-02-11	69/31	-26	-15	-32	-26
LNT Solutions	*LNT P188*	*PG*	*18-11-28[13]*	*70/30*	*-24.5*	*-12*	*-31.5*	*-25*
Newave Aerochemical Co. Ltd.	FCY-1A	EG	23-04-08	75/25	-40	-40	-40	-40
Newave Aerochemical Co. Ltd.	FCY-1Bio+	EG	20-07-22	75/25	Not tested[10]	Not tested[10]	-40.5	-41
Oksayd Co. Ltd.	*DEFROST ECO 1*	*NG*	*16-07-09[9]*	*70/30*	*Not tested[10]*	*Not tested[10]*	*-36*	*-33*
Oksayd Co. Ltd.	DEFROST EG 88.1	EG	21-04-25	70/30	-40.5	-41	-44.5	-48
Oksayd Co. Ltd.	DEFROST PG 1	PG	19-10-18	70/30	-24.5	-12	-31.5	-25
ROMCHIM PROTECT SRL	ADD-PROTECT Type I	PG	20-12-12	70/30	-25.5	-14	-31	-24
Shaanxi Cleanway Aviation Chemical Co., Ltd	Cleansurface I	EG	21-08-22	75/25	Not tested[10]	Not tested[10]	-40.5	-41
Shaanxi Cleanway Aviation Chemical Co., Ltd	Cleansurface I-BIO	EG	22-05-02	75/25	Not tested[10]	Not tested[10]	-37	-35
Velvana a.s.[11]	*AIRVEL OK 1*	*PG*	*17-01-28[9]*	*70/30*	*-26*	*-15*	*-30*	*-22*
Xinjiang Zhongtian	*Clearice-I Type I*	*EG*	*19-05-24[13]*	*60/40*	*Not tested[10]*	*Not tested[10]*	*-30*	*-22*

TABLE 45:
TYPE II FLUIDS TESTED FOR ANTI-ICING PERFORMANCE AND AERODYNAMIC ACCEPTANCE

(see cautions and notes on page 60)

COMPANY NAME	FLUID NAME	TYPE OF GLYCOL[1]	EXPIRY[2] (Y-M-D)	DILUTION (FLUID/WATER)	LOWEST OPERATIONAL USE TEMPERATURE[3]		LOWEST ON-WING VISCOSITY[7,8] (mPa.s)	
					HIGH SPEED AERODYNAMIC TEST[6]		MANUFACTURER METHOD	AS 9968 METHOD
					°C	°F		
ABAX Industries	*ECOWING 26*	*PG*	*17-04-28[9]*	*100/0*	*-25*	*-13*	*4 900 (f)*	*4 600 (a)*
				75/25	*-14*	*7*	*2 200 (a)*	*2 200 (a)*
				50/50	*-4*	*25*	*50 (a)*	*50 (a)*
ABAX Industries	ECOWING AD-2	PG	21-03-28	100/0	-27	-17	5 750 (a)	5 750 (a)
				75/25	-15	5	12 000 (c)	12 000 (c)
				50/50	-3	27	7 500 (a)	7 500 (a)
Aviation Shaanxi Hi-Tech Physical Chemical Co. Ltd.	Cleanwing II	PG	21-05-22	100/0	-25	-13	4 650 (d)	4 500 (a)
				75/25	-15	5	9 450 (d)	10 000 (a)
				50/50	-4.5	24	10 150 (d)	10 200 (a)
Beijing Yadilite Aviation Advanced Materials Corporation	*YD-102 Type II*	*PG*	*18-02-26[9]*	*100/0*	*-29*	*-20*	*4 500 (a)*	*4 500 (a)*
				75/25	*-14*	*7*	*12 850 (a)*	*12 850 (a)*
				50/50	*-3*	*27*	*820 (a)*	*300 (l)*
Clariant Produkte (Deutschland) GmbH	Safewing MP II FLIGHT	PG	20-02-20	100/0	-29	-20	3 340 (a)	3 340 (a)
				75/25	-14	7	12 900 (c)	12 900 (c)
				50/50	-3.5	26	11 500 (a)	11 500 (a)
Clariant Produkte (Deutschland) GmbH	Safewing MP II FLIGHT PLUS	PG	20-02-26	100/0	-29	-20	3 650 (m)	3 100 (a)
				75/25	-14.5	6	12 400 (m)	10 450 (a)
				50/50	-4	25	7 800 (m)	7 050 (a)
Cryotech Deicing Technology	Polar Guard® II	PG	21-03-21	100/0	-30.5	-23	4 400 (e)	4 050 (a)
				75/25	-14	7	11 600 (e)	9 750 (a)
				50/50	-3.5	26	80 (a)	80 (a)
Kilfrost Limited	ABC-K Plus	PG	20-12-20	100/0	-29	-20	2 850 (d)	2 640 (a)
				75/25	-14.5	6	12 650 (d)	12 650 (c)
				50/50	-3.5	26	4 200 (d)	5 260 (a)
Kilfrost Limited	Ice Clear II	PG	20-06-20	100/0	-24	-11	8 450 (a)	8 450 (a)
				75/25	Dilution Not Applicable		Dilution Not Applicable	
				50/50	Dilution Not Applicable		Dilution Not Applicable	
Newave Aerochemical Co. Ltd.	FCY-2	PG	21-05-13	100/0	-28	-18	7 000 (d)	8 920 (a)
				75/25	-14.5	6	18 550 (d)	18 550 (c)
				50/50	-4.5	24	6 750 (d)	7 030 (a)

TABLE 45 (CONT'D):
TYPE II FLUIDS TESTED FOR ANTI-ICING PERFORMANCE AND AERODYNAMIC ACCEPTANCE

(see cautions and notes on page 60)

Company Name	Fluid Name	Type of Glycol[1]	Expiry[2] (Y-M-D)	Dilution (fluid/water)	Lowest Operational Use Temperature[3]		Lowest On-Wing Viscosity[7,8] (mPa.s)	
					High Speed Aerodynamic Test[6]		Manufacturer Method	AS 9968 Method
					°C	°F		
Newave Aerochemical Co. Ltd.	*FCY-2 Bio+*	*PG*	*19-04-10[13]*	*100/0*	*-28.5*	*-19*	*7 210 (a)*	*7 210 (a)*
				75/25	*-14*	*7*	*21 400 (c)*	*21 400 (c)*
				50/50	*-3*	*27*	*1 900 (a)*	*1 900 (a)*
Oksayd Co. Ltd.	Defrost PG 2	PG	20-06-27	100/0	-27	-17	4 450 (a)	4 450 (a)
				75/25	-16	3	8 000 (a)	8 000 (a)
				50/50	-4	25	17 900 (g)	25 400 (c)
ROMCHIM PROTECT SRL	ADD-PROTECT Type II	PG	21-01-18	100/0	-28	-18	4 000 (a)	4 000 (a)
				75/25	-14	7	7 700 (a)	7 700 (a)
				50/50	-3	27	14 500 (a)	14 500 (a)

TABLE 46:
TYPE III FLUIDS TESTED FOR ANTI-ICING PERFORMANCE AND AERODYNAMIC ACCEPTANCE

(see cautions and notes on page 60)

COMPANY NAME	FLUID NAME	TYPE OF GLYCOL[1]	EXPIRY[2] (Y-M-D)	DILUTION (FLUID/WATER)	LOWEST OPERATIONAL USE TEMPERATURE[3]				LOWEST ON-WING VISCOSITY[7,8] (mPa.s)	
					LOW SPEED AERODYNAMIC TEST[6]		HIGH SPEED AERODYNAMIC TEST[6]		MANUFACTURER METHOD	AS 9968 METHOD
					°C	°F	°C	°F		
AllClear Systems LLC	AeroClear MAX	EG	21-02-25	100/0	-16	3	-35	-31	7 800 (k)	Not Available[15]
				75/25	Dilution Not Applicable		Dilution Not Applicable		Dilution Not Applicable	
				50/50	Dilution Not Applicable		Dilution Not Applicable		Dilution Not Applicable	

TABLE 47:
TYPE IV FLUIDS TESTED FOR ANTI-ICING PERFORMANCE AND AERODYNAMIC ACCEPTANCE

(see cautions and notes on page 60)

Company Name	Fluid Name	Type of Glycol[1]	Expiry[2] (Y-M-D)	Dilution (fluid/water)	Lowest Operational Use Temperature[3]		Lowest On-Wing Viscosity[7,8] (mPa.s)	
					High Speed Aerodynamic Test[6]		Manufacturer Method	AS 9968 Method
					°C	°F		
ABAX Industries	ECOWING AD-49	PG	20-04-25	100/0	-26	-15	12 150 (g)	11 000 (a)
				75/25	Dilution Not Applicable		Dilution Not Applicable	
				50/50	Dilution Not Applicable		Dilution Not Applicable	
AllClear Systems LLC	ClearWing EG	EG	21-01-31	100/0	-29	-20	35 500 (j)	13 350 (a)
				75/25	Dilution Not Applicable		Dilution Not Applicable	
				50/50	Dilution Not Applicable		Dilution Not Applicable	
CHEMCO Inc.	ChemR EG IV	EG	21-04-02	100/0	-27	-17	46 400 (i)	19 450 (c)
				75/25	Dilution Not Applicable		Dilution Not Applicable	
				50/50	Dilution Not Applicable		Dilution Not Applicable	
Clariant Produkte (Deutschland) GmbH	*Max Flight 04*	*PG*	*16-07-23*[9]	*100/0*	*-23.5*	*-10*	*5 540 (b)*	*5 540 (a)*
				75/25	*Dilution Not Applicable*		*Dilution Not Applicable*	
				50/50	*Dilution Not Applicable*		*Dilution Not Applicable*	
Clariant Produkte (Deutschland) GmbH	Max Flight AVIA	EG	20-06-06	100/0	-28.5	-19	1 000 (l)	1 000 (l)
				75/25	Dilution Not Applicable		Dilution Not Applicable	
				50/50	Dilution Not Applicable		Dilution Not Applicable	
Clariant Produkte (Deutschland) GmbH	Max Flight SNEG	PG	20-05-25	100/0	-29	-20	8 700 (n)	8 050 (a)
				75/25	-14	7	20 200 (o)	21 800 (c)
				50/50	-3	27	13 600(o)	15 000 (c)
Clariant Produkte (Deutschland) GmbH	Safewing EG IV NORTH	EG	20-07-13	100/0	-30	-22	830 (l)	830 (l)
				75/25	Dilution Not Applicable		Dilution Not Applicable	
				50/50	Dilution Not Applicable		Dilution Not Applicable	
Clariant Produkte (Deutschland) GmbH	Safewing MP IV LAUNCH	PG	20-03-07	100/0	-28.5	-19	7 550 (a)	7 550 (a)
				75/25	-14	7	18 000 (a)	18 000 (a)
				50/50	-3.5	26	17 800 (a)	17 800 (a)
Clariant Produkte (Deutschland) GmbH	Safewing MP IV LAUNCH PLUS	PG	21-04-01	100/0	-29	-20	8 700 (n)	8 450 (a)
				75/25	-14	7	18 800 (o)	17 200 (c)
				50/50	-3.5	26	9 700 (n)	12 150 (a)
Cryotech Deicing Technology	Polar Guard® Advance	PG	21-01-31	100/0	-30.5	-23	4 400 (e)	4 050 (a)
				75/25	-14	7	11 600 (e)	9 750 (a)
				50/50	-3.5	26	80 (a)	80 (a)

TABLE 47 (CONT'D): TYPE IV FLUIDS TESTED FOR ANTI-ICING PERFORMANCE AND AERODYNAMIC ACCEPTANCE

(see cautions and notes on page 60)

Company Name	Fluid Name	Type of Glycol[1]	Expiry[2] (Y-M-D)	Dilution (fluid/water)	Lowest Operational Use Temperature[3]		Lowest On-Wing Viscosity[7,8] (mPa.s)	
					High Speed Aerodynamic Test[6]		Manufacturer Method	AS 9968 Method
					°C	°F		
Cryotech Deicing Technology	Polar Guard® Xtend	PG	21-05-15	100/0	-29	-20	6 000 (e)	6 350 (a)
				75/25	Dilution Not Applicable		Dilution Not Applicable	
				50/50	Dilution Not Applicable		Dilution Not Applicable	
Dow Chemical Company	UCAR™ Endurance EG106 De/Anti-Icing Fluid	EG	21-03-01	100/0	-29	-20	24 850 (h)	2 230 (a)
				75/25	Dilution Not Applicable		Dilution Not Applicable	
				50/50	Dilution Not Applicable		Dilution Not Applicable	
Dow Chemical Company	UCAR™ FlightGuard AD-49	PG	21-04-25	100/0	-26	-15	12 150 (g)	11 000 (a)
				75/25	Dilution Not Applicable		Dilution Not Applicable	
				50/50	Dilution Not Applicable		Dilution Not Applicable	
Inland Technologies	ECO-SHIELD®	PG	20-08-16	100/0	-25.5	-14	11 050 (a)	11 050 (a)
				75/25	Dilution Not Applicable		Dilution Not Applicable	
				50/50	Dilution Not Applicable		Dilution Not Applicable	
Kilfrost Limited	ABC-S Plus	PG	21-06-07	100/0	-28	-18	17 900 (d)	17 900 (c)
				75/25	-14.5	6	18 300 (d)	18 300 (c)
				50/50	-3.5	26	7 500 (d)	7 500 (a)
LNT Solutions	*LNT E450*	*EG*	*17-07-29[13]*	*100/0*	*-22.5*	*-9*	*45 300 (i)*	*Not Available[15]*
				75/25	*Dilution Not Applicable*		*Dilution Not Applicable*	
				50/50	*Dilution Not Applicable*		*Dilution Not Applicable*	
Newave Aerochemical Co. Ltd.	FCY 9311	PG	20-01-23	100/0	-29.5	-21	14 100 (c)	14 100 (c)
				75/25	Dilution Not Applicable		Dilution Not Applicable	
				50/50	Dilution Not Applicable		Dilution Not Applicable	
Oksayd Co. Ltd.	Defrost ECO 4	PG	21-05-24	100/0	-25.5	-14	9 800 (g)	12 350 (a)
				75/25	Dilution Not Applicable		Dilution Not Applicable	
				50/50	Dilution Not Applicable		Dilution Not Applicable	
Oksayd Co. Ltd.	Defrost EG 4	EG	20-05-17	100/0	-26	-15	12 000 (g)	12 950 (a)
				75/25	Dilution Not Applicable		Dilution Not Applicable	
				50/50	Dilution Not Applicable		Dilution Not Applicable	
Shaanxi Cleanway Aviation Chemical Co., Ltd	*Cleansurface IV*	*PG*	*19-02-24[9]*	*100/0*	*-28.5*	*-19*	*15 200 (c)*	*15 200 (c)*
				75/25	*-19*	*-2*	*28 500 (c)*	*28 500 (c)*
				50/50	*-6.5*	*20*	*17 500 (c)*	*17 500 (c)*

CAUTIONS AND NOTES FOR TABLES 44, 45, 46, 47

CAUTIONS

- These tables list fluids that have been tested with respect to endurance time performance (Holdover Times), anti-icing performance (Water Spray Endurance Testing/High Humidity Endurance Testing) and aerodynamic acceptance (Type I: SAE ARP6207 §3.4.1, AMS1424 §3.5.2 and §3.5.3; Type II/ III/ IV: SAE ARP5718 §FOREWARD, AMS1428 §3.2.4 and §3.2.5) only. These tests were conducted by APS Aviation Inc. (www.apsaviation.ca) and Anti-icing Materials International Laboratory (AMIL) (www.uqac.ca/amil). The end user is responsible for contacting the fluid manufacturer to confirm all other SAE AMS1424/1428 technical requirement tests, such as fluid stability, toxicity, materials compatibility, etc. have been conducted. These technical requirement tests are typically conducted by Scientific Material International (SMI) (www.smiinc.com) and AMIL, or any acceptable source.
- LOUT data provided in these tables is based strictly on the manufacturer's data; the end user is responsible for verifying the validity of this data.
- Type I fluids supplied in concentrated form must not be used in that form and must be diluted.

NOTES

1 PG = conventional glycol (propylene glycol); EG = conventional glycol (ethylene glycol); DEG = conventional glycol (diethylene glycol); NCG = non-conventional glycol (organic non-ionic diols and triols, e.g. 1,3-propanediol, glycerine) and mixtures of non-conventional glycol and conventional glycol; NG = non-glycol (e.g. organic salts) and mixtures of non-glycol and glycol.

2 Expiry date is the earlier expiry date of the Aerodynamic Test(s) or Water Spray Endurance Test. Fluids that are tested after the issuance of this list will appear in a later update.

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

a) The lowest temperature at which the fluid meets the aerodynamic acceptance test for a given aircraft type; or
b) The actual freezing point of the fluid plus its freezing point buffer (Type I = 10 °C/18 °F; Type II/III/IV = 7 °C/13 °F).

Note: LOUTs are rounded to the nearest half degree Celsius and the values in degrees Fahrenheit are calculated to the nearest whole degree.

4 The LOUT for Type I fluids that are intended to be diluted is derived from a dilution that provides the lowest operational use temperature. For other Type I dilutions, determine the freezing point of the fluid and add a 10 °C freezing point buffer, as a dilution will usually yield a higher and more restrictive operational use temperature. Consult the fluid manufacturer or fluid documentation for further clarification and guidance on establishing the appropriate operational use temperature of a diluted fluid.

5 Type I concentrate fluids have also been tested at 50/50 (glycol/water) dilution.

6 If uncertain whether the aircraft to be treated conforms to the low speed or the high speed aerodynamic test, consult the aircraft manufacturer. The aerodynamic test is defined in SAE AS5900 (latest version).

7 The viscosity values in this table are those of the fluids provided by the manufacturers for holdover time testing. For the holdover times to be valid, the viscosity of the fluid on the wing shall not be lower than that in this table. The user should periodically ensure that the viscosity of a fluid sample taken from the wing surface is not lower than that listed.

8 The SAE AS9968 viscosity method should only be used for field verification and auditing purposes; when in doubt as to which method is appropriate, use the manufacturer method. Viscosity measurement methods are indicated as letters (in parentheses) beside each viscosity value. Details of each measurement method are shown in the table below. The exact measurement method (spindle, container, fluid volume, temperature, speed, duration) must be used to compare the viscosity of a sample to a viscosity given in this table.

Method	Brookfield Spindle*	Container	Fluid Volume	Temp.**	Speed	Duration
a	LV1 (with guard leg)	600 mL low form (Griffin) beaker	575 mL***	20 °C	0.3 rpm	10.0 minutes
b	LV1 (with guard leg)	600 mL low form (Griffin) beaker	575 mL***	20 °C	0.3 rpm	33.3 minutes
c	LV2-disc (with guard leg)	600 mL low form (Griffin) beaker	425 mL***	20 °C	0.3 rpm	10.0 minutes
d	LV2-disc (with guard leg)	150 mL tall form (Berzelius) beaker	135 mL***	20 °C	0.3 rpm	10.0 minutes
e	SC4-34/13R	small sample adapter	10 mL	20 °C	0.3 rpm	10.0 minutes
f	SC4-34/13R	small sample adapter	10 mL	20 °C	0.3 rpm	30.0 minutes
g	SC4-31/13R	small sample adapter	10 mL	20 °C	0.3 rpm	10.0 minutes
h	SC4-31/13R	small sample adapter	10 mL	0 °C	0.3 rpm	10.0 minutes
i	SC4-31/13R	small sample adapter	9 mL	0 °C	0.3 rpm	10.0 minutes
j	SC4-31/13R	small sample adapter	9 mL	0 °C	0.3 rpm	30.0 minutes
k	SC4-31/13R	small sample adapter	9 mL	0 °C	0.3 rpm	65.0 minutes
l	LV0	ultra low adapter	16 mL	20 °C	0.3 rpm	10.0 minutes
m	LV1	big sample adapter	50 mL	20 °C	0.3 rpm	10.0 minutes
n	LV1	big sample adapter	55 mL	20 °C	0.3 rpm	10.0 minutes
o	LV2-disc	big sample adapter	60 mL	20 °C	0.3 rpm	10.0 minutes

* Spindle must be attached to a Brookfield viscometer model equipped with an LV spring.
** Sample temperature will affect readings; ensure sufficient time is allowed for sample to reach thermal equilibrium before starting test. Use of a cooling bath strongly recommended.
*** If necessary, adjust fluid volume to ensure fluid is level with notch on the spindle shaft.

9 Fluids listed in italics have expired and will be removed from this listing four years after expiry.

10 Manufacturer has indicated fluid was not tested.

11 Manufacturer has not provided fluid information as required in SAE ARP5718A; fluid may be removed from this listing in subsequent revisions.

12 Dow UCAR™ ADF Concentrate, sold under the product name Inland ADF Concentrate, qualified from 2015-09-04.

13 Currently in the test/re-test process.

14 Fluid was not retested for low speed aerodynamics. This data will be removed four years after the expiry of the last low speed test.

15 Measurements using the SAE AS9968 method do not provide stable, reliable results. Use the manufacturer method to evaluate viscosity.

16 For UCAR™ ADF XL54, refer to primary site qualification of UCAR™ ADF Concentrate.

17 For UCAR™ PG ADF Dilute 55/45, refer to primary site qualification of UCAR™ PG ADF Concentrate.

18 Refer to preproduction qualification of SafeTemp® ES Plus submitted by HOC Industries, qualified from 2017-11-20.

TABLE 48: GUIDELINES FOR THE APPLICATION OF SAE TYPE I FLUID

Outside Air Temperature (OAT)[1]	One-Step Procedure De/Anti-icing	Two-Step Procedure	
		First Step: Deicing	Second Step: Anti-icing[2]
0 °C (32 °F) and above	Heated mix of fluid and water with a freezing point of at least 10 °C (18 °F) below OAT	Heated water or a heated fluid/water mixture	Heated mix of fluid and water with a freezing point of at least 10 °C (18 °F) below OAT
Below 0 °C (32 °F) to LOUT		Heated fluid/water mixture with a freezing point at OAT or below	

NOTES

1 Fluids must not be used at temperatures below their lowest operational use temperature (LOUT).

2 To be applied before first-step fluid freezes, typically within 3 minutes. (This time may be higher than 3 minutes in some conditions, but potentially lower in heavy precipitation, colder temperatures, or for critical surfaces constructed of composite materials. If necessary, the second step shall be applied area by area.)

CAUTIONS

- This table is applicable for the use of Type I holdover time guidelines in all conditions, including active frost. If holdover times are not required, a temperature of 60 °C (140 °F) at the nozzle is desirable.
- If holdover times are required, the temperature of water or fluid/water mixtures shall be at least 60 °C (140 °F) at the nozzle. Upper temperature limit shall not exceed fluid and aircraft manufacturers' recommendations.
- To use Type I Holdover Times Guidelines in all conditions including active frost, an additional minimum of 1 liter/m^2 (~2 gal./100 sq. ft.) of heated Type I fluid mixture must be applied to the surfaces after all frozen contamination is removed. This application is necessary to heat the surfaces, as heat contributes significantly to the Type I fluid holdover times. The required protection can be provided using a 1-step method by applying more fluid than is strictly needed to just remove all of the frozen contamination (the same additional amount stated above is required).
- The lowest operational use temperature (LOUT) for a given Type I fluid is the higher (warmer) of:
  a) The lowest temperature at which the fluid meets the aerodynamic acceptance test for a given aircraft type; or
  b) The actual freezing point of the fluid plus a freezing point buffer of 10 °C (18 °F).
- Wing skin temperatures may differ and, in some cases, be lower than the OAT. A stronger mix (more glycol) may be needed under these conditions.

TABLE 49: GUIDELINES FOR THE APPLICATION OF SAE TYPE II AND IV FLUID

(FLUID CONCENTRATIONS IN % VOLUME)

Outside Air Temperature (OAT)[1]	One-Step Procedure De/Anti-icing	Two-Step Procedure	
		First Step: Deicing	Second Step: Anti-icing[2]
0 °C (32 °F) and above	100/0, 75/25 or 50/50 Heated[3] Type II or IV fluid/water mixture	Heated water or a heated Type I, II, III, or IV fluid/water mixture	100/0, 75/25 or 50/50 Heated or unheated Type II or IV fluid/water mixture
Below 0 °C (32 °F) to -3 °C (27 °F)	100/0, 75/25 or 50/50 Heated[3] Type II or IV fluid/water mixture	Heated Type I, II, III, or IV fluid/water mixture with a freezing point at OAT or below	100/0, 75/25 or 50/50 Heated or unheated Type II or IV fluid/water mixture
Below -3 °C (27 °F) to -14 °C (7 °F)	100/0 or 75/25 Heated[3] Type II or IV fluid/water mixture	Heated Type I, II, III, or IV fluid/water mixture with a freezing point at OAT or below	100/0 or 75/25 Heated or unheated Type II or IV fluid/water mixture
Below -14 °C (7 °F) to LOUT	100/0 Heated[3] Type II or IV fluid/water mixture	Heated Type I, II, III, or IV fluid/water mixture with a freezing point at OAT or below	100/0 Heated or unheated Type II or IV fluid/water mixture

NOTES

1 One step or second step fluids must not be used at temperatures below their lowest operational use temperature (LOUT). First step fluids must not be used below their freezing points. Consideration should be given to the use of Type I/III fluid when Type II/IV fluid cannot be used due to LOUT limitations (see Tables 48 and 50). The LOUT for a given Type II/IV fluid is the higher (warmer) of:

a) The lowest temperature at which the fluid meets the aerodynamic acceptance test for a given aircraft type; or
b) The actual freezing point of the fluid plus its freezing point buffer of 7 °C (13 °F).

Although some LOUTs are lower than the temperatures stated in the HOT table, holdover times do not apply when anti-icing below the lowest temperature stated in the band.

2 To be applied before first step fluid freezes, typically within 3 minutes. (Time may be longer than 3 minutes in some conditions, but potentially shorter in heavy precipitation, in colder temperatures, or for critical surfaces constructed of composite materials. If necessary, the second step shall be applied area by area.)

3 Clean aircraft may be anti-iced with unheated fluid.

CAUTIONS

- For heated fluids, a fluid temperature not less than 60 °C (140 °F) at the nozzle is desirable.
- Upper temperature limit shall not exceed fluid and aircraft manufacturers' recommendations.
- Wing skin temperatures may differ and in some cases may be lower than the OAT. A stronger mix (more glycol) may be needed under these conditions.
- Whenever frost or ice occurs on the lower surface of the wing in the area of the fuel tank, indicating a cold soaked wing, the 50/50 dilutions of Type II or IV shall not be used for the anti-icing step because fluid freezing may occur.
- An insufficient amount of anti-icing fluid may cause a substantial loss of holdover time. This is particularly true when using a Type I fluid mixture for the first step in a two-step procedure.

TABLE 50: GUIDELINES FOR THE APPLICATION OF UNHEATED SAE TYPE III FLUID

(FLUID CONCENTRATIONS IN % VOLUME)

Outside Air Temperature (OAT)[1]	One-Step Procedure Anti-icing Only[4]	Two-Step Procedure	
		First Step: Deicing	Second Step: Anti-icing[2]
0 °C (32 °F) and above	100/0, 75/25 or 50/50 Unheated Type III fluid/water mixture	Heated[3] water or a heated[3] Type I, II, III, or IV fluid/water mixture	100/0, 75/25 or 50/50 Unheated Type III fluid/water mixture
Below 0 °C (32 °F) to -3 °C (27 °F)	100/0, 75/25 or 50/50 Unheated Type III fluid/water mixture	Heated[3] Type I, II, III, or IV fluid/water mixture with a freezing point at OAT or below	100/0, 75/25 or 50/50 Unheated Type III fluid/water mixture
Below -3 °C (27 °F) to -10 °C (14 °F)	100/0 or 75/25 Unheated Type III fluid/water mixture	Heated[3] Type I, II, III, or IV fluid/water mixture with a freezing point at OAT or below	100/0 or 75/25 Unheated Type III fluid/water mixture
Below -10 °C (14 °F) to LOUT	100/0 Unheated Type III fluid/water mixture	Heated[3] Type I, II, III, or IV fluid/water mixture with a freezing point at OAT or below	100/0 Unheated Type III fluid/water mixture

NOTES

1 One step or second step fluids must not be used at temperatures below their lowest operational use temperature (LOUT). First step fluids must not be used below their freezing points. Consider the use of Type I when Type III fluid cannot be used (see Table 48). The LOUT for a given Type III fluid is the higher (warmer) of:

   a) The lowest temperature at which the fluid meets the aerodynamic acceptance test for a given aircraft type; or
   b) The actual freezing point of the fluid plus its freezing point buffer of 7 °C (13 °F).

   Although the LOUTs may be lower than the temperatures stated in the HOT table, holdover times do not apply when anti-icing below the lowest temperature stated in the band.

2 To be applied before first step fluid freezes, typically within 3 minutes. (This time may be longer than 3 minutes in some conditions, but potentially shorter in heavy precipitation, in colder temperatures, or for critical surfaces constructed of composite materials. If necessary, the second step shall be applied area by area.)

3 For heated fluids, a fluid temperature not less than 60 °C (140 °F) at the nozzle is desirable.

4 One-step procedure with unheated Type III fluid is only possible on a clean aircraft. If deicing is required, a two-step procedure must be used.

CAUTIONS

- Upper temperature limit shall not exceed fluid and aircraft manufacturers' recommendations.
- Wing skin temperatures may differ and in some cases may be lower than the OAT. A stronger mix (more glycol) may be needed under these conditions.
- Whenever frost or ice occurs on the lower surface of the wing in the area of the fuel tank, indicating a cold soaked wing, the 50/50 dilutions of Type III shall not be used for the anti-icing step because fluid freezing may occur.
- An insufficient amount of anti-icing fluid may cause a substantial loss of holdover time. This is particularly true when using a Type I fluid mixture for the first step in a two-step procedure.

APPENDIX A:
ADJUSTED HOLDOVER TIME (HOT) GUIDELINES

These tables are for use when flaps/slats are deployed prior to de/anti-icing. Holdover and allowance times have been adjusted to 76 percent of standard times. Standard holdover and allowance times can be used if flaps and slats are deployed as close to departure as safety allows.

Note: Industry data indicates the possibility of increased takeoff misconfigurations when the selection of takeoff flaps is delayed later in the taxi regime. If an air carrier chooses to select the flaps/slats to the takeoff configuration prior to beginning the anti-icing process, operators should have robust procedures in place to ensure that the aircraft is properly configured prior to takeoff. Air Carriers should follow the airframe manufacturer's recommended procedures regarding anti-icing operations and the configuration of flaps/slats while taxiing.

Appendix A: FAA Adjusted Holdover Time Guidelines Winter 2019-2020

ADJUSTED HOLDOVER TIME (HOT) GUIDELINES FOR WINTER 2019-2020

Table ADJ-1: Adjusted Active Frost Holdover Times for SAE Type I, Type II, Type III, and Type IV Fluids A-3
Table ADJ-2: Adjusted Holdover Times for SAE Type I Fluid on Critical Aircraft Surfaces Composed Predominantly of Aluminum A-4
Table ADJ-3: Adjusted Holdover Times for SAE Type I Fluid on Critical Aircraft Surfaces Composed Predominantly of Composites A-5
Table ADJ-4: Adjusted Generic Holdover Times for SAE Type II Fluids A-6
Table ADJ-5: Adjusted Type II Holdover Times for ABAX ECOWING 26 ..... A-7
Table ADJ-6: Adjusted Type II Holdover Times for ABAX ECOWING AD-2 ..... A-8
Table ADJ-7: Adjusted Type II Holdover Times for Aviation Shaanxi Hi-Tech Cleanwing II A-9
Table ADJ-8: Adjusted Type II Holdover Times for Beijing Yadilite Aviation YD-102 Type II A-10
Table ADJ-9: Adjusted Type II Holdover Times for Clariant Safewing MP II FLIGHT A-11
Table ADJ-10: Adjusted Type II Holdover Times for Clariant Safewing MP II FLIGHT PLUS A-12
Table ADJ-11: Adjusted Type II Holdover Times for Cryotech Polar Guard® II A-13
Table ADJ-12: Adjusted Type II Holdover Times for Kilfrost ABC-K Plus A-14
Table ADJ-13: Adjusted Type II Holdover Times for Kilfrost Ice Clear II A-15
Table ADJ-14: Adjusted Type II Holdover Times for Newave Aerochemical FCY-2 ..... A-16
Table ADJ-15: Adjusted Type II Holdover Times for Newave Aerochemical FCY-2 Bio+ A-17
Table ADJ-16: Adjusted Type II Holdover Times for Oksayd Defrost PG 2 ..... A-18
Table ADJ-17: Adjusted Type II Holdover Times for ROMCHIM ADD-PROTECT Type II A-19
Table ADJ-18: Adjusted Type III Holdover Times for AllClear AeroClear MAX Applied Unheated on Low Speed Aircraft A-20
Table ADJ-19: Adjusted Type III Holdover Times for AllClear AeroClear MAX Applied Unheated on High Speed Aircraft A-21
Table ADJ-20: Adjusted Generic Holdover Times for SAE Type IV Fluids A-22
Table ADJ-21: Adjusted Type IV Holdover Times for ABAX ECOWING AD-49 ..... A-23
Table ADJ-22: Adjusted Type IV Holdover Times for AllClear ClearWing EG A-24
Table ADJ-23: Adjusted Type IV Holdover Times for CHEMCO ChemR EG IV A-25
Table ADJ-24: Adjusted Type IV Holdover Times for Clariant Max Flight 04 ..... A-26
Table ADJ-25: Adjusted Type IV Holdover Times for Clariant Max Flight AVIA A-27
Table ADJ-26: Adjusted Type IV Holdover Times for Clariant Max Flight SNEG A-28
Table ADJ-27: Adjusted Type IV Holdover Times for Clariant Safewing EG IV NORTH A-29
Table ADJ-28: Adjusted Type IV Holdover Times for Clariant Safewing MP IV LAUNCH A-30
Table ADJ-29: Adjusted Type IV Holdover Times for Clariant Safewing MP IV LAUNCH PLUS A-31
Table ADJ-30: Adjusted Type IV Holdover Times for Cryotech Polar Guard® Advance A-32
Table ADJ-31: Adjusted Type IV Holdover Times for Cryotech Polar Guard® Xtend A-33
Table ADJ-32: Adjusted Type IV Holdover Times for Dow Chemical UCAR™ Endurance EG106 ..... A-34
Table ADJ-33: Adjusted Type IV Holdover Times for Dow Chemical UCAR™ FlightGuard AD-49 ..... A-35
Table ADJ-34: Adjusted Type IV Holdover Times for Inland Technologies ECO-SHIELD® A-36
Table ADJ-35: Adjusted Type IV Holdover Times for Kilfrost ABC-S Plus A-37
Table ADJ-36: Adjusted Type IV Holdover Times for LNT Solutions E450 ..... A-38
Table ADJ-37: Adjusted Type IV Holdover Times for Newave Aerochemical FCY 9311 ..... A-39
Table ADJ-38: Adjusted Type IV Holdover Times for Oksayd Defrost ECO 4 ..... A-40
Table ADJ-39: Adjusted Type IV Holdover Times for Oksayd Defrost EG 4 ..... A-41
Table ADJ-40: Adjusted Type IV Holdover Times for Shaanxi Cleanway Aviation Cleansurface IV A-42
Table ADJ-41: Adjusted Allowance Times for SAE Type III Fluids A-43
Table ADJ-42: Adjusted Allowance Times for SAE Type IV Fluids A-44

Appendix A: FAA Adjusted Holdover Time Guidelines — Winter 2019-2020

TABLE ADJ-1: ADJUSTED ACTIVE FROST HOLDOVER TIMES FOR SAE TYPE I, TYPE II, TYPE III, AND TYPE IV FLUIDS

Outside Air Temperature[1,2,3]	Type I
-1 °C and above (30 °F and above)	0:34 *(0:26)*[5]
below -1 to -3 °C (below 30 to 27 °F)	
below -3 to -10 °C (below 27 to 14 °F)	
below -10 to -14 °C (below 14 to 7 °F)	
below -14 to -21 °C (below 7 to -6 °F)	
below -21 to -25 °C (below -6 to -13 °F)	
below -25 °C to LOUT (below -13 °F to LOUT)	

Outside Air Temperature[2,3]	Concentration Fluid/Water By % Volume	Type II	Type III[4]	Type IV
-1 °C and above (30 °F and above)	100/0	6:04	1:31	9:07
	75/25	3:48	0:45	3:48
	50/50	2:16	0:22	2:16
below -1 to -3 °C (below 30 to 27 °F)	100/0	6:04	1:31	9:07
	75/25	3:48	0:45	3:48
	50/50	1:08	0:22	2:16
below -3 to -10 °C (below 27 to 14 °F)	100/0	6:04	1:31	7:36
	75/25	3:48	0:45	3:48
below -10 to -14 °C (below 14 to 7 °F)	100/0	4:33	1:31	4:33
	75/25	0:45	0:45	0:45
below -14 to -21 °C (below 7 to -6 °F)	100/0	4:33	1:31	4:33
below -21 to -25 °C (below -6 to -13 °F)	100/0	1:31	1:31	3:02
below -25 °C (below -13 °F)	100/0	No Holdover Time Guidelines Exist		

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Type I Fluid / Water Mixture must be selected so that the freezing point of the mixture is at least 10 °C (18 °F) below outside air temperature.
2 Ensure that the lowest operational use temperature (LOUT) is respected.
3 Changes in outside air temperature (OAT) over the course of longer frost events can be significant; the appropriate holdover time to use is the one provided for the coldest OAT that has occurred in the time between the de/anti-icing fluid application and takeoff.
4 To use the Type III fluid frost holdover times, the fluid brand being used must be known. AllClear AeroClear MAX must be applied unheated.
5 Value in parentheses is for aircraft with critical surfaces that are predominantly or entirely constructed of composite materials.

CAUTIONS

- The responsibility for the application of these data remains with the user.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

Appendix A: FAA Adjusted Holdover Time Guidelines — Winter 2019-2020

TABLE ADJ-2: ADJUSTED HOLDOVER TIMES FOR SAE TYPE I FLUID ON CRITICAL AIRCRAFT SURFACES COMPOSED PREDOMINANTLY OF ALUMINUM

Outside Air Temperature[1,2]	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[3,4]	Light Snow, Snow Grains or Snow Pellets[3,4]	Moderate Snow, Snow Grains or Snow Pellets[3]	Freezing Drizzle[5]	Light Freezing Rain	Rain on Cold Soaked Wing[6]	Other[7]
-3 °C and above (27 °F and above)	0:08 - 0:13	0:14 - 0:17	0:08 - 0:14	0:05 - 0:08	0:07 - 0:10	0:02 - 0:04	0:02 - 0:04	
below -3 to -6 °C (below 27 to 21 °F)	0:06 - 0:10	0:11 - 0:13	0:06 - 0:11	0:04 - 0:06	0:04 - 0:07	0:02 - 0:04	CAUTION: No holdover time guidelines exist	
below -6 to -10 °C (below 21 to 14 °F)	0:05 - 0:08	0:08 - 0:10	0:05 - 0:08	0:03 - 0:05	0:03 - 0:05	0:02 - 0:04		
below -10 °C (below 14 °F)	0:04 - 0:07	0:05 - 0:06	0:03 - 0:05	0:02 - 0:03				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Type I fluid / water mixture must be selected so that the freezing point of the mixture is at least 10 °C (18 °F) below outside air temperature.
2 Ensure that the lowest operational use temperature (LOUT) is respected.
3 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
4 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
5 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
6 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
7 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

Appendix A: FAA Adjusted Holdover Time Guidelines — Winter 2019-2020

TABLE ADJ-3: ADJUSTED HOLDOVER TIMES FOR SAE TYPE I FLUID ON CRITICAL AIRCRAFT SURFACES COMPOSED PREDOMINANTLY OF COMPOSITES

Outside Air Temperature[1,2]	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[3,4]	Light Snow, Snow Grains or Snow Pellets[3,4]	Moderate Snow, Snow Grains or Snow Pellets[3]	Freezing Drizzle[5]	Light Freezing Rain	Rain on Cold Soaked Wing[6]	Other[7]
-3 °C and above (27 °F and above)	0:07 - 0:12	0:09 - 0:11	0:05 - 0:09	0:02 - 0:05	0:06 - 0:10	0:02 - 0:04	0:01 - 0:04	
below -3 to -6 °C (below 27 to 21 °F)	0:05 - 0:06	0:08 - 0:10	0:04 - 0:08	0:02 - 0:04	0:04 - 0:07	0:02 - 0:04	CAUTION: No holdover time guidelines exist	
below -6 to -10 °C (below 21 to 14 °F)	0:03 - 0:06	0:07 - 0:09	0:04 - 0:07	0:02 - 0:04	0:03 - 0:05	0:02 - 0:04		
below -10 °C (below 14 °F)	0:03 - 0:05	0:05 - 0:06	0:03 - 0:05	0:02 - 0:03				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Type I fluid / water mixture must be selected so that the freezing point of the mixture is at least 10 °C (18 °F) below outside air temperature.
2 Ensure that the lowest operational use temperature (LOUT) is respected.
3 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
4 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
5 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
6 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
7 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

Appendix A: FAA Adjusted Holdover Time Guidelines — Winter 2019-2020

TABLE ADJ-4: ADJUSTED GENERIC HOLDOVER TIMES FOR SAE TYPE II FLUIDS

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets[2,3]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	0:42 - 1:24	0:19 - 0:38	0:23 - 0:46	0:15 - 0:27	0:06 - 0:34	
	75/25	0:19 - 0:42	0:11 - 0:19	0:11 - 0:30	0:08 - 0:15	0:03 - 0:19	
	50/50	0:11 - 0:19	0:04 - 0:08	0:06 - 0:11	0:05 - 0:07	CAUTION: No holdover time guidelines exist	
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:23 - 0:34	0:15 - 0:27	0:15 - 0:34	0:11 - 0:15		
	75/25	0:19 - 0:38	0:08 - 0:15	0:11 - 0:19	0:06 - 0:11		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:23 - 0:34	0:11 - 0:23	0:15 - 0:34[7]	0:11 - 0:15[7]		
	75/25	0:19 - 0:38	0:06 - 0:15	0:11 - 0:19[7]	0:06 - 0:11[7]		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:11 - 0:19	0:02 - 0:05				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:11 - 0:19[8]	0:01 - 0:02[8]				
below -25 °C to LOUT (below -13 °F to LOUT)	100/0	0:11 - 0:19[8]	0:00 - 0:01[8]				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).
8 If the LOUT is unknown, no holdover time guidelines exist below -24 °C (-11 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

Appendix A: FAA Adjusted Holdover Time Guidelines — Winter 2019-2020

TABLE ADJ-5: ADJUSTED TYPE II HOLDOVER TIMES FOR ABAX ECOWING 26

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	1:05 - 1:58	1:12 - 1:24	0:46 - 1:12	0:30 - 0:46	0:38 - 1:12	0:30 - 0:38	0:15 - 1:05	
	75/25	0:49 - 1:27	1:01 - 1:16	0:30 - 1:01	0:15 - 0:30	0:34 - 0:49	0:19 - 0:27	0:08 - 0:46	
	50/50	0:23 - 0:34	0:30 - 0:38	0:15 - 0:30	0:05 - 0:15	0:11 - 0:19	0:06 - 0:08	CAUTION: No holdover time guidelines exist	
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:34 - 1:43	1:08 - 1:20	0:42 - 1:08	0:27 - 0:42	0:23 - 0:53	0:11 - 0:27		
	75/25	0:27 - 0:57	0:49 - 1:01	0:27 - 0:49	0:15 - 0:27	0:15 - 0:38	0:11 - 0:19		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:34 - 1:43	1:05 - 1:16	0:42 - 1:05	0:27 - 0:42	0:23 - 0:53[7]	0:11 - 0:27[7]		
	75/25	0:27 - 0:57	0:42 - 0:53	0:23 - 0:42	0:11 - 0:23	0:15 - 0:38[7]	0:11 - 0:19[7]		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:19 - 0:34	0:15 - 0:23	0:05 - 0:15	0:02 - 0:05				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:19 - 0:34	0:07 - 0:11	0:02 - 0:07	0:01 - 0:02				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

Appendix A: FAA Adjusted Holdover Time Guidelines — Winter 2019-2020

TABLE ADJ-6: ADJUSTED TYPE II HOLDOVER TIMES FOR ABAX ECOWING AD-2

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	1:01 - 2:17	1:50 - 2:13	0:57 - 1:50	0:30 - 0:57	0:30 - 1:16	0:23 - 0:34	0:07 - 1:05	
	75/25	0:57 - 1:05	1:20 - 1:39	0:42 - 1:20	0:19 - 0:42	0:27 - 0:49	0:15 - 0:23	0:03 - 0:38	
	50/50	0:11 - 0:23	0:27 - 0:30	0:11 - 0:27	0:05 - 0:11	0:07 - 0:11	0:05 - 0:07	CAUTION: No holdover time guidelines exist	
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:34 - 1:54	1:31 - 1:50	0:46 - 1:31	0:23 - 0:46	0:19 - 0:53	0:15 - 0:23		
	75/25	0:27 - 1:27	1:16 - 1:35	0:38 - 1:16	0:19 - 0:38	0:11 - 0:42	0:15 - 0:27		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:34 - 1:54	1:20 - 1:35	0:42 - 1:20	0:23 - 0:42	0:19 - 0:53[7]	0:15 - 0:23[7]		
	75/25	0:27 - 1:27	1:12 - 1:31	0:38 - 1:12	0:19 - 0:38	0:11 - 0:42[7]	0:15 - 0:27[7]		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:11 - 0:30	0:15 - 0:23	0:05 - 0:15	0:02 - 0:05				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:11 - 0:30	0:07 - 0:11	0:02 - 0:07	0:01 - 0:02				
below -25 to -27 °C (below -13 to -17 °F)	100/0	0:11 - 0:30	0:04 - 0:05	0:01 - 0:04	0:00 - 0:01				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

Appendix A: FAA Adjusted Holdover Time Guidelines — Winter 2019-2020

TABLE ADJ-7: ADJUSTED TYPE II HOLDOVER TIMES FOR AVIATION SHAANXI HI-TECH CLEANWING II

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets[2,3]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	0:42 - 1:24	0:23 - 0:42	0:27 - 0:49	0:19 - 0:27	0:08 - 0:42	
	75/25	0:38 - 1:01	0:19 - 0:34	0:27 - 0:46	0:15 - 0:23	0:05 - 0:38	
	50/50	0:27 - 0:46	0:11 - 0:23	0:15 - 0:30	0:08 - 0:15	CAUTION: No holdover time guidelines exist	
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:34 - 1:24	0:23 - 0:42	0:23 - 0:42	0:15 - 0:19		
	75/25	0:30 - 1:20	0:19 - 0:34	0:27 - 0:30	0:15 - 0:19		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:34 - 1:24	0:23 - 0:42	0:23 - 0:42[7]	0:15 - 0:19[7]		
	75/25	0:30 - 1:20	0:19 - 0:34	0:27 - 0:30[7]	0:15 - 0:19[7]		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:15 - 0:38	0:02 - 0:05				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:15 - 0:38	0:01 - 0:02				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

TABLE ADJ-8: ADJUSTED TYPE II HOLDOVER TIMES FOR BEIJING YADILITE AVIATION YD-102 TYPE II

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	0:53 - 1:31	1:16 - 1:31	0:38 - 1:16	0:19 - 0:38	0:30 - 0:57	0:27 - 0:30	0:08 - 0:46	
	75/25	0:19 - 0:42	0:38 - 0:49	0:19 - 0:38	0:11 - 0:19	0:11 - 0:30	0:08 - 0:15	0:03 - 0:19	
	50/50	0:11 - 0:19	0:19 - 0:23	0:08 - 0:19	0:04 - 0:08	0:06 - 0:11	0:05 - 0:07	CAUTION: No holdover time guidelines exist	
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:34 - 1:08	0:57 - 1:08	0:27 - 0:57	0:15 - 0:27	0:27 - 0:38	0:19 - 0:19		
	75/25	0:23 - 0:38	0:30 - 0:38	0:15 - 0:30	0:08 - 0:15	0:11 - 0:19	0:07 - 0:11		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:34 - 1:08	0:46 - 0:57	0:23 - 0:46	0:11 - 0:23	0:27 - 0:38[7]	0:19 - 0:19[7]		
	75/25	0:23 - 0:38	0:27 - 0:34	0:15 - 0:27	0:06 - 0:15	0:11 - 0:19[7]	0:07 - 0:11[7]		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:15 - 0:34	0:15 - 0:23	0:05 - 0:15	0:02 - 0:05				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:15 - 0:34	0:07 - 0:11	0:02 - 0:07	0:01 - 0:02				
below -25 to -29 °C (below -13 to -20 °F)	100/0	0:15 - 0:34	0:04 - 0:05	0:01 - 0:04	0:00 - 0:01				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

Appendix A: FAA Adjusted Holdover Time Guidelines — Winter 2019-2020

TABLE ADJ-9: ADJUSTED TYPE II HOLDOVER TIMES FOR CLARIANT SAFEWING MP II FLIGHT

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	2:40 - 3:02	1:58 - 2:21	1:12 - 1:58	0:46 - 1:12	1:01 - 1:31	0:34 - 1:05	0:08 - 1:08	
	75/25	1:24 - 2:05	1:58 - 2:24	1:01 - 1:58	0:30 - 1:01	0:53 - 1:08	0:23 - 0:42	0:05 - 0:38	
	50/50	0:42 - 1:20	0:34 - 0:42	0:19 - 0:34	0:08 - 0:19	0:15 - 0:23	0:08 - 0:11	CAUTION: No holdover time guidelines exist	
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:42 - 1:20	1:35 - 1:54	0:57 - 1:35	0:34 - 0:57	0:27 - 1:08	0:19 - 0:34		
	75/25	0:19 - 0:49	1:20 - 1:39	0:42 - 1:20	0:23 - 0:42	0:19 - 0:53	0:15 - 0:27		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:42 - 1:20	1:24 - 1:39	0:49 - 1:24	0:30 - 0:49	0:27 - 1:08[7]	0:19 - 0:34[7]		
	75/25	0:19 - 0:49	1:01 - 1:16	0:30 - 1:01	0:15 - 0:30	0:19 - 0:53[7]	0:15 - 0:27[7]		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:23 - 0:38	0:53 - 1:16	0:19 - 0:53	0:06 - 0:19				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:23 - 0:38	0:23 - 0:30	0:08 - 0:23	0:02 - 0:08				
below -25 to -29 °C (below -13 to -20 °F)	100/0	0:23 - 0:38	0:15 - 0:23	0:05 - 0:15	0:02 - 0:05				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

Appendix A: FAA Adjusted Holdover Time Guidelines — Winter 2019-2020

TABLE ADJ-10: ADJUSTED TYPE II HOLDOVER TIMES FOR CLARIANT SAFEWING MP II FLIGHT PLUS

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets[2,3]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	2:02 - 3:02	0:38 - 1:24	1:05 - 1:31	0:34 - 0:46	0:11 - 1:31	
	75/25	1:58 - 3:02	0:46 - 1:20	1:12 - 1:31	0:38 - 0:57	0:11 - 0:57	
	50/50	0:49 - 1:46	0:11 - 0:19	0:23 - 0:49	0:11 - 0:15	CAUTION: No holdover time guidelines exist	
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:30 - 1:46	0:30 - 1:08	0:27 - 1:05	0:27 - 0:42		
	75/25	0:23 - 1:20	0:46 - 1:16	0:19 - 0:53	0:23 - 0:34		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:30 - 1:46	0:27 - 0:57	0:27 - 1:05[7]	0:27 - 0:42[7]		
	75/25	0:23 - 1:20	0:42 - 1:16	0:19 - 0:53[7]	0:23 - 0:34[7]		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:15 - 0:30	0:02 - 0:05				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:15 - 0:30	0:01 - 0:02				
below -25 to -29 °C (below -13 to -20 °F)	100/0	0:15 - 0:30	0:00 - 0:01				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

Appendix A: FAA Adjusted Holdover Time Guidelines — Winter 2019-2020

TABLE ADJ-11: ADJUSTED TYPE II HOLDOVER TIMES FOR CRYOTECH POLAR GUARD® II

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	2:09 - 3:02	2:28 - 2:59	1:27 - 2:28	0:49 - 1:27	1:12 - 1:31	0:57 - 1:08	0:11 - 1:31	
	75/25	1:54 - 3:02	2:17 - 2:55	1:05 - 2:17	0:30 - 1:05	1:16 - 1:31	0:30 - 0:53	0:07 - 1:16	
	50/50	0:38 - 1:05	0:53 - 1:12	0:19 - 0:53	0:08 - 0:19	0:15 - 0:34	0:07 - 0:15		
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:42 - 1:54	1:50 - 2:09	1:05 - 1:50	0:38 - 1:05	0:27 - 1:12	0:27 - 0:34		
	75/25	0:30 - 1:08	1:46 - 2:17	0:49 - 1:46	0:23 - 0:49	0:19 - 0:49	0:27 - 0:34		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:42 - 1:54	1:31 - 1:46	0:53 - 1:31	0:30 - 0:53	0:27 - 1:12[7]	0:27 - 0:34[7]		
	75/25	0:30 - 1:08	1:31 - 1:54	0:42 - 1:31	0:19 - 0:42	0:19 - 0:49[7]	0:27 - 0:34[7]		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:19 - 0:38	1:12 - 1:43	0:27 - 1:12	0:08 - 0:27				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:19 - 0:38	0:30 - 0:42	0:11 - 0:30	0:03 - 0:11				
below -25 to -30.5 °C (below -13 to -23 °F)	100/0	0:19 - 0:38	0:19 - 0:23	0:05 - 0:19	0:02 - 0:05				

CAUTION: No holdover time guidelines exist

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

Appendix A: FAA Adjusted Holdover Time Guidelines — Winter 2019-2020

TABLE ADJ-12: ADJUSTED TYPE II HOLDOVER TIMES FOR KILFROST ABC-K PLUS

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets[2,3]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	1:43 - 2:51	0:46 - 1:16	1:24 - 1:31	0:46 - 1:05	0:15 - 1:31	
	75/25	1:16 - 1:54	0:27 - 0:53	1:05 - 1:31	0:38 - 0:53	0:11 - 1:31	
	50/50	0:27 - 0:49	0:05 - 0:11	0:15 - 0:23	0:08 - 0:11	CAUTION: No holdover time guidelines exist	
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:23 - 0:49	0:42 - 1:08	0:19 - 0:46	0:11 - 0:27		
	75/25	0:19 - 1:05	0:27 - 0:49	0:15 - 0:42	0:07 - 0:23		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:23 - 0:49	0:38 - 1:05	0:19 - 0:46[7]	0:11 - 0:27[7]		
	75/25	0:19 - 1:05	0:27 - 0:49	0:15 - 0:42[7]	0:07 - 0:23[7]		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:23 - 0:42	0:02 - 0:05				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:23 - 0:42	0:01 - 0:02				
below -25 to -29 °C (below -13 to -20 °F)	100/0	0:23 - 0:42	0:00 - 0:01				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

Appendix A: FAA Adjusted Holdover Time Guidelines — Winter 2019-2020

TABLE ADJ-13: ADJUSTED TYPE II HOLDOVER TIMES FOR KILFROST ICE CLEAR II

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	0:49 - 1:31	1:31 - 1:50	0:49 - 1:31	0:27 - 0:49	0:27 - 0:46	0:19 - 0:30	0:08 - 0:49	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A		
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:42 - 1:27	1:20 - 1:39	0:42 - 1:20	0:23 - 0:42	0:30 - 0:46	0:19 - 0:23		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:42 - 1:27	1:16 - 1:31	0:42 - 1:16	0:23 - 0:42	0:30 - 0:46[7]	0:19 - 0:23[7]	CAUTION: No holdover time guidelines exist	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:23 - 0:42	0:15 - 0:23	0:05 - 0:15	0:02 - 0:05				
below -18 to -24 °C (below 0 to -11 °F)	100/0	0:23 - 0:42	0:07 - 0:11	0:02 - 0:07	0:01 - 0:02				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

TABLE ADJ-14: ADJUSTED TYPE II HOLDOVER TIMES FOR NEWAVE AEROCHEMICAL FCY-2

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Snow, Snow Grains or Snow Pellets[2,3]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	0:57 - 1:50	0:23 - 0:42	0:27 - 0:49	0:19 - 0:27	0:06 - 0:34	
	75/25	0:38 - 1:08	0:15 - 0:30	0:19 - 0:34	0:11 - 0:19	0:04 - 0:19	
	50/50	0:19 - 0:27	0:11 - 0:19	0:08 - 0:15	0:05 - 0:08	CAUTION: No holdover time guidelines exist	
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:34 - 1:08	0:15 - 0:30	0:15 - 0:34	0:11 - 0:15		
	75/25	0:23 - 0:49	0:11 - 0:19	0:11 - 0:23	0:06 - 0:11		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:34 - 1:08	0:11 - 0:23	0:15 - 0:34[7]	0:11 - 0:15[7]		
	75/25	0:23 - 0:49	0:08 - 0:15	0:11 - 0:23[7]	0:06 - 0:11[7]		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:19 - 0:27	0:02 - 0:05				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:19 - 0:27	0:01 - 0:02				
below -25 to -28 °C (below -13 to -18 °F)	100/0	0:19 - 0:27	0:00 - 0:01				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

Appendix A: FAA Adjusted Holdover Time Guidelines — Winter 2019-2020

TABLE ADJ-15: ADJUSTED TYPE II HOLDOVER TIMES FOR NEWAVE AEROCHEMICAL FCY-2 BIO+

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	1:05 - 1:54	1:46 - 2:13	0:49 - 1:46	0:23 - 0:49	0:38 - 1:01	0:19 - 0:34	0:06 - 0:57	
	75/25	0:34 - 1:01	1:01 - 1:16	0:30 - 1:01	0:15 - 0:30	0:19 - 0:38	0:11 - 0:19	0:05 - 0:27	
	50/50	0:11 - 0:23	0:19 - 0:23	0:11 - 0:19	0:06 - 0:11	0:08 - 0:15	0:06 - 0:08	CAUTION: No holdover time guidelines exist	
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:30 - 1:08	1:05 - 1:24	0:30 - 1:05	0:15 - 0:30	0:27 - 0:49	0:11 - 0:23		
	75/25	0:23 - 0:49	0:38 - 0:49	0:19 - 0:38	0:08 - 0:19	0:15 - 0:27	0:11 - 0:15		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:30 - 1:08	0:46 - 0:57	0:23 - 0:46	0:11 - 0:23	0:27 - 0:49[7]	0:11 - 0:23[7]		
	75/25	0:23 - 0:49	0:27 - 0:34	0:15 - 0:27	0:06 - 0:15	0:15 - 0:27[7]	0:11 - 0:15[7]		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:15 - 0:46	0:15 - 0:23	0:05 - 0:15	0:02 - 0:05				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:15 - 0:46	0:07 - 0:11	0:02 - 0:07	0:01 - 0:02				
below -25 to -28.5 °C (below -13 to -19 °F)	100/0	0:15 - 0:46	0:04 - 0:05	0:01 - 0:04	0:00 - 0:01				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

Appendix A: FAA Adjusted Holdover Time Guidelines — Winter 2019-2020

TABLE ADJ-16: ADJUSTED TYPE II HOLDOVER TIMES FOR OKSAYD DEFROST PG 2

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	0:42 - 1:24	1:24 - 1:43	0:42 - 1:24	0:23 - 0:42	0:23 - 0:46	0:15 - 0:27	0:08 - 1:01	
	75/25	0:49 - 1:31	1:20 - 1:43	0:34 - 1:20	0:15 - 0:34	0:19 - 0:38	0:11 - 0:23	0:05 - 0:27	
	50/50	0:46 - 1:24	1:39 - 2:02	0:46 - 1:39	0:23 - 0:46	0:23 - 0:38	0:11 - 0:23	CAUTION: No holdover time guidelines exist	
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:42 - 1:05	1:05 - 1:20	0:34 - 1:05	0:19 - 0:34	0:27 - 0:38	0:15 - 0:23		
	75/25	0:30 - 1:01	0:53 - 1:08	0:23 - 0:53	0:11 - 0:23	0:19 - 0:30	0:11 - 0:15		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:42 - 1:05	0:57 - 1:08	0:30 - 0:57	0:15 - 0:30	0:27 - 0:38[7]	0:15 - 0:23[7]		
	75/25	0:30 - 1:01	0:42 - 0:49	0:19 - 0:42	0:08 - 0:19	0:19 - 0:30[7]	0:11 - 0:15[7]		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:27 - 0:49	0:15 - 0:23	0:05 - 0:15	0:02 - 0:05				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:27 - 0:49	0:07 - 0:11	0:02 - 0:07	0:01 - 0:02				
below -25 to -27 °C (below -13 to -17 °F)	100/0	0:27 - 0:49	0:04 - 0:05	0:01 - 0:04	0:00 - 0:01				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

TABLE ADJ-17: ADJUSTED TYPE II HOLDOVER TIMES FOR ROMCHIM ADD-PROTECT TYPE II

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	1:16 - 2:40	1:27 - 1:50	0:46 - 1:27	0:23 - 0:46	0:30 - 1:12	0:19 - 0:34	0:07 - 0:38	
	75/25	0:30 - 0:53	0:46 - 0:53	0:23 - 0:46	0:11 - 0:23	0:19 - 0:30	0:11 - 0:19	0:04 - 0:19	
	50/50	0:15 - 0:27	0:23 - 0:27	0:11 - 0:23	0:07 - 0:11	0:08 - 0:23	0:06 - 0:08	CAUTION: No holdover time guidelines exist	
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:23 - 0:34	1:01 - 1:16	0:30 - 1:01	0:15 - 0:30	0:19 - 0:38	0:15 - 0:23		
	75/25	0:23 - 0:42	0:30 - 0:38	0:19 - 0:30	0:08 - 0:19	0:15 - 0:23	0:11 - 0:15		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:23 - 0:34	0:49 - 1:01	0:27 - 0:49	0:11 - 0:27	0:19 - 0:38[7]	0:15 - 0:23[7]		
	75/25	0:23 - 0:42	0:27 - 0:30	0:15 - 0:27	0:07 - 0:15	0:15 - 0:23[7]	0:11 - 0:15[7]		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:11 - 0:19	0:15 - 0:23	0:05 - 0:15	0:02 - 0:05				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:11 - 0:19	0:07 - 0:11	0:02 - 0:07	0:01 - 0:02				
below -25 to -28 °C (below -13 to -18 °F)	100/0	0:11 - 0:19	0:04 - 0:05	0:01 - 0:04	0:00 - 0:01				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type II fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

Appendix A: FAA Adjusted Holdover Time Guidelines — Winter 2019-2020

TABLE ADJ-18: ADJUSTED TYPE III HOLDOVER TIMES FOR ALLCLEAR AEROCLEAR MAX APPLIED UNHEATED ON LOW SPEED AIRCRAFT[1]

Outside Air Temperature[2]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[3,4]	Light Snow, Snow Grains or Snow Pellets[3,4]	Moderate Snow, Snow Grains or Snow Pellets[3]	Freezing Drizzle[5]	Light Freezing Rain	Rain on Cold Soaked Wing[6]	Other[7]
-3 °C and above (27 °F and above)	100/0	0:34 - 1:27	1:01 - 1:20	0:30 - 1:01	0:14 - 0:30	0:19 - 0:38	0:11 - 0:19	0:04 - 0:30	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A	CAUTION: No holdover time guidelines exist	
below -3 to -10 °C (below 27 to 14 °F)	100/0	0:38 - 1:16	1:01 - 1:20	0:30 - 1:01	0:14 - 0:30	0:19 - 0:34	0:11 - 0:19		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -10 to -16 °C (below 14 to 3 °F)	100/0	0:30 - 1:20	1:01 - 1:20	0:30 - 1:01	0:14 - 0:30				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 These holdover times are for aircraft conforming to the SAE AS5900 low speed aerodynamic test criterion. Fluid must be applied unheated to use these holdover times. No holdover times exist for this fluid applied heated.
2 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type III fluid cannot be used.
3 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
4 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
5 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
6 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
7 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail.

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

Appendix A: FAA Adjusted Holdover Time Guidelines — Winter 2019-2020

TABLE ADJ-19: ADJUSTED TYPE III HOLDOVER TIMES FOR ALLCLEAR AEROCLEAR MAX APPLIED UNHEATED ON HIGH SPEED AIRCRAFT[1]

Outside Air Temperature[2]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[3,4]	Light Snow, Snow Grains or Snow Pellets[3,4]	Moderate Snow, Snow Grains or Snow Pellets[3]	Freezing Drizzle[5]	Light Freezing Rain	Rain on Cold Soaked Wing[6]	Other[7]
-3 °C and above (27 °F and above)	100/0	0:34 - 1:27	1:01 - 1:20	0:30 - 1:01	0:14 - 0:30	0:19 - 0:38	0:11 - 0:19	0:04 - 0:30	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A	CAUTION: No holdover time guidelines exist	
below -3 to -10 °C (below 27 to 14 °F)	100/0	0:38 - 1:16	1:01 - 1:20	0:30 - 1:01	0:14 - 0:30	0:19 - 0:34	0:11 - 0:19		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -10 to -25 °C (below 14 to -13 °F)	100/0	0:30 - 1:20	1:01 - 1:20	0:30 - 1:01	0:14 - 0:30				
below -25 to -35 °C (below -13 to -31 °F)	100/0	0:19 - 0:46	0:34 - 0:46	0:15 - 0:34	0:08 - 0:15				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 These holdover times are for aircraft conforming to the SAE AS5900 high speed aerodynamic test criterion. Fluid must be applied unheated to use these holdover times. No holdover times exist for this fluid applied heated.
2 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type III fluid cannot be used.
3 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
4 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
5 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
6 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
7 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table ADJ-41 provides allowance times for ice pellets and small hail for SAE Type III fluids, applied unheated).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

Appendix A: FAA Adjusted Holdover Time Guidelines — Winter 2019-2020

TABLE ADJ-20: ADJUSTED GENERIC HOLDOVER TIMES FOR SAE TYPE IV FLUIDS

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	0:57 - 2:02	1:46 - 2:05	0:53 - 1:46	0:27 - 0:53	0:30 - 1:08	0:19 - 0:30	0:06 - 0:53	
	75/25	1:05 - 2:02	1:35 - 1:50	0:57 - 1:35	0:30 - 0:57	0:38 - 1:01	0:23 - 0:34	0:07 - 0:57	
	50/50	0:23 - 0:42	0:46 - 0:53	0:19 - 0:46	0:08 - 0:19	0:11 - 0:30	0:07 - 0:15		
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:15 - 1:12	1:24 - 1:46	0:42 - 1:24	0:23 - 0:42	0:19 - 1:01	0:15 - 0:19		
	75/25	0:23 - 1:01	1:24 - 1:39	0:46 - 1:24	0:23 - 0:46	0:15 - 0:49	0:11 - 0:19		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:15 - 1:12	1:01 - 1:16	0:34 - 1:01	0:19 - 0:34	0:19 - 1:01[7]	0:15 - 0:19[7]		
	75/25	0:23 - 1:01	1:16 - 1:31	0:34 - 1:16	0:15 - 0:34	0:15 - 0:49[7]	0:11 - 0:19[7]	CAUTION: No holdover time guidelines exist	
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:15 - 0:30	0:23 - 0:34	0:07 - 0:23	0:02 - 0:07				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:15 - 0:30[8]	0:08 - 0:15[8]	0:02 - 0:08[8]	0:01 - 0:02[8]				
below -25° C to LOUT (below -13° F to LOUT)	100/0	0:15 - 0:30[8]	0:05 - 0:08[8]	0:02 - 0:05[8]	0:00 - 0:02[8]				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table ADJ-42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).
8 If the LOUT is unknown, no holdover time guidelines exist below -22.5 °C (-8.5 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

TABLE ADJ-21: ADJUSTED TYPE IV HOLDOVER TIMES FOR ABAX ECOWING AD-49

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	2:32 - 3:02	2:47 - 3:00	1:27 - 2:47	0:46 - 1:27	1:05 - 1:31	0:46 - 1:05	0:08 - 1:27	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A		
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:15 - 1:12	2:13 - 2:40	1:08 - 2:13	0:34 - 1:08	0:19 - 1:05	0:15 - 0:19		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:15 - 1:12	1:50 - 2:17	0:57 - 1:50	0:30 - 0:57	0:19 - 1:05[7]	0:15 - 0:19[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	CAUTION: No holdover time guidelines exist	
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:19 - 0:30	0:23 - 0:34	0:07 - 0:23	0:02 - 0:07				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:19 - 0:30	0:08 - 0:15	0:02 - 0:08	0:01 - 0:02				
below -25 to -26 °C (below -13 to -15 °F)	100/0	0:19 - 0:30	0:05 - 0:08	0:02 - 0:05	0:00 - 0:02				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table ADJ-42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

TABLE ADJ-22: ADJUSTED TYPE IV HOLDOVER TIMES FOR ALLCLEAR CLEARWING EG

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	1:24 - 2:28	2:02 - 2:32	1:01 - 2:02	0:30 - 1:01	0:53 - 1:12	0:23 - 0:46	0:08 - 1:08	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A		
below -3 to -8 °C (below 27 to 18 °F)	100/0	1:12 - 2:51	1:50 - 2:17	0:53 - 1:50	0:27 - 0:53	0:49 - 1:08	0:23 - 0:46		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14 °C (below 18 to 7 °F)	100/0	1:12 - 2:51	1:43 - 2:05	0:49 - 1:43	0:23 - 0:49	0:49 - 1:08[7]	0:23 - 0:46[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:42 - 1:31	0:38 - 0:49	0:19 - 0:38	0:08 - 0:19				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:42 - 1:31	0:30 - 0:42	0:11 - 0:30	0:04 - 0:11				
below -25 to -29 °C (below -13 to -20 °F)	100/0	0:42 - 1:31	0:19 - 0:27	0:06 - 0:19	0:02 - 0:06				

CAUTION: No holdover time guidelines exist

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table ADJ-42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

TABLE ADJ-23: ADJUSTED TYPE IV HOLDOVER TIMES FOR CHEMCO CHEMR EG IV

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	1:35 - 2:43	2:17 - 2:55	0:57 - 2:17	0:27 - 0:57	0:34 - 1:16	0:19 - 0:30	0:07 - 1:20	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A		
below -3 to -8 °C (below 27 to 18 °F)	100/0	1:05 - 2:47	2:17 - 2:55	0:57 - 2:17	0:27 - 0:57	0:46 - 1:12	0:27 - 0:38		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14 °C (below 18 to 7 °F)	100/0	1:05 - 2:47	2:17 - 2:55	0:57 - 2:17	0:27 - 0:57	0:46 - 1:12[7]	0:27 - 0:38[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:30 - 1:05	0:38 - 0:49	0:19 - 0:38	0:08 - 0:19				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:30 - 1:05	0:30 - 0:42	0:11 - 0:30	0:04 - 0:11				
below -25 to -27 °C (below -13 to -17 °F)	100/0	0:30 - 1:05	0:19 - 0:27	0:06 - 0:19	0:02 - 0:06				

CAUTION: No holdover time guidelines exist

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table ADJ-42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

Appendix A: FAA Adjusted Holdover Time Guidelines — Winter 2019-2020

TABLE ADJ-24: ADJUSTED TYPE IV HOLDOVER TIMES FOR CLARIANT MAX FLIGHT 04

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	2:02 - 3:02	3:00 - 3:00	2:05 - 3:00	1:05 - 2:05	1:31 - 1:31	0:53 - 1:08	0:15 - 1:31	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A	CAUTION: No holdover time guidelines exist	
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:38 - 1:54	2:28 - 3:00	1:16 - 2:28	0:38 - 1:16	0:19 - 1:08	0:15 - 0:30		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:38 - 1:54	1:46 - 2:09	0:53 - 1:46	0:27 - 0:53	0:19 - 1:08[7]	0:15 - 0:30[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:15 - 0:34	0:23 - 0:34	0:07 - 0:23	0:02 - 0:07				
below -18 to -23.5 °C (below 0 to -10 °F)	100/0	0:15 - 0:34	0:08 - 0:15	0:02 - 0:08	0:01 - 0:02				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table ADJ-42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

TABLE ADJ-25: ADJUSTED TYPE IV HOLDOVER TIMES FOR CLARIANT MAX FLIGHT AVIA

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	2:21 - 3:02	2:17 - 2:43	1:20 - 2:17	0:46 - 1:20	1:05 - 1:31	0:42 - 0:53	0:07 - 1:31	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A	CAUTION: No holdover time guidelines exist	
below -3 to -8 °C (below 27 to 18 °F)	100/0	1:20 - 2:59	1:54 - 2:17	1:05 - 1:54	0:38 - 1:05	0:53 - 1:31	0:42 - 1:08		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14 °C (below 18 to 7 °F)	100/0	1:20 - 2:59	1:39 - 1:58	0:57 - 1:39	0:30 - 0:57	0:53 - 1:31[7]	0:42 - 1:08[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:27 - 1:05	0:38 - 0:49	0:19 - 0:38	0:08 - 0:19				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:27 - 1:05	0:30 - 0:42	0:11 - 0:30	0:04 - 0:11				
below -25 to -28.5 °C (below -13 to -19 °F)	100/0	0:27 - 1:05	0:19 - 0:27	0:06 - 0:19	0:02 - 0:06				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table ADJ-42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

TABLE ADJ-26: ADJUSTED TYPE IV HOLDOVER TIMES FOR CLARIANT MAX FLIGHT SNEG

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	1:50 - 3:02	2:17 - 2:47	1:16 - 2:17	0:42 - 1:16	1:31 - 1:31	0:38 - 1:16	0:15 - 1:08	
	75/25	3:02 - 3:02	1:50 - 2:09	1:08 - 1:50	0:42 - 1:08	1:08 - 1:31	0:49 - 1:01	0:11 - 1:20	
	50/50	1:08 - 2:40	1:20 - 1:46	0:34 - 1:20	0:15 - 0:34	0:27 - 0:53	0:11 - 0:23		
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:34 - 1:46	1:50 - 2:13	1:01 - 1:50	0:34 - 1:01	0:23 - 1:05	0:19 - 0:30		
	75/25	0:23 - 1:05	1:27 - 1:43	0:53 - 1:27	0:34 - 0:53	0:15 - 0:49	0:15 - 0:30		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:34 - 1:46	1:35 - 1:54	0:53 - 1:35	0:30 - 0:53	0:23 - 1:05[7]	0:19 - 0:30[7]		
	75/25	0:23 - 1:05	1:16 - 1:31	0:46 - 1:16	0:30 - 0:46	0:15 - 0:49[7]	0:15 - 0:30[7]		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:15 - 0:38	0:23 - 0:34	0:07 - 0:23	0:02 - 0:07				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:15 - 0:38	0:08 - 0:15	0:02 - 0:08	0:01 - 0:02				
below -25 to -29 °C (below -13 to -20 °F)	100/0	0:15 - 0:38	0:05 - 0:08	0:02 - 0:05	0:00 - 0:02				

CAUTION: No holdover time guidelines exist

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table ADJ-42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

TABLE ADJ-27: ADJUSTED TYPE IV HOLDOVER TIMES FOR CLARIANT SAFEWING EG IV NORTH

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	1:46 - 2:59	2:17 - 2:47	1:16 - 2:17	0:38 - 1:16	1:08 - 1:31	0:38 - 0:42	0:06 - 1:31	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A		
below -3 to -8 °C (below 27 to 18 °F)	100/0	1:20 - 3:02	2:09 - 2:40	1:08 - 2:09	0:38 - 1:08	0:49 - 1:24	0:42 - 1:05		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14 °C (below 18 to 7 °F)	100/0	1:20 - 3:02	2:05 - 2:32	1:08 - 2:05	0:38 - 1:08	0:49 - 1:24[7]	0:42 - 1:05[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:30 - 1:01	0:38 - 0:49	0:19 - 0:38	0:08 - 0:19				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:30 - 1:01	0:30 - 0:42	0:11 - 0:30	0:04 - 0:11				
below -25 to -30 °C (below -13 to -22 °F)	100/0	0:30 - 1:01	0:19 - 0:27	0:06 - 0:19	0:02 - 0:06				

CAUTION: No holdover time guidelines exist

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table ADJ-42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

Appendix A: FAA Adjusted Holdover Time Guidelines — Winter 2019-2020

TABLE ADJ-28: ADJUSTED TYPE IV HOLDOVER TIMES FOR CLARIANT SAFEWING MP IV LAUNCH

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	3:02 - 3:02	2:09 - 2:32	1:20 - 2:09	0:49 - 1:20	1:08 - 1:31	0:46 - 1:16	0:11 - 1:16	
	75/25	2:47 - 3:02	2:21 - 2:47	1:20 - 2:21	0:46 - 1:20	1:16 - 1:31	0:34 - 0:57	0:08 - 1:20	
	50/50	1:05 - 2:05	1:05 - 1:16	0:34 - 1:05	0:19 - 0:34	0:23 - 0:38	0:15 - 0:19	CAUTION: No holdover time guidelines exist	
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:46 - 1:27	1:50 - 2:09	1:08 - 1:50	0:42 - 1:08	0:27 - 1:16	0:19 - 0:34		
	75/25	0:30 - 1:01	2:02 - 2:28	1:08 - 2:02	0:38 - 1:08	0:19 - 0:53	0:19 - 0:34		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:46 - 1:27	1:39 - 1:54	1:01 - 1:39	0:38 - 1:01	0:27 - 1:16[7]	0:19 - 0:34[7]		
	75/25	0:30 - 1:01	1:50 - 2:13	1:05 - 1:50	0:34 - 1:05	0:19 - 0:53[7]	0:19 - 0:34[7]		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:23 - 0:38	0:57 - 1:20	0:15 - 0:57	0:05 - 0:15				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:23 - 0:38	0:23 - 0:34	0:07 - 0:23	0:02 - 0:07				
below -25 to -28.5 °C (below -13 to -19 °F)	100/0	0:23 - 0:38	0:15 - 0:23	0:05 - 0:15	0:01 - 0:05				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table ADJ-42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

TABLE ADJ-29: ADJUSTED TYPE IV HOLDOVER TIMES FOR CLARIANT SAFEWING MP IV LAUNCH PLUS

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	2:59 - 3:02	3:00 - 3:00	1:35 - 3:00	0:42 - 1:35	1:31 - 1:31	0:46 - 1:31	0:15 - 1:31	
	75/25	2:59 - 3:02	3:00 - 3:00	1:27 - 3:00	0:38 - 1:27	1:31 - 1:31	1:01 - 1:05	0:15 - 1:24	
	50/50	0:57 - 1:24	1:12 - 1:31	0:34 - 1:12	0:15 - 0:34	0:19 - 0:46	0:11 - 0:15	CAUTION: No holdover time guidelines exist	
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:42 - 1:43	2:51 - 3:00	1:16 - 2:51	0:34 - 1:16	0:19 - 1:12	0:19 - 0:30		
	75/25	0:30 - 1:31	2:40 - 3:00	1:08 - 2:40	0:27 - 1:08	0:15 - 0:49	0:15 - 0:23		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:42 - 1:43	2:28 - 3:00	1:05 - 2:28	0:30 - 1:05	0:19 - 1:12[7]	0:19 - 0:30[7]		
	75/25	0:30 - 1:31	2:13 - 2:55	0:57 - 2:13	0:23 - 0:57	0:15 - 0:49[7]	0:15 - 0:23[7]		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:19 - 0:38	0:57 - 1:24	0:19 - 0:57	0:05 - 0:19				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:19 - 0:38	0:23 - 0:34	0:07 - 0:23	0:02 - 0:07				
below -25 to -29 °C (below -13 to -20 °F)	100/0	0:19 - 0:38	0:15 - 0:23	0:05 - 0:15	0:02 - 0:05				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table ADJ-42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

Appendix A: FAA Adjusted Holdover Time Guidelines — Winter 2019-2020

TABLE ADJ-30: ADJUSTED TYPE IV HOLDOVER TIMES FOR CRYOTECH POLAR GUARD® ADVANCE

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	2:09 - 3:02	2:28 - 2:59	1:27 - 2:28	0:49 - 1:27	1:12 - 1:31	0:57 - 1:08	0:11 - 1:31	
	75/25	1:54 - 3:02	2:17 - 2:55	1:05 - 2:17	0:30 - 1:05	1:16 - 1:31	0:30 - 0:53	0:07 - 1:16	
	50/50	0:38 - 1:05	0:53 - 1:12	0:19 - 0:53	0:08 - 0:19	0:15 - 0:34	0:07 - 0:15		
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:42 - 1:54	1:50 - 2:09	1:05 - 1:50	0:38 - 1:05	0:27 - 1:12	0:27 - 0:34		
	75/25	0:30 - 1:08	1:46 - 2:17	0:49 - 1:46	0:23 - 0:49	0:19 - 0:49	0:27 - 0:34		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:42 - 1:54	1:31 - 1:46	0:53 - 1:31	0:30 - 0:53	0:27 - 1:12[7]	0:27 - 0:34[7]		
	75/25	0:30 - 1:08	1:31 - 1:54	0:42 - 1:31	0:19 - 0:42	0:19 - 0:49[7]	0:27 - 0:34[7]		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:19 - 0:38	1:12 - 1:43	0:27 - 1:12	0:08 - 0:27				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:19 - 0:38	0:30 - 0:42	0:11 - 0:30	0:03 - 0:11				
below -25 to -30.5 °C (below -13 to -23 °F)	100/0	0:19 - 0:38	0:19 - 0:23	0:05 - 0:19	0:02 - 0:05				

CAUTION: No holdover time guidelines exist

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table ADJ-42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

Appendix A: FAA Adjusted Holdover Time Guidelines — Winter 2019-2020

TABLE ADJ-31: ADJUSTED TYPE IV HOLDOVER TIMES FOR CRYOTECH POLAR GUARD® XTEND

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	1:54 - 3:02	2:43 - 3:00	1:31 - 2:43	0:49 - 1:31	1:31 - 1:31	0:46 - 1:24	0:15 - 1:20	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A	CAUTION: No holdover time guidelines exist	
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:46 - 1:24	2:09 - 2:36	1:12 - 2:09	0:38 - 1:12	0:27 - 1:16	0:38 - 0:42		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:46 - 1:24	1:50 - 2:13	1:01 - 1:50	0:34 - 1:01	0:27 - 1:16[7]	0:38 - 0:42[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:19 - 0:30	0:23 - 0:34	0:07 - 0:23	0:02 - 0:07				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:19 - 0:30	0:08 - 0:15	0:02 - 0:08	0:01 - 0:02				
below -25 to -29 °C (below -13 to -20 °F)	100/0	0:19 - 0:30	0:05 - 0:08	0:02 - 0:05	0:00 - 0:02				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table ADJ-42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

Appendix A: FAA Adjusted Holdover Time Guidelines — Winter 2019-2020

TABLE ADJ-32: ADJUSTED TYPE IV HOLDOVER TIMES FOR DOW CHEMICAL UCAR™ ENDURANCE EG106

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	1:35 - 2:24	2:05 - 2:40	1:01 - 2:05	0:30 - 1:01	0:53 - 1:31	0:38 - 0:57	0:15 - 1:31	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A	CAUTION: No holdover time guidelines exist	
below -3 to -8 °C (below 27 to 18 °F)	100/0	1:24 - 2:32	1:50 - 2:17	0:53 - 1:50	0:27 - 0:53	0:42 - 1:24	0:34 - 0:53		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14 °C (below 18 to 7 °F)	100/0	1:24 - 2:32	1:39 - 2:05	0:49 - 1:39	0:23 - 0:49	0:42 - 1:24[7]	0:34 - 0:53[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:23 - 0:49	1:20 - 1:43	0:38 - 1:20	0:19 - 0:38				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:23 - 0:49	1:08 - 1:27	0:30 - 1:08	0:15 - 0:30				
below -25 to -29 °C (below -13 to -20 °F)	100/0	0:23 - 0:49	1:01 - 1:20	0:30 - 1:01	0:15 - 0:30				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table ADJ-42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures

TABLE ADJ-33: ADJUSTED TYPE IV HOLDOVER TIMES FOR DOW CHEMICAL UCAR™ FLIGHTGUARD AD-49

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	2:32 - 3:02	2:47 - 3:00	1:27 - 2:47	0:46 - 1:27	1:05 - 1:31	0:46 - 1:05	0:08 - 1:27	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A		
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:15 - 1:12	2:13 - 2:40	1:08 - 2:13	0:34 - 1:08	0:19 - 1:05	0:15 - 0:19		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:15 - 1:12	1:50 - 2:17	0:57 - 1:50	0:30 - 0:57	0:19 - 1:05[7]	0:15 - 0:19[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	CAUTION: No holdover time guidelines exist	
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:19 - 0:30	0:23 - 0:34	0:07 - 0:23	0:02 - 0:07				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:19 - 0:30	0:08 - 0:15	0:02 - 0:08	0:01 - 0:02				
below -25 to -26 °C (below -13 to -15 °F)	100/0	0:19 - 0:30	0:05 - 0:08	0:02 - 0:05	0:00 - 0:02				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table ADJ-42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

Appendix A: FAA Adjusted Holdover Time Guidelines — Winter 2019-2020

TABLE ADJ-34: ADJUSTED TYPE IV HOLDOVER TIMES FOR INLAND TECHNOLOGIES ECO-SHIELD®

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	0:57 - 2:02	1:50 - 2:09	1:01 - 1:50	0:34 - 1:01	0:30 - 1:08	0:27 - 0:30	0:11 - 1:12	CAUTION: No holdover time guidelines exist
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A		
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:53 - 1:58	1:35 - 1:54	0:53 - 1:35	0:30 - 0:53	0:38 - 1:05	0:23 - 0:30		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:53 - 1:58	1:27 - 1:43	0:49 - 1:27	0:27 - 0:49	0:38 - 1:05[7]	0:23 - 0:30[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:23 - 0:46	0:23 - 0:34	0:07 - 0:23	0:02 - 0:07				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:23 - 0:46	0:08 - 0:15	0:02 - 0:08	0:01 - 0:02				
below -25 to -25.5 °C (below -13 to -14 °F)	100/0	0:23 - 0:46	0:05 - 0:08	0:02 - 0:05	0:00 - 0:02				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table ADJ-42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

TABLE ADJ-35: ADJUSTED TYPE IV HOLDOVER TIMES FOR KILFROST ABC-S PLUS

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	1:39 - 3:02	2:43 - 3:00	1:35 - 2:43	0:57 - 1:35	1:24 - 1:31	0:49 - 1:31	0:19 - 1:31	
	75/25	1:05 - 2:02	1:35 - 1:50	0:57 - 1:35	0:34 - 0:57	0:46 - 1:01	0:23 - 0:38	0:08 - 1:01	
	50/50	0:23 - 0:42	0:46 - 0:53	0:23 - 0:46	0:11 - 0:23	0:11 - 0:30	0:11 - 0:15	CAUTION: No holdover time guidelines exist	
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:42 - 2:40	2:24 - 2:51	1:24 - 2:24	0:49 - 1:24	0:19 - 1:12	0:15 - 0:23		
	75/25	0:34 - 1:24	1:24 - 1:39	0:49 - 1:24	0:30 - 0:49	0:15 - 0:53	0:11 - 0:19		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:42 - 2:40	2:13 - 2:40	1:20 - 2:13	0:46 - 1:20	0:19 - 1:12[7]	0:15 - 0:23[7]		
	75/25	0:34 - 1:24	1:20 - 1:31	0:46 - 1:20	0:27 - 0:46	0:15 - 0:53[7]	0:11 - 0:19[7]		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:30 - 0:46	0:23 - 0:34	0:07 - 0:23	0:02 - 0:07				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:30 - 0:46	0:08 - 0:15	0:02 - 0:08	0:01 - 0:02				
below -25 to -28 °C (below -13 to -18 °F)	100/0	0:30 - 0:46	0:05 - 0:08	0:02 - 0:05	0:00 - 0:02				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table ADJ-42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

Appendix A: FAA Adjusted Holdover Time Guidelines — Winter 2019-2020

TABLE ADJ-36: ADJUSTED TYPE IV HOLDOVER TIMES FOR LNT SOLUTIONS E450

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	1:24 - 2:13	1:50 - 2:05	1:12 - 1:50	0:46 - 1:12	1:12 - 1:31	0:42 - 1:01	0:19 - 1:31	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A		
below -3 to -8 °C (below 27 to 18 °F)	100/0	1:08 - 2:59	1:35 - 1:46	1:01 - 1:35	0:38 - 1:01	1:20 - 1:31	0:49 - 1:16		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14 °C (below 18 to 7 °F)	100/0	1:08 - 2:59	1:24 - 1:35	0:53 - 1:24	0:34 - 0:53	1:20 - 1:31[7]	0:49 - 1:16[7]	CAUTION: No holdover time guidelines exist	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:27 - 0:49	2:24 - 3:00	0:49 - 2:24	0:15 - 0:49				
below -18 to -25°C[8] (below 0 to -13°F)[8]	100/0	0:27 - 0:49	1:12 - 1:43	0:23 - 1:12	0:08 - 0:23				
below -25 to -32.5°C[8] (below -13 to -27°F)[8]	100/0	0:19 - 0:46	0:30 - 0:53	0:11 - 0:30	0:03 - 0:11				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table ADJ-42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).
8 Use LOUT of -22.5 °C (-9 °F) unless indicated otherwise by fluid manufacturer.

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

Appendix A: FAA Adjusted Holdover Time Guidelines — Winter 2019-2020

TABLE ADJ-37: ADJUSTED TYPE IV HOLDOVER TIMES FOR NEWAVE AEROCHEMICAL FCY 9311

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	1:27 - 3:02	1:46 - 2:13	0:53 - 1:46	0:27 - 0:53	0:53 - 1:31	0:30 - 0:49	0:11 - 1:05	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A		
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:27 - 1:35	1:24 - 1:46	0:42 - 1:24	0:23 - 0:42	0:27 - 1:01	0:15 - 0:27		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:27 - 1:35	1:12 - 1:31	0:38 - 1:12	0:19 - 0:38	0:27 - 1:01[7]	0:15 - 0:27[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	CAUTION: No holdover time guidelines exist	
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:23 - 0:42	0:23 - 0:34	0:07 - 0:23	0:02 - 0:07				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:23 - 0:42	0:08 - 0:15	0:02 - 0:08	0:01 - 0:02				
below -25 to -29.5 °C (below -13 to -21 °F)	100/0	0:23 - 0:42	0:05 - 0:08	0:02 - 0:05	0:00 - 0:02				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table ADJ-42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

Appendix A: FAA Adjusted Holdover Time Guidelines — Winter 2019-2020

TABLE ADJ-38: ADJUSTED TYPE IV HOLDOVER TIMES FOR OKSAYD DEFROST ECO 4

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	1:08 - 2:02	1:54 - 2:24	0:57 - 1:54	0:27 - 0:57	0:49 - 1:08	0:30 - 0:49	0:11 - 0:53	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A		
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:42 - 1:58	1:43 - 2:05	0:49 - 1:43	0:27 - 0:49	0:38 - 1:01	0:27 - 0:38		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:42 - 1:58	1:35 - 1:58	0:46 - 1:35	0:23 - 0:46	0:38 - 1:01[7]	0:27 - 0:38[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:23 - 0:38	0:23 - 0:34	0:07 - 0:23	0:02 - 0:07				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:23 - 0:38	0:08 - 0:15	0:02 - 0:08	0:01 - 0:02				
below -25 to -25.5 °C (below -13 to -14 °F)	100/0	0:23 - 0:38	0:05 - 0:08	0:02 - 0:05	0:00 - 0:02				

CAUTION: No holdover time guidelines exist

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table ADJ-42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

TABLE ADJ-39: ADJUSTED TYPE IV HOLDOVER TIMES FOR OKSAYD DEFROST EG 4

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	2:05 - 3:02	3:00 - 3:00	1:50 - 3:00	1:05 - 1:50	1:31 - 1:31	0:46 - 1:20	0:15 - 1:31	
	75/25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	50/50	N/A	N/A	N/A	N/A	N/A	N/A		
below -3 to -8 °C (below 27 to 18 °F)	100/0	1:46 - 3:02	2:43 - 3:00	1:35 - 2:43	0:57 - 1:35	0:46 - 1:31	1:01 - 1:24		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -8 to -14 °C (below 18 to 7 °F)	100/0	1:46 - 3:02	2:28 - 2:59	1:27 - 2:28	0:53 - 1:27	0:46 - 1:31[7]	1:01 - 1:24[7]		
	75/25	N/A	N/A	N/A	N/A	N/A	N/A		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:34 - 1:50	0:38 - 0:49	0:19 - 0:38	0:08 - 0:19				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:34 - 1:50	0:30 - 0:42	0:11 - 0:30	0:04 - 0:11				
below -25 to -26 °C (below -13 to -15 °F)	100/0	0:34 - 1:50	0:19 - 0:27	0:06 - 0:19	0:02 - 0:06				

CAUTION: No holdover time guidelines exist

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table ADJ-42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

Appendix A: FAA Adjusted Holdover Time Guidelines — Winter 2019-2020

TABLE ADJ-40: ADJUSTED TYPE IV HOLDOVER TIMES FOR SHAANXI CLEANWAY AVIATION CLEANSURFACE IV

Outside Air Temperature[1]	Fluid Concentration Fluid/Water By % Volume	Freezing Fog or Ice Crystals	Very Light Snow, Snow Grains or Snow Pellets[2,3]	Light Snow, Snow Grains or Snow Pellets[2,3]	Moderate Snow, Snow Grains or Snow Pellets[2]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 °C and above (27 °F and above)	100/0	2:09 - 3:02	2:43 - 3:00	1:27 - 2:43	0:46 - 1:27	1:31 - 1:31	1:05 - 1:08	0:11 - 1:31	
	75/25	1:58 - 3:02	2:40 - 3:00	1:12 - 2:40	0:34 - 1:12	0:38 - 1:31	0:27 - 0:34	0:07 - 0:57	
	50/50	0:49 - 1:50	1:16 - 1:46	0:30 - 1:16	0:11 - 0:30	0:19 - 0:38	0:11 - 0:15	CAUTION: No holdover time guidelines exist	
below -3 to -8 °C (below 27 to 18 °F)	100/0	0:46 - 2:21	1:31 - 1:50	0:49 - 1:31	0:27 - 0:49	0:27 - 1:20	0:15 - 0:27		
	75/25	0:38 - 1:27	1:43 - 2:13	0:46 - 1:43	0:23 - 0:46	0:23 - 1:01	0:19 - 0:30		
below -8 to -14 °C (below 18 to 7 °F)	100/0	0:46 - 2:21	1:01 - 1:16	0:34 - 1:01	0:19 - 0:34	0:27 - 1:20[7]	0:15 - 0:27[7]		
	75/25	0:38 - 1:27	1:16 - 1:39	0:34 - 1:16	0:15 - 0:34	0:23 - 1:01[7]	0:19 - 0:30[7]		
below -14 to -18 °C (below 7 to 0 °F)	100/0	0:23 - 0:38	0:23 - 0:34	0:07 - 0:23	0:02 - 0:07				
below -18 to -25 °C (below 0 to -13 °F)	100/0	0:23 - 0:38	0:08 - 0:15	0:02 - 0:08	0:01 - 0:02				
below -25 to -28.5 °C (below -13 to -19 °F)	100/0	0:23 - 0:38	0:05 - 0:08	0:02 - 0:05	0:00 - 0:02				

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. HOLDOVER TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I fluid when Type IV fluid cannot be used.
2 To determine snowfall intensity, the Snowfall Intensities as a Function of Prevailing Visibility table (Table 43) is required.
3 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 Includes light, moderate and heavy freezing drizzle. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover time guidelines exist for this condition for 0 °C (32 °F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail (Table ADJ-42 provides allowance times for ice pellets and small hail).
7 No holdover time guidelines exist for this condition below -10 °C (14 °F).

CAUTIONS

- The responsibility for the application of these data remains with the user.
- The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity, or jet blast may reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than outside air temperature.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.

Appendix A: FAA Adjusted Holdover Time Guidelines Winter 2019-2020

TABLE ADJ-41: ADJUSTED ALLOWANCE TIMES FOR SAE TYPE III FLUIDS[1]

Precipitation Type	Outside Air Temperature		
	-5 °C and above	Below -5 to -10 °C	Below -10 °C[2]
Light Ice Pellets	8 minutes	8 minutes	**Caution: No allowance times currently exist**
Light Ice Pellets Mixed with Snow	8 minutes	8 minutes	
Light Ice Pellets Mixed with Freezing Drizzle	5 minutes	4 minutes	
Light Ice Pellets Mixed with Freezing Rain	5 minutes	4 minutes	
Light Ice Pellets Mixed with Rain	5 minutes[3]		
Moderate Ice Pellets (or Small Hail)[4]	4 minutes	4 minutes	

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. ALLOWANCE TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 These allowance times are for use with undiluted (100/0) fluids applied unheated on aircraft with rotation speeds of 100 knots or greater.

2 Ensure that the lowest operational use temperature (LOUT) is respected.

3 No allowance times exist in this condition for temperatures below 0 °C; consider use of light ice pellets mixed with freezing rain.

4 If no intensity is reported with small hail, use the “moderate ice pellets or small hail” allowance times. If an intensity is reported with small hail, the ice pellet condition with the equivalent intensity can be used, e.g. if light small hail is reported, the “light ice pellets” allowance times can be used. This also applies in mixed conditions, e.g. if light small hail mixed with snow is reported, use the “light ice pellets mixed with snow” allowance times.

CAUTIONS

- The responsibility for the application of these data remains with the user.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.
- Allowance time cannot be extended by an inspection of the aircraft critical surfaces.
- Takeoff is allowed up to 90 minutes after start of fluid application if the precipitation stops at or before the allowance time expires and does not restart. The OAT must not decrease during the 90 minutes to use this guidance in conditions of light ice pellets mixed with either: freezing drizzle, freezing rain or rain.

Appendix A: FAA Adjusted Holdover Time Guidelines Winter 2019-2020

TABLE ADJ-42: ADJUSTED ALLOWANCE TIMES FOR SAE TYPE IV FLUIDS[1]

Precipitation Type	Outside Air Temperature			
	-5 °C and above	Below -5 to -10 °C	Below -10 to -16 °C	Below -16 to -22 °C[2]
Light Ice Pellets	38 minutes	23 minutes	23 minutes[3]	23 minutes[3]
Light Ice Pellets Mixed with Snow	30 minutes	11 minutes	11 minutes[3]	
Light Ice Pellets Mixed with Freezing Drizzle	19 minutes	8 minutes	**Caution: No allowance times currently exist**	
Light Ice Pellets Mixed with Freezing Rain	19 minutes	8 minutes		
Light Ice Pellets Mixed with Rain	19 minutes[4]			
Moderate Ice Pellets (or Small Hail)[5]	19 minutes[6]	8 minutes	8 minutes[3]	8 minutes[7]
Moderate Ice Pellets (or Small Hail)[5] Mixed with Freezing Drizzle	8 minutes	5 minutes	**Caution: No allowance times currently exist**	
Moderate Ice Pellets (or Small Hail)[5] Mixed with Rain	8 minutes[8]			

THIS TABLE IS FOR USE WHEN FLAPS/SLATS ARE DEPLOYED PRIOR TO DE/ANTI-ICING. ALLOWANCE TIMES HAVE BEEN ADJUSTED TO 76 PERCENT.

NOTES

1 These allowance times are for use with undiluted (100/0) fluids applied on aircraft with rotation speeds of 100 knots or greater. All Type IV fluids are propylene glycol based with the exception of AllClear ClearWing EG, CHEMCO ChemR EG IV, Clariant Max Flight AVIA, Clariant Safewing EG IV NORTH, Dow EG106, LNT E450 and Oksayd Defrost EG 4, which are ethylene glycol based.
2 Ensure that the lowest operational use temperature (LOUT) is respected.
3 No allowance times exist for propylene glycol (PG) fluids when used on aircraft with rotation speeds less than 115 knots. If the glycol type is unknown, no allowance times exist for aircraft with rotation speeds of less than 115 knots.
4 No allowance times exist in this condition for temperatures below 0 °C; consider use of light ice pellets mixed with freezing rain.
5 If no intensity is reported with small hail, use the “moderate ice pellets or small hail” allowance times. If an intensity is reported with small hail, the ice pellet condition with the equivalent intensity can be used, e.g. if light small hail is reported, the “light ice pellets” allowance times can be used. This also applies in mixed conditions, e.g. if light small hail mixed with snow is reported, use the “light ice pellets mixed with snow” allowance times.
6 Allowance time is 14 minutes for propylene glycol (PG) fluids or when the fluid type is unknown.
7 No allowance times exist for propylene glycol (PG) fluids in this condition for temperatures below -16 °C.
8 No allowance times exist in this condition for temperatures below 0 °C.

CAUTIONS

- The responsibility for the application of these data remains with the user.
- Fluids used during ground de/anti-icing do not provide in-flight icing protection.
- This table is for departure planning only and should be used in conjunction with pretakeoff check procedures.
- Allowance time cannot be extended by an inspection of the aircraft critical surfaces.
- Takeoff is allowed up to 90 minutes after start of fluid application if the precipitation stops at or before the allowance time expires and does not restart. The OAT must not decrease during the 90 minutes to use this guidance in conditions of light ice pellets mixed with either: freezing drizzle, freezing rain or rain.

APPENDIX B:
TESTING LABORATORIES

TESTING LABORATORIES

The following laboratories are known to provide testing for de/anti-icing fluids given they verifiably adhere to internationally accepted standards and recommended practices that are associated with the holdover times published by the FAA.

Please enquire directly with the laboratories for a full list of testing available.

- **Anti-icing Materials International Laboratory (AMIL):** 555, boulevard de l'Université, Chicoutimi, Québec, G7H 2B1, Canada, 418-545-5011 ext. 2406, www.amillaboratory.ca. Provides testing for anti-icing performance (described in AMS1424, AMS1428, and AS5901), aerodynamic acceptance (described in AMS1424, AMS1428 and AS5900), physical properties including fluid stability (described in AMS1424 and AMS1428), environmental information (described in AMS1424 and AMS1428) and most of tests to evaluate materials compatibility (described in AMS1424 and AMS1428).

- **APS Aviation Inc.:** 6700, chemin de la Côte-de-Liesse, Suite 102, Saint-Laurent, Quebec, H4T 2B5, Canada, 514-878-4388, www.apsaviation.ca. Provides endurance time testing (described in ARP5485 and ARP5945).

- **Scientific Material International (SMI):** 12219 SW 131st Avenue, Miami, Florida, USA 33186-6401; 305-971-7047, www.smiinc.com. Provides testing for physical properties including fluid stability (described in AMS1424 and AMS1428), environmental information (described in AMS1424 and AMS1428) and most of tests to evaluate materials compatibility (described in AMS1424 and AMS1428).

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APPENDIX I

TRANSPORT CANADA AND FEDERAL AVIATION ADMINISTRATION REGRESSION INFORMATION, WINTER 2019-2020

TRANSPORT CANADA
HOLDOVER TIME (HOT) GUIDELINES
REGRESSION INFORMATION
WINTER 2019-2020

Transport Canada
Holdover Time (HOT) Guidelines
Regression Information
Winter 2019-2020

Original Issue: August 6, 2019

This document should be used in conjunction with the Transport Canada Holdover Time Guidelines, available at: http://www.tc.gc.ca/eng/civilaviation/standards/commerce-holdovertime-menu-1877.htm.

Questions or comments on the content of the holdover time guidelines should be addressed to Transport Canada Civil Aviation Communication Centre Telephone 1-800-305-2059 Facsimile 613-957-4208 e-mail services@tc.gc.ca

To receive notification of HOT Guideline updates, subscribe to or update your e news subscription at the following Transport Canada Web site: http://wwwapps.tc.gc.ca/Comm/5/ListServ/menu.aspx. Subscribing to e-news will require an email address and selecting Holdover Time (HOT) Guidelines under Publications / Air Transportation / Aviation Safety - Safety Information.

CHANGE CONTROL RECORDS

This page indicates any changes made to individual pages within the document. Changed pages have the appropriate revision date in the footer. Sidebars are shown to assist in identifying where changes have been made on these pages.

It is the responsibility of the end user to periodically check the following website for updates on Regression Information: http://www.tc.gc.ca/eng/civilaviation/standards/commerce-holdovertime-menu-1877.htm.

REVISION	*DATE*	*DESCRIPTION OF CHANGES*	*AFFECTED PAGES*	*AUTHOR*

TABLE OF CONTENTS

Change Control Records 2
Table of Contents 3
List of Tables 4
Highlights and Changes for Winter 2019-2020 5
Guidance for Using Regression Information 6
Regression Information Tables for Winter 2019-2020 9

LIST OF TABLES

Table 1-1: Generic Type I (Aluminum Wing Surfaces) 10
Table 1-2: Generic Type I (Composite Wing Surfaces) 11
Table 2-1: ABAX ECOWING 26 12
Table 2-2: ABAX ECOWING AD-2 13
Table 2-3: Aviation Shaanxi Hi-Tech Cleanwing II 14
Table 2-4: Beijing Yadilite Aviation YD-102 Type II 15
Table 2-5: Clariant Safewing MP II FLIGHT 16
Table 2-6: Clariant Safewing MP II FLIGHT PLUS 17
Table 2-7: Cryotech Polar Guard® II 18
Table 2-8: Kilfrost ABC-K Plus 19
Table 2-9: Kilfrost Ice Clear II 20
Table 2-10: Newave Aerochemical FCY-2 21
Table 2-11: Newave Aerochemical FCY-2 Bio+ 22
Table 2-12: Oksayd Defrost PG 2 23
Table 2-13: ROMCHIM ADD-PROTECT Type II 24
Table 2-14: Type II Generic 25
Table 3-1: AllClear AeroClear MAX, Applied Unheated on Low Speed Aircraft 26
Table 3-2: AllClear AeroClear MAX, Applied Unheated on High Speed Aircraft 27
Table 4-1: ABAX ECOWING AD-49 28
Table 4-2: AllClear ClearWing EG 29
Table 4-3: CHEMCO ChemR EG IV 30
Table 4-4: Clariant Max Flight 04 31
Table 4-5: Clariant Max Flight AVIA 32
Table 4-6: Clariant Max Flight SNEG 33
Table 4-7: Clariant Safewing EG IV NORTH 34
Table 4-8: Clariant Safewing MP IV LAUNCH 35
Table 4-9: Clariant Safewing MP IV LAUNCH PLUS 36
Table 4-10: Cryotech Polar Guard® Advance 37
Table 4-11: Cryotech Polar Guard® Xtend 38
Table 4-12: Dow Chemical UCAR™ Endurance EG106 39
Table 4-13: Dow Chemical UCAR™ FlightGuard AD-49 40
Table 4-14: Inland Technologies ECO-SHIELD® 41
Table 4-15: Kilfrost ABC-S Plus 42
Table 4-16: LNT Solutions E450 43
Table 4-17: Newave Aerochemical FCY 9311 44
Table 4-18: Oksayd Defrost ECO 4 45
Table 4-19: Oksayd Defrost EG 4 46
Table 4-20: Shaanxi Cleanway Aviation Cleansurface IV 47
Table 4-21: Type IV Generic 48
Table 5: Lowest Usable Precipitation Rates in Snow 49
Table 6: Highest Usable Precipitation Rates in Snow 51

Highlights and Changes for Winter 2019-2020

The principal changes from the previous year are briefly indicated herein.

Type I Fluid

- The Type I regression coefficients are unchanged.

Type II Fluid

- A regression coefficients table and verification table have been added for ROMCHIM ADD-PROTECT Type II, a new Type II fluid added to the holdover time (HOT) guidelines for winter 2019-2020.
- Snow holdover times at temperatures below -14°C have been updated for all Type II fluids that have not undergone fluid-specific very cold snow testing. The associated regression coefficients have been updated accordingly.
- Several changes were made to the Type II generic holdover times for winter 2019-2020. The Type II generic verification table has been updated accordingly.

Type III Fluid

- The Type III regression coefficients are unchanged.

Type IV Fluid

- Regression coefficients tables and verification tables have been added for two new Type IV fluids added to the HOT guidelines for winter 2019-2020: AllClear Clearwing EG and Cryotech Polar Guard® Xtend.
- Snow holdover times at temperatures below -14°C have been updated for all Type IV fluids that have not undergone fluid-specific very cold snow testing. The associated regression coefficients have been updated accordingly.
- Supplemental testing with LNT Solutions E450 (100/0) resulted in a change to its LOUT (decreased from -22.5°C to -32.5°C) and to some of its holdover times at colder temperatures. Changes have been made to this fluid's regression coefficients and verification tables accordingly.
- Several changes were made to the Type IV generic holdover times for winter 2019-2020. The Type IV generic verification table has been updated accordingly.

Guidance

- Minor changes have been made to the guidance section.

GUIDANCE FOR USING REGRESSION INFORMATION

In recent years, several companies have been developing systems that measure temperature, precipitation type and precipitation rate in real-time. These systems, referred to as holdover time determination systems (HOTDS), use the weather data they collect and the regression information underlying the holdover time guidelines to calculate more precise holdover times than can be obtained from the holdover time guidelines.

As a result of the development of HOTDS, Transport Canada is required to make the regression coefficients and equations underlying the holdover time tables available to users. The purpose of this document is to provide the holdover time guidelines regression information for the 2019-2020 holdover time guidelines and to provide guidance on its usage.

The sources of the regression data, along with a history of the publication of regression information, are documented in the Transport Canada report, *Regression Coefficients and Equations Used to Develop the Winter 2019-20 Aircraft Ground Deicing Holdover Time Tables*. This document can be referenced for further information if required.

At this time, operational approval for use of these systems is only possible by meeting the conditions set by Transport Canada through an exemption (hereafter, the exemption document) from the requirements in sections 1.0, 3.0, 6.0, 6.2, 6.3 and 7.1.1.1 of Standard 622.11 "*Ground Icing Operations*" (http://www.tc.gc.ca/eng/civilaviation/regserv/cars/part6-standards-standard622-513.htm) specifically related to the element of HOT tables forming part of the "Ground Icing Operations Program" made pursuant to subsection 602.11(4) of the *Canadian Aviation Regulations* (CARs). The information contained in this report can only be used in conjunction with the exemption document, which can be found at: http://www.tc.gc.ca/CivilAviation/Regserv/Affairs/exemptions/docs/en/3021.htm.

Interpreting Regression Coefficients Tables

Regression information is provided in this document in a series of regression coefficients tables. Each regression coefficients table shows the regression coefficients and equations that are to be used to calculate holdover times at specific outside air temperatures, under specific precipitation types, with specific fluid dilutions (as applicable for Type II/III/IV fluids).

Each regression coefficients table is presented in the format of its corresponding holdover time table. (One exception is the Type II and Type IV regression coefficients tables, which have a single temperature band (below -3 to -14°C) which provides the regression coefficients for both the below -3 to -8°C and below -8 to -14°C temperature bands in the Type II and Type IV holdover time tables.) A footnote is provided at the top of each column to indicate the form of the regression equation for the cells in that column. The regression coefficients required for the equation are given in the corresponding cells below.

The coefficients provided in each table cell are valid only for the conditions (temperature, precipitation type, fluid dilution) of that cell. In cells where no temperature coefficient (coefficient "B") is provided, temperature is not an input into the equation.

Applicability of Regression Coefficients Tables

The Type I generic regression coefficients tables are applicable for all Type I fluids. Fluid-specific regression coefficients tables are available and applicable for all Type II, Type III, and Type IV fluids. If the specific fluid being used is not known, the methodology for calculating Type II or Type IV generic holdover times must be followed (see next page).

To use the regression information provided in this document to obtain holdover times that are valid for operations in which flaps/slats are deployed prior to de/anti-icing: use the regression information applicable to the fluid and weather condition and multiply the result obtained by 76%.

Calculating Type II and Type IV Generic Holdover Times

Generic Type II and Type IV holdover times are used when a flight crew is unaware of the specific fluid that has been used to de/anti-ice their aircraft. The generic values represent the shortest possible holdover time of either all Type II or all Type IV fluids available. The following methodologies must be applied to HOTDS programming to enable the systems to determine generic Type II and Type IV holdover times.

Type II: To calculate Type II generic holdover times, the HOTDS must be programmed to calculate the holdover time for each Type II fluid on the Transport Canada list of fluids tested for anti-icing performance and aerodynamic acceptance and return the shortest holdover time calculated. This is the generic Type II holdover time.

Type IV: To calculate Type IV generic holdover times, the HOTDS must be programmed to calculate the holdover time for each Type IV fluid on the Transport Canada list of fluids tested for anti-icing performance and aerodynamic acceptance and return the shortest holdover time calculated. This is the generic Type IV holdover time.

Verification Tables

Verification tables are provided for each of the regression coefficients tables and also for the generic Type II and generic Type IV holdover times. Each verification table provides verification values for select boundary conditions in the associated holdover time table. For Type II, III and IV fluids, the verification tables also include verification values for the lowest usable precipitation rate in snow.

NOTE: HOTDS manufacturers may find it useful to use these verification tables as an aid in verifying the implementation of their software algorithms. However, HOTDS manufacturers are cautioned that these tables are not all encompassing and that they must develop comprehensive verification and validation methods to ensure the adequacy of their software algorithms.

Lowest and Highest Usable Precipitation Rates in Snow (Table 5 and Table 6)

Snow test data for some fluids is not sufficient to support extrapolation of the regression curves to very low and/or very high rates of precipitation. The lowest usable precipitation rates (LUPRs) and highest usable precipitation rates (HUPRs) in snow have been identified and are included in Table 5 (LUPRs) and Table 6 (HUPRs) for Type II, III and IV fluids (Type I fluids are not affected). The LUPRs and HUPRs differ by fluid brand, fluid dilution and temperature.

NOTE: At this time LUPRs and HUPRs are provided for snow only; LUPRs and HUPRs are not provided for any other precipitation type. The lowest and highest precipitation rates that can be used in other precipitation types are specified in the applicable exemption document.

Limitations of Regression Information

Users are cautioned that care must be taken in the application of the regression information. There are a number of rules, exceptions and cautions detailed in both this document and in the holdover time guidelines that must be considered. It is also important to note that additional restrictions may be put on their usage by the applicable Transport Canada exemption document.

Several limitations on the usage of the regression information are listed below.

- The regression coefficients can only be used with liquid water equivalent information that is provided by an HOTDS in accordance with the exemption document.
- If regression equations include a temperature coefficient, 0°C must be input into the HOTDS when temperature is above 0°C.
- Regression data is developed for specific fluid dilutions. The data cannot be interpolated to determine holdover times for use with dilutions other than the standard 100/0, 75/25 and 50/50 mixtures.

- The regression coefficients are based on best-fit power-law curves and the shape of these curves can result in extreme values outside the precipitation rate limits at which endurance time tests are conducted. Therefore, these values are not necessarily accurate. Caution must therefore be exercised when using the regression equations to calculate holdover times outside of the precipitation rate limits used in the development of holdover time tables, especially at precipitation rates below the lower precipitation rate limit, where the power-law curves give much longer holdover times.

- The lowest precipitation rate to be used as an input to the snow regression equations (this does not apply to other precipitation types) is constrained by the higher of the following:

    1. Minimum demonstrated precipitation measuring equipment rates in accordance with the Transport Canada exemption document (in no case shall this be less than 2.0 g/dm²/h); and

    2. Lowest usable precipitation rate (LUPR) for each fluid/dilution/temperature as defined in Table 5 of this document. The LUPR is the lowest precipitation rate for which sufficient snow data exists to support use of the regression coefficients.

- The highest precipitation rate to be used as an input to the snow regression equations (this does not apply to other precipitation types) is constrained by the lower of the following:

    1. The highest precipitation rate for snow stated in the applicable Transport Canada exemption document (50 g/dm²/h); and

    2. The highest usable precipitation rate (HUPR) for each fluid/dilution/temperature as defined in Table 6 of this document. The HUPR is the highest precipitation rate for which sufficient snow data exists to support use of the regression coefficients.

- All other lowest and highest precipitation rates to be used as inputs to the regression equations are precipitation type dependent and provided in the applicable Transport Canada exemption document.

- As regression coefficients and equations are not currently used in the determination of frost holdover times, regression coefficient information is not provided for frost.

- As regression coefficients and equations are not used in the determination of the allowance times provided for ice pellets, small hail and ice pellets mixed with other types of precipitation, regression coefficient information is not provided for allowance times.

REGRESSION INFORMATION TABLES FOR WINTER 2019-2020

The regression information for winter 2019-2020 is presented in a series of tables on the following pages. The regression information tables are presented first and are followed by the tables of highest and lowest usable precipitation rates.

The regression information tables are sorted by fluid type (Type I, then Type II, then Type III, then Type IV). Within each fluid type group, the tables are arranged in alphabetical order. The tables are as follows:

- Tables 1-1 to 1-2: Type I Fluid Regression Information Tables
- Tables 2-1 to 2-14: Type II Fluid Regression Information Tables
- Tables 3-1 to 3-2: Type III Fluid Regression Information Tables
- Tables 4-1 to 4-21: Type IV Fluid Regression Information Tables

The tables of highest and lowest usable precipitation rates are presented following the regression information. The tables are as follows:

- Table 5: Lowest Usable Precipitation Rates
- Table 6: Highest Usable Precipitation Rates

TABLE 1-1: GENERIC TYPE I (ALUMINUM WING SURFACES)

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions					
	Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]	Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
-3 °C and above (27 °F and above)	I = 1.3735 A = -0.4751	I = 2.0072 A = -0.5752 B = -0.5585	I = 1.3829 A = -0.3848	I = 1.4688 A = -0.6200	I = 0.9355 A = -0.3384	
below -3 to -6 °C (below 27 to 21 °F)	I = 1.2734 A = -0.5299	I = 2.0072 A = -0.5752 B = -0.5585	I = 1.3842 A = -0.6152	I = 1.4688 A = -0.6200		
below -6 to -10 °C (below 21 to 14 °F)	I = 1.1678 A = -0.5575	I = 2.0072 A = -0.5752 B = -0.5585	I = 1.2545 A = -0.5857	I = 2.2598 A = -1.4012	CAUTION: No holdover time guidelines exist	
below -10 °C (below 14 °F)	I = 1.1473 A = -0.6415	I = 2.0072 A = -0.5752 B = -0.5585				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 Type I aluminum snow values are rounded down to the nearest one minute (e.g. 6.5 mins = 6 mins, 18.6 mins = 18 mins) to determine holdover time table values

Outside Air Temp. (°C)	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
	Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
	5	2	25	10	4	13	5	25	13	75	5
+1 / -3 *	11.0	17.0	6.5	11.0	18.6	9.0	13.0	4.0	6.0	2.0	5.0
-6	8.0	13.0	5.0	8.5	14.3	5.0	9.0	4.0	6.0		
-10	6.0	10.0	4.0	6.7	11.4	4.0	7.0	2.0	5.0		
-25	5.0	9.0	2.5	4.3	7.3						

* Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C

TABLE 1-2: GENERIC TYPE I (COMPOSITE WING SURFACES)

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions					
	Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]	Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
-3 °C and above (27 °F and above)	I = 1.3931 A = -0.6279	I = 1.6656 A = -0.7424 B = -0.2094	I = 1.4691 A = -0.5081	I = 1.4688 A = -0.6200	I = 1.1144 A = -0.5943	
below -3 to -6 °C (below 27 to 21 °F)	I = 0.9976 A = -0.3140	I = 1.6656 A = -0.7424 B = -0.2094	I = 1.3842 A = -0.6152	I = 1.4688 A = -0.6200		
below -6 to -10 °C (below 21 to 14 °F)	I = 1.1308 A = -0.7565	I = 1.6656 A = -0.7424 B = -0.2094	I = 1.2545 A = -0.5857	I = 2.2598 A = -1.4012	CAUTION: No holdover time guidelines exist	
below -10 °C (below 14 °F)	I = 1.0289 A = -0.6107	I = 2.0072 A = -0.5752 B = -0.5585				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 Type I composite snow values below 10 mins are rounded down to the nearest one minute (e.g. 2.5 mins = 2 mins) to determine holdover time table values

Outside Air Temp. (°C)	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
	Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
	5	2	25	10	4	13	5	25	13	75	5
+1 / -3 *	9.0	16.0	3.0	6.0	11.8	8.0	13.0	4.0	6.0	1.0	5.0
-6	6.0	8.0	2.7	5.4	10.7	5.0	9.0	4.0	6.0		
-10	4.0	8.0	2.5	5.0	9.8	4.0	7.0	2.0	5.0		
-25	4.0	7.0	2.5	4.3	7.3						

* Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C

TABLE 2-1: ABAX ECOWING 26

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1,4]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.3810 A = -0.6352	I = 2.3598 A = -0.5098 B = -0.0978	I = 2.3598 A = -0.5098 B = -0.0978	I = 2.3598 A = -0.5098 B = -0.0978	I = 2.4589 A = -0.6723	I = 2.0131 A = -0.2946	I = 2.3224 A = -0.5535	
	75/25	I = 2.2439 A = -0.6073	I = 2.5394 A = -0.7194 B = -0.2887	I = 2.5394 A = -0.7194 B = -0.2887	I = 2.5394 A = -0.7194 B = -0.2887	I = 2.1009 A = -0.4085	I = 2.0488 A = -0.4806	I = 2.2032 A = -0.6072	
	50/50	I = 1.7955 A = -0.5090	I = 2.4646 A = -0.9041 B = -0.4545	I = 2.4646 A = -0.9041 B = -0.4545	I = 2.4646 A = -0.9041 B = -0.4545	I = 1.7327 A = -0.5413	I = 1.6166 A = -0.5058	CAUTION: No holdover time guidelines exist	
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.5006 A = -1.2335	I = 2.3598 A = -0.5098 B = -0.0978	I = 2.3598 A = -0.5098 B = -0.0978	I = 2.3598 A = -0.5098 B = -0.0978	I = 2.4044 A = -0.8101	I = 2.7587 A = -1.1217		
	75/25	I = 2.1380 A = -0.8452	I = 2.5394 A = -0.7194 B = -0.2887	I = 2.5394 A = -0.7194 B = -0.2887	I = 2.5394 A = -0.7194 B = -0.2887	I = 2.2768 A = -0.8445	I = 2.3760 A = -0.8759		
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 1.8682 A = -0.6972	I = 2.1496 A = -1.4094 B = 0.0000	I = 1.9908 A = -1.1457 B = 0.0000	I = 2.2123 A = -1.3672 B = 0.0000				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 1.8682 A = -0.6972	I = 2.0233 A = -1.7757 B = 0.0000	I = 1.6761 A = -1.1990 B = 0.0000	I = 1.6761 A = -1.1990 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6
4 Freezing drizzle and light freezing rain values were calculated at 12.7 g/dm²/h the year the holdover time table for this fluid was produced. Since they are now calculated at 13.0 g/dm²/h, values in the holdover time table may differ slightly from those calculated using these coefficients.

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	86.5	154.8	37.9	60.5	111.7	51.3	97.5	39.9	48.4	19.3	86.2
	75/25	66.0	115.1	21.5	41.5	98.7	44.2	65.4	23.8	32.6	11.6	60.1
	50/50	27.5	43.9	7.6	17.5	51.9	13.5	22.6	8.1	11.3		
-8	100/0	43.5	134.7	35.4	56.5	104.4	31.8	68.9	15.5	32.3		
	75/25	35.3	76.5	17.6	34.0	80.8	21.7	48.6	14.2	25.1		
-10 / -14 ***	100/0	43.5	134.7	33.8	54.0	99.7	31.8	68.9	15.5	32.3		
	75/25	35.3	76.5	15.3	29.7	70.6	21.7	48.6	14.2	25.1		
-18	100/0	24.0	45.5	2.0	7.0	30.0						
-25	100/0	24.0	45.5	1.0	3.0	15.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 2-2: ABAX ECOWING AD-2

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.5300 A = -0.8946	I = 2.7889 A = -0.7155 B = -0.2871	I = 2.7889 A = -0.7155 B = -0.2871	I = 2.7889 A = -0.7155 B = -0.2871	I = 2.6240 A = -0.8987	I = 2.5285 A = -0.7682	I = 2.4977 A = -0.8034	
	75/25	I = 1.9838 A = -0.1716	I = 2.5435 A = -0.7664 B = -0.0812	I = 2.5435 A = -0.7664 B = -0.0812	I = 2.5435 A = -0.7664 B = -0.0812	I = 2.2055 A = -0.5820	I = 2.2411 A = -0.6851	I = 2.3107 A = -0.8650	
	50/50	I = 1.6478 A = -0.5976	I = 2.0999 A = -0.7867 B = -0.1524	I = 2.0999 A = -0.7867 B = -0.1524	I = 2.0999 A = -0.7867 B = -0.1524	I = 1.6770 A = -0.6366	I = 1.5734 A = -0.5302		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.5699 A = -1.2862	I = 2.7889 A = -0.7155 B = -0.2871	I = 2.7889 A = -0.7155 B = -0.2871	I = 2.7889 A = -0.7155 B = -0.2871	I = 2.6096 A = -1.0768	I = 2.3302 A = -0.7561		
	75/25	I = 2.4425 A = -1.2784	I = 2.5435 A = -0.7664 B = -0.0812	I = 2.5435 A = -0.7664 B = -0.0812	I = 2.5435 A = -0.7664 B = -0.0812	I = 2.7079 A = -1.3713	I = 2.3728 A = -0.7324	CAUTION: No holdover time guidelines exist	
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 1.8390 A = -0.8725	I = 2.1496 A = -1.4094 B = 0.0000	I = 1.9908 A = -1.1457 B = 0.0000	I = 2.2123 A = -1.3672 B = 0.0000				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 1.8390 A = -0.8725	I = 2.0233 A = -1.7757 B = 0.0000	I = 1.6761 A = -1.1990 B = 0.0000	I = 1.6761 A = -1.1990 B = 0.0000				
below -25 to -27 °C (below -13 to -17 °F)	100/0	I = 1.8390 A = -0.8725	I = 1.4031 A = -1.1696 B = 0.0000	I = 1.7565 A = -1.7565 B = 0.0000	I = 5.0259 A = -5.0259 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*									
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	80.3	182.3	38.7	74.6	176.5	42.0	99.0	28.5	47.1	9.8	86.3
	75/25	73.1	85.5	26.0	52.5	132.2	36.1	62.9	19.2	30.1	4.9	50.8
	50/50	17.0	29.4	7.8	16.1	41.5	9.3	17.1	6.8	9.6		
-8	100/0	46.9	152.3	31.7	61.1	144.7	25.7	71.9	18.8	30.8		
	75/25	35.4	114.2	24.6	49.6	124.9	15.1	56.2	22.3	36.1		
-10 / -14 ***	100/0	46.9	152.3	27.7	53.4	126.4	25.7	71.9	18.8	30.8		
	75/25	35.4	114.2	23.7	47.8	120.2	15.1	56.2	22.3	36.1		
-18	100/0	16.9	37.7	2.0	7.0	30.0						
-25	100/0	16.9	37.7	1.0	3.0	15.0						
-27	100/0	16.9	37.7	0.0	1.0	7.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 2-3: AVIATION SHAANXI HI-TECH CLEANWING II

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions					
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]	Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
-3 °C and above (27 °F and above)	100/0	I = 2.2573 A = -0.7407	I = 2.4007 A = -0.6714 B = 0.0000	I = 2.1979 A = -0.5728	I = 2.2567 A = -0.6317	I = 2.1512 A = -0.6064	
	75/25	I = 2.0742 A = -0.5411	I = 2.3510 A = -0.6986 B = 0.0000	I = 2.1475 A = -0.5338	I = 2.2158 A = -0.6683	I = 2.1568 A = -0.6861	
	50/50	I = 1.9836 A = -0.6276	I = 2.3242 A = -0.6725 B = -0.2889	I = 2.0341 A = -0.6288	I = 2.1847 A = -0.7830		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.3283 A = -0.9431	I = 2.4007 A = -0.6714 B = 0.0000	I = 2.1441 A = -0.6033	I = 1.8282 A = -0.4021		
	75/25	I = 2.3328 A = -1.0611	I = 2.3510 A = -0.6986 B = 0.0000	I = 1.6685 A = -0.1061	I = 1.7474 A = -0.3274		CAUTION: No holdover time guidelines exist
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 1.9950 A = -0.9540	I = 2.2123 A = -1.3672 B = 0.0000				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 1.9950 A = -0.9540	I = 1.6761 A = -1.1990 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate ($g/dm^2/h$)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate ($g/dm^2/h$) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
		Freezing Fog or Ice Crystals ($g/dm^2/h$)		Snow, Snow Grains or Snow Pellets ($g/dm^2/h$)			Freezing Drizzle ($g/dm^2/h$)		Light Freezing Rain ($g/dm^2/h$)		Rain on Cold Soaked Wing ($g/dm^2/h$)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	54.9	108.2	29.0	53.6	120.3	36.3	62.7	23.6	35.7	10.3	53.4
	75/25	49.7	81.5	23.7	44.9	104.2	35.7	59.5	19.1	29.6	7.4	47.6
	50/50	35.1	62.3	15.2	28.2	35.8	21.6	39.3	12.3	20.5		
-8	100/0	46.7	110.8	29.0	53.6	120.3	29.7	52.8	18.5	24.0		
	75/25	39.0	103.1	23.7	44.9	85.2	35.5	39.3	19.5	24.1		
-10 / -14 ***	100/0	46.7	110.8	29.0	53.6	120.3	29.7	52.8	18.5	24.0		
	75/25	39.0	103.1	23.7	44.9	85.2	35.5	39.3	19.5	24.1		
-18	100/0	21.3	51.0	2.0	7.0	7.0						
-25	100/0	21.3	51.0	1.0	3.0	3.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 2-4: BEIJING YADILITE AVIATION YD-102 TYPE II

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.2562 A = -0.5977	I = 2.7385 A = -0.7402 B = -0.4299	I = 2.7385 A = -0.7402 B = -0.4299	I = 2.7385 A = -0.7402 B = -0.4299	I = 2.3920 A = -0.7249	I = 1.9465 A = -0.3059	I = 2.2622 A = -0.6682	
	75/25	I = 1.9892 A = -0.8353	I = 2.4080 A = -0.7439 B = -0.3491	I = 2.4080 A = -0.7439 B = -0.3491	I = 2.4080 A = -0.7439 B = -0.3491	I = 2.2407 A = -0.9340	I = 2.3425 A = -0.9259	I = 1.7678 A = -0.5942	
	50/50	I = 1.5895 A = -0.5473	I = 2.1960 A = -0.8600 B = -0.3992	I = 2.1960 A = -0.8600 B = -0.3992	I = 2.1960 A = -0.8600 B = -0.3992	I = 1.6035 A = -0.6300	I = 1.5230 A = -0.4848		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.1988 A = -0.7861	I = 2.7385 A = -0.7402 B = -0.4299	I = 2.7385 A = -0.7402 B = -0.4299	I = 2.7385 A = -0.7402 B = -0.4299	I = 2.0314 A = -0.4651	I = 1.4027 A = 0.0002		
	75/25	I = 1.8916 A = -0.6222	I = 2.4080 A = -0.7439 B = -0.3491	I = 2.4080 A = -0.7439 B = -0.3491	I = 2.4080 A = -0.7439 B = -0.3491	I = 1.8407 A = -0.6501	I = 1.5490 A = -0.3996		CAUTION: No holdover time guidelines exist
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 1.9202 A = -0.8505	I = 2.1496 A = -1.4094 B = 0.0000	I = 1.9908 A = -1.1457 B = 0.0000	I = 2.2123 A = -1.3672 B = 0.0000				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 1.9202 A = -0.8505	I = 2.0233 A = -1.7757 B = 0.0000	I = 1.6761 A = -1.1990 B = 0.0000	I = 1.6761 A = -1.1990 B = 0.0000				
below -25 to -29 °C (below -13 to -20 °F)	100/0	I = 1.9202 A = -0.8505	I = 1.4031 A = -1.1696 B = 0.0000	I = 1.7565 A = -1.7565 B = 0.0000	I = 5.0259 A = -5.0259 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*									
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	68.9	119.2	25.3	49.9	121.6	38.4	76.8	33.0	40.3	10.2	62.4
	75/25	25.4	54.7	13.3	26.3	64.4	15.9	38.7	11.2	20.5	4.5	22.5
	50/50	16.1	26.6	5.2	11.4	32.1	8.0	14.6	7.0	9.6		
-8	100/0	44.6	91.7	18.8	37.0	90.2	32.6	50.9	25.3	25.3		
	75/25	28.6	50.6	10.4	20.7	50.6	13.1	24.3	9.8	12.7		
-10 / -14 ***	100/0	44.6	91.7	15.3	30.2	73.7	32.6	50.9	25.3	25.3		
	75/25	28.6	50.6	8.9	17.5	42.9	13.1	24.3	9.8	12.7		
-18	100/0	21.2	46.2	2.0	7.0	30.0						
-25	100/0	21.2	46.2	1.0	3.0	15.0						
-29	100/0	21.2	46.2	0.0	1.0	7.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 2-5: CLARIANT SAFEWING MP II FLIGHT

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.4369 A = -0.1630	I = 2.7425 A = -0.5435 B = -0.3120	I = 2.7425 A = -0.5435 B = -0.3120	I = 2.7425 A = -0.5435 B = -0.3120	I = 2.6541 A = -0.6697	I = 2.9080 A = -0.8860	I = 2.4810 A = -0.7583	
	75/25	I = 2.3415 A = -0.4326	I = 3.0163 A = -0.7162 B = -0.5615	I = 3.0163 A = -0.7162 B = -0.5615	I = 3.0163 A = -0.7162 B = -0.5615	I = 2.1306 A = -0.2689	I = 2.5596 A = -0.7512	I = 2.5884 A = -0.9638 or[4] I = 2.2277 A = -0.7375	
	50/50	I = 2.2250 A = -0.6732	I = 2.2879 A = -0.7080 B = -0.2971	I = 2.2879 A = -0.7080 B = -0.2971	I = 2.2879 A = -0.7080 B = -0.2971	I = 1.7413 A = -0.3693	I = 1.9070 A = -0.6463		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.2233 A = -0.6827	I = 2.7425 A = -0.5435 B = -0.3120	I = 2.7425 A = -0.5435 B = -0.3120	I = 2.7425 A = -0.5435 B = -0.3120	I = 2.6220 A = -0.9557	I = 2.5701 A = -0.8095		
	75/25	I = 2.1182 A = -1.0244	I = 3.0163 A = -0.7162 B = -0.5615	I = 3.0163 A = -0.7162 B = -0.5615	I = 3.0163 A = -0.7162 B = -0.5615	I = 2.6085 A = -1.0800 or[4] I = 2.7141 A = -1.2023	I = 2.3076 A = -0.6932		CAUTION: No holdover time guidelines exist
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 1.8996 A = -0.6356	I = 6.2483 A = -1.1556 B = -2.8476	I = 6.2483 A = -1.1556 B = -2.8476	I = 6.2483 A = -1.1556 B = -2.8476				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 1.8996 A = -0.6356	I = 6.2483 A = -1.1556 B = -2.8476	I = 6.2483 A = -1.1556 B = -2.8476	I = 6.2483 A = -1.1556 B = -2.8476				
below -25 to -29 °C (below -13 to -20 °F)	100/0	I = 1.8996 A = -0.6356	I = 6.2483 A = -1.1556 B = -2.8476	I = 6.2483 A = -1.1556 B = -2.8476	I = 6.2483 A = -1.1556 B = -2.8476				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2-T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6
4 Calculate value using both sets of coefficients; take shortest holdover time calculated

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*									
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	210.4	244.2	58.2	95.7	184.1	80.9	153.5	46.7	83.4	11.5	89.3
	75/25	109.4	162.7	41.9	80.8	191.5	67.8	87.6	32.3	52.8	6.0	51.5
	50/50	56.8	105.3	12.3	23.6	55.3	21.4	30.4	10.1	15.4		
-8	100/0	55.7	104.2	46.9	77.1	148.3	36.1	89.9	27.4	46.6		
	75/25	25.2	64.5	28.4	54.8	129.7	23.7	71.4	21.8	34.3		
-10 / -14 ***	100/0	55.7	104.2	40.5	66.6	128.1	36.1	89.9	27.4	46.6		
	75/25	25.2	64.5	21.8	42.1	99.6	23.7	71.4	21.8	34.3		
-18	100/0	28.5	51.1	8.5	24.4	98.2						
-25	100/0	28.5	51.1	3.6	10.4	41.8						
-29	100/0	28.5	51.1	2.4	7.0	28.2						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 2-6: CLARIANT SAFEWING MP II FLIGHT PLUS

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions					
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]	Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
-3 °C and above (27 °F and above)	100/0	I = 2.5234 A = -0.4612	I = 3.1605 A = -0.8880 B = -0.3275	I = 2.4469 A = -0.4650	I = 2.2484 A = -0.4093	I = 2.6707 A = -0.8193	
	75/25	I = 2.5521 A = -0.5255	I = 2.6834 A = -0.6171 B = -0.0598	I = 2.3720 A = -0.3524	I = 2.6120 A = -0.6593	I = 2.3026 A = -0.5932	
	50/50	I = 2.4106 A = -0.8778	I = 2.6120 A = -0.6769 B = -0.7145	I = 2.3447 A = -0.7750	I = 1.8799 A = -0.5318		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.5312 A = -1.2991	I = 3.1605 A = -0.8880 B = -0.3275	I = 2.6242 A = -0.9778	I = 2.5660 A = -0.7490		
	75/25	I = 2.4057 A = -1.2869	I = 2.6834 A = -0.6171 B = -0.0598	I = 2.5280 A = -0.9864	I = 2.1271 A = -0.4438		CAUTION: No holdover time guidelines exist
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 1.8877 A = -0.8771	I = 2.2123 A = -1.3672 B = 0.0000				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 1.8877 A = -0.8771	I = 1.6761 A = -1.1990 B = 0.0000				
below -25 to -29 °C (below -13 to -20 °F)	100/0	I = 1.8877 A = -0.8771	I = 5.0259 A = -5.0259 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	158.9	242.4	49.0	110.6	249.4	84.9	132.4	47.4	62.0	13.6	125.3
	75/25	153.0	247.7	60.1	105.8	222.4	95.4	133.6	49.0	75.4	15.5	77.3
	50/50	62.7	140.1	14.7	27.3	50.7	30.3	63.5	13.7	19.4		
-8	100/0	42.0	138.1	39.1	88.1	198.8	34.3	87.2	33.0	53.9		
	75/25	32.1	104.3	57.7	101.5	213.4	26.9	69.0	32.1	42.9		
-10 / -14 ***	100/0	42.0	138.1	33.5	75.5	170.4	34.3	87.2	33.0	53.9		
	75/25	32.1	104.3	56.1	98.7	207.5	26.9	69.0	32.1	42.9		
-18	100/0	18.8	42.0	2.0	7.0	7.0						
-25	100/0	18.8	42.0	1.0	3.0	3.0						
-29	100/0	18.8	42.0	0.0	1.0	1.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 2-7: CRYOTECH POLAR GUARD® II

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.5794 A = -0.5025	I = 2.9600 A = -0.5988 B = -0.4378	I = 2.9600 A = -0.5988 B = -0.4378	I = 2.9600 A = -0.5988 B = -0.4378	I = 2.2682 A = -0.2524	I = 2.2584 A = -0.2806	I = 2.6661 A = -0.7999	
	75/25	I = 2.5776 A = -0.5705	I = 2.9905 A = -0.8191 B = -0.3466	I = 2.9905 A = -0.8191 B = -0.3466	I = 2.9905 A = -0.8191 B = -0.3466	I = 2.2204 A = -0.1898	I = 2.8328 A = -0.8896	I = 2.6248 A = -0.8807	
	50/50	I = 2.1254 A = -0.6271	I = 2.8810 A = -1.0631 B = -0.5673	I = 2.8810 A = -1.0631 B = -0.5673	I = 2.8810 A = -1.0631 B = -0.5673	I = 2.2943 A = -0.9086	I = 2.3695 A = -0.9996		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.5101 A = -1.1145	I = 2.9600 A = -0.5988 B = -0.4378	I = 2.9600 A = -0.5988 B = -0.4378	I = 2.9600 A = -0.5988 B = -0.4378	I = 2.7077 A = -1.0390	I = 2.0801 A = -0.3886		
	75/25	I = 2.2594 A = -0.9785	I = 2.9905 A = -0.8191 B = -0.3466	I = 2.9905 A = -0.8191 B = -0.3466	I = 2.9905 A = -0.8191 B = -0.3466	I = 2.4495 A = -0.9076	I = 2.0483 A = -0.3597	CAUTION: No holdover time guidelines exist	
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 1.9253 A = -0.6979	I = 6.4718 A = -1.1603 B = -2.9134	I = 6.4718 A = -1.1603 B = -2.9134	I = 6.4718 A = -1.1603 B = -2.9134				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 1.9253 A = -0.6979	I = 6.4718 A = -1.1603 B = -2.9134	I = 6.4718 A = -1.1603 B = -2.9134	I = 6.4718 A = -1.1603 B = -2.9134				
below -25 to -30.5 °C (below -13 to -23 °F)	100/0	I = 1.9253 A = -0.6979	I = 2.0544 A = -1.1592 B = 0.0000	I = 2.0544 A = -1.1592 B = 0.0000	I = 2.0544 A = -1.1592 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*									
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	169.1	268.0	65.6	113.6	233.5	97.1	123.5	73.5	88.3	14.7	127.9
	75/25	151.0	254.6	40.1	84.9	227.7	102.1	122.4	38.8	69.5	9.4	102.1
	50/50	48.6	86.4	10.0	26.4	94.9	19.2	45.6	9.4	18.0		
-8	100/0	53.8	149.5	48.4	83.8	172.4	35.5	95.8	34.4	44.4		
	75/25	37.6	92.2	31.5	66.8	179.1	27.4	65.3	35.1	44.4		
-10 / -14 ***	100/0	53.8	149.5	39.4	68.2	140.3	35.5	95.8	34.4	44.4		
	75/25	37.6	92.2	26.8	56.8	152.2	27.4	65.3	35.1	44.4		
-18	100/0	27.4	51.9	11.5	33.2	134.2						
-25	100/0	27.4	51.9	4.8	13.8	56.0						
-30.5	100/0	27.4	51.9	2.7	7.9	31.7						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 2-8: KILFROST ABC-K PLUS

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions					
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]	Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
-3 °C and above (27 °F and above)	100/0	I = 2.5148 A = -0.5532	I = 2.6804 A = -0.5771 B = -0.1414	I = 2.2527 A = -0.1978	I = 2.5473 A = -0.5588	I = 2.6523 A = -0.7393	
	75/25	I = 2.3020 A = -0.4342	I = 2.5273 A = -0.6849 B = -0.0149	I = 2.3200 A = -0.3522	I = 2.4709 A = -0.5601	I = 2.5956 A = -0.7470	
	50/50	I = 1.9950 A = -0.6463	I = 2.3972 A = -0.8261 B = -0.5288	I = 1.7256 A = -0.3910	I = 2.0364 A = -0.7354		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.0780 A = -0.8928	I = 2.6804 A = -0.5771 B = -0.1414	I = 2.4865 A = -0.9979	I = 3.2510 A = -1.5260		
	75/25	I = 2.3405 A = -1.3357	I = 2.5273 A = -0.6849 B = -0.0149	I = 2.4921 A = -1.0863	I = 3.6906 A = -1.9574		
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 1.9498 A = -0.6590	I = 2.2123 A = -1.3672 B = 0.0000			CAUTION: No holdover time guidelines exist	
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 1.9498 A = -0.6590	I = 1.6761 A = -1.1990 B = 0.0000				
below -25 to -29 °C (below -13 to -20 °F)	100/0	I = 1.9498 A = -0.6590	I = 5.0259 A = -5.0259 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	134.3	223.0	59.5	101.0	202.4	107.7	130.1	58.4	84.1	18.5	136.6
	75/25	99.7	148.4	36.3	67.9	127.2	84.7	118.5	48.7	70.3	15.7	118.4
	50/50	34.9	63.2	7.5	15.9	43.0	19.5	28.3	10.2	16.5		
-8	100/0	28.4	64.5	54.0	91.6	183.5	23.7	61.5	13.1	35.6		
	75/25	25.5	86.8	35.9	67.2	125.9	19.1	54.1	9.0	32.4		
-10 / -14 ***	100/0	28.4	64.5	50.5	85.7	171.7	23.7	61.5	13.1	35.6		
	75/25	25.5	86.8	35.6	66.8	125.0	19.1	54.1	9.0	32.4		
-18	100/0	30.8	56.4	2.0	7.0	7.0						
-25	100/0	30.8	56.4	1.0	3.0	3.0						
-29	100/0	30.8	56.4	0.0	1.0	1.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 2-9: KILFROST ICE CLEAR II

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.2677 A = -0.6475	I = 2.6141 A = -0.6774 B = -0.1796	I = 2.6141 A = -0.6774 B = -0.1796	I = 2.6141 A = -0.6774 B = -0.1796	I = 2.1865 A = -0.5621	I = 2.3411 A = -0.6851	I = 2.3039 A = -0.6959	
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
	50/50	n/a	n/a	n/a	n/a	n/a	n/a	CAUTION: No holdover time guidelines exist	
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.3107 A = -0.8288	I = 2.6141 A = -0.6774 B = -0.1796	I = 2.6141 A = -0.6774 B = -0.1796	I = 2.6141 A = -0.6774 B = -0.1796	I = 1.9909 A = -0.3307	I = 2.0695 A = -0.5048		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a		
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 1.9438 A = -0.6425	I = 2.1496 A = -1.4094 B = 0.0000	I = 1.9908 A = -1.1457 B = 0.0000	I = 2.2123 A = -1.3672 B = 0.0000				
below -18 to -24 °C (below 0 to -11 °F)	100/0	I = 1.9438 A = -0.6425	I = 2.0233 A = -1.7757 B = 0.0000	I = 1.6761 A = -1.1990 B = 0.0000	I = 1.6761 A = -1.1990 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*									
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	65.3	118.2	34.8	64.7	146.3	36.3	62.2	24.2	37.8	10.0	65.7
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	50/50	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-8	100/0	53.9	115.1	30.7	57.2	129.2	41.9	57.5	23.1	32.2		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-10 / -14 ***	100/0	53.9	115.1	28.2	52.5	118.8	41.9	57.5	23.1	32.2		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-18	100/0	31.2	56.3	2.0	7.0	30.0						
-24	100/0	31.2	56.3	1.0	3.0	15.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 2-10: NEWAVE AEROCHEMICAL FCY-2

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions					
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]	Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
-3 °C and above (27 °F and above)	100/0	I = 2.3831 A = -0.7394	I = 2.7862 A = -0.6652 B = -0.5351	I = 2.3424 A = -0.7349	I = 2.1756 A = -0.5685	I = 2.0886 A = -0.6241	
	75/25	I = 2.1617 A = -0.6765	I = 2.6255 A = -0.6413 B = -0.5531	I = 2.1241 A = -0.6856	I = 2.6154 A = -1.0787	I = 1.8312 A = -0.6039	
	50/50	I = 1.6808 A = -0.3883	I = 2.1561 A = -0.7445 B = 0.0000	I = 1.7656 A = -0.6698	I = 1.6020 A = -0.5128		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.1844 A = -0.7552	I = 2.7862 A = -0.6652 B = -0.5351	I = 2.2637 A = -0.8968	I = 1.6935 A = -0.3738		
	75/25	I = 2.0300 A = -0.7545	I = 2.6255 A = -0.6413 B = -0.5531	I = 2.0031 A = -0.7745	I = 2.0994 A = -0.8524		CAUTION: No holdover time guidelines exist
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 1.7388 A = -0.5485	I = 2.2123 A = -1.3672 B = 0.0000				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 1.7388 A = -0.5485	I = 1.6761 A = -1.1990 B = 0.0000				
below -25 to -28 °C (below -13 to -18 °F)	100/0	I = 1.7388 A = -0.5485	I = 5.0259 A = -5.0259 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	73.5	144.7	30.4	55.8	124.4	33.4	67.4	24.0	34.9	8.3	44.9
	75/25	48.8	90.8	22.0	39.6	85.7	22.9	44.1	12.8	25.9	5.0	25.7
	50/50	25.7	36.6	13.0	25.8	63.2	10.5	19.8	7.7	10.7		
-8	100/0	45.3	90.6	21.0	38.5	85.8	18.4	43.3	14.8	18.9		
	75/25	31.8	63.5	15.0	27.0	58.4	13.8	29.0	8.1	14.1		
-10 / -14 ***	100/0	45.3	90.6	16.3	30.0	66.8	18.4	43.3	14.8	18.9		
	75/25	31.8	63.5	11.6	20.8	45.0	13.8	29.0	8.1	14.1		
-18	100/0	22.7	37.5	2.0	7.0	7.0						
-25	100/0	22.7	37.5	1.0	3.0	3.0						
-28	100/0	22.7	37.5	0.0	1.0	1.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 2-11: NEWAVE AEROCHEMICAL FCY-2 BIO+

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.3819 A = -0.6607	I = 3.1420 A = -0.8361 B = -0.7102	I = 3.1420 A = -0.8361 B = -0.7102	I = 3.1420 A = -0.8361 B = -0.7102	I = 2.2626 A = -0.5057	I = 2.6041 A = -0.8687	I = 2.4390 A = -0.8058	
	75/25	I = 2.0853 A = -0.6218	I = 2.8399 A = -0.7994 B = -0.6556	I = 2.8399 A = -0.7994 B = -0.6556	I = 2.8399 A = -0.7994 B = -0.6556	I = 2.2267 A = -0.7378	I = 1.9393 A = -0.5060	I = 1.9514 A = -0.5966	
	50/50	I = 1.6563 A = -0.6034	I = 1.9658 A = -0.5568 B = -0.3538	I = 1.9658 A = -0.5568 B = -0.3538	I = 1.9658 A = -0.5568 B = -0.3538	I = 1.6641 A = -0.5675	I = 1.7844 A = -0.6234		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.2250 A = -0.8616	I = 3.1420 A = -0.8361 B = -0.7102	I = 3.1420 A = -0.8361 B = -0.7102	I = 3.1420 A = -0.8361 B = -0.7102	I = 2.2571 A = -0.6478	I = 2.4418 A = -0.8745		
	75/25	I = 2.0676 A = -0.8031	I = 2.8399 A = -0.7994 B = -0.6556	I = 2.8399 A = -0.7994 B = -0.6556	I = 2.8399 A = -0.7994 B = -0.6556	I = 1.9065 A = -0.5604	I = 1.8028 A = -0.4737		CAUTION: No holdover time guidelines exist
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 2.0929 A = -1.0828	I = 2.1496 A = -1.4094 B = 0.0000	I = 1.9908 A = -1.1457 B = 0.0000	I = 2.2123 A = -1.3672 B = 0.0000				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 2.0929 A = -1.0828	I = 2.0233 A = -1.7757 B = 0.0000	I = 1.6761 A = -1.1990 B = 0.0000	I = 1.6761 A = -1.1990 B = 0.0000				
below -25 to -28.5 °C (below -13 to -19 °F)	100/0	I = 2.0929 A = -1.0828	I = 1.4031 A = -1.1696 B = 0.0000	I = 1.7565 A = -1.7565 B = 0.0000	I = 5.0259 A = -5.0259 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*									
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	83.2	152.4	30.0	64.5	176.5	50.0	81.1	24.5	43.3	8.5	75.1
	75/25	44.7	79.1	18.4	38.2	100.1	25.4	51.4	17.1	23.7	6.8	34.2
	50/50	17.2	29.8	8.7	14.5	28.4	10.8	18.5	8.2	12.3		
-8	100/0	42.0	92.4	18.3	39.4	107.9	34.3	63.7	16.6	29.4		
	75/25	32.1	67.0	11.7	24.3	63.5	19.2	32.7	13.8	18.8		
-10 / -14 ***	100/0	42.0	92.4	13.1	28.2	77.3	34.3	63.7	16.6	29.4		
	75/25	32.1	67.0	8.6	17.8	46.7	19.2	32.7	13.8	18.8		
-18	100/0	21.7	58.5	2.0	7.0	30.0						
-25	100/0	21.7	58.5	1.0	3.0	15.0						
-28.5	100/0	21.7	58.5	0.0	1.0	7.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 2-12: OKSAYD DEFROST PG 2

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.2918 A = -0.8145	I = 2.7346 A = -0.7309 B = -0.3571	I = 2.7346 A = -0.7309 B = -0.3571	I = 2.7346 A = -0.7309 B = -0.3571	I = 2.2402 A = -0.6580	I = 2.3748 A = -0.7498	I = 2.4186 A = -0.7567	
	75/25	I = 2.2699 A = -0.6569	I = 2.9389 A = -0.8579 B = -0.5828	I = 2.9389 A = -0.8579 B = -0.5828	I = 2.9389 A = -0.8579 B = -0.5828	I = 2.0887 A = -0.5872	I = 2.4497 A = -0.9006	I = 1.9718 A = -0.6216	
	50/50	I = 2.2311 A = -0.6560	I = 2.7673 A = -0.7928 B = -0.2600	I = 2.7673 A = -0.7928 B = -0.2600	I = 2.7673 A = -0.7928 B = -0.2600	I = 2.1018 A = -0.5878	I = 2.3509 A = -0.8146		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.0963 A = -0.5196	I = 2.7346 A = -0.7309 B = -0.3571	I = 2.7346 A = -0.7309 B = -0.3571	I = 2.7346 A = -0.7309 B = -0.3571	I = 1.9595 A = -0.3909	I = 2.1235 A = -0.5815		
	75/25	I = 2.1158 A = -0.7229	I = 2.9389 A = -0.8579 B = -0.5828	I = 2.9389 A = -0.8579 B = -0.5828	I = 2.9389 A = -0.8579 B = -0.5828	I = 1.9013 A = -0.4425	I = 1.8645 A = -0.4846		CAUTION: No holdover time guidelines exist
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 2.0196 A = -0.6831	I = 2.1496 A = -1.4094 B = 0.0000	I = 1.9908 A = -1.1457 B = 0.0000	I = 2.2123 A = -1.3672 B = 0.0000				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 2.0196 A = -0.6831	I = 2.0233 A = -1.7757 B = 0.0000	I = 1.6761 A = -1.1990 B = 0.0000	I = 1.6761 A = -1.1990 B = 0.0000				
below -25 to -27 °C (below -13 to -17 °F)	100/0	I = 2.0196 A = -0.6831	I = 1.4031 A = -1.1696 B = 0.0000	I = 1.7565 A = -1.7565 B = 0.0000	I = 5.0259 A = -5.0259 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*									
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	52.8	111.3	29.1	56.8	136.9	32.2	60.3	21.2	34.6	10.0	77.6
	75/25	64.7	118.1	21.5	47.2	132.5	27.2	47.7	15.5	28.0	6.4	34.5
	50/50	59.2	108.0	30.0	62.1	161.2	28.0	49.1	16.3	27.8		
-8	100/0	54.1	87.1	22.7	44.3	106.8	33.4	48.6	20.4	29.9		
	75/25	40.8	79.1	14.3	31.5	88.5	25.6	39.1	15.4	21.1		
-10 / -14 ***	100/0	54.1	87.1	19.2	37.5	90.3	33.4	48.6	20.4	29.9		
	75/25	40.8	79.1	10.9	23.9	67.3	25.6	39.1	15.4	21.1		
-18	100/0	34.8	65.2	2.0	7.0	30.0						
-25	100/0	34.8	65.2	1.0	3.0	15.0						
-27	100/0	34.8	65.2	0.0	1.0	7.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 2-13: ROMCHIM ADD-PROTECT TYPE II

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.5740 A = -0.8251	I = 2.8637 A = -0.7431 B = -0.5033	I = 2.8637 A = -0.7431 B = -0.5033	I = 2.8637 A = -0.7431 B = -0.5033	I = 2.6191 A = -0.9213	I = 2.4792 A = -0.7630	I = 2.1185 A = -0.6149	
	75/25	I = 2.0354 A = -0.6203	I = 2.5210 A = -0.6815 B = -0.4862	I = 2.5210 A = -0.6815 B = -0.4862	I = 2.5210 A = -0.6815 B = -0.4862	I = 2.0120 A = -0.5901	I = 2.1011 A = -0.6689	I = 1.7686 A = -0.5325	
	50/50	I = 1.7404 A = -0.6221	I = 1.9864 A = -0.5840 B = -0.2529	I = 1.9864 A = -0.5840 B = -0.2529	I = 1.9864 A = -0.5840 B = -0.2529	I = 2.0897 A = -0.9018	I = 1.7429 A = -0.6010		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 1.8401 A = -0.5735	I = 2.8637 A = -0.7431 B = -0.5033	I = 2.8637 A = -0.7431 B = -0.5033	I = 2.8637 A = -0.7431 B = -0.5033	I = 2.2574 A = -0.7754	I = 2.0901 A = -0.5723		
	75/25	I = 1.9219 A = -0.6509	I = 2.5210 A = -0.6815 B = -0.4862	I = 2.5210 A = -0.6815 B = -0.4862	I = 2.5210 A = -0.6815 B = -0.4862	I = 1.8894 A = -0.5596	I = 1.8836 A = -0.5597	CAUTION: No holdover time guidelines exist	
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 1.5810 A = -0.5714	I = 2.1496 A = -1.4094 B = 0.0000	I = 1.9908 A = -1.1457 B = 0.0000	I = 2.2123 A = -1.3672 B = 0.0000				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 1.5810 A = -0.5714	I = 2.0233 A = -1.7757 B = 0.0000	I = 1.6761 A = -1.1990 B = 0.0000	I = 1.6761 A = -1.1990 B = 0.0000				
below -25 to -28 °C (below -13 to -18 °F)	100/0	I = 1.5810 A = -0.5714	I = 1.4031 A = -1.1696 B = 0.0000	I = 1.7565 A = -1.7565 B = 0.0000	I = 5.0259 A = -5.0259 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*									
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	99.4	211.7	29.7	58.7	143.7	39.2	94.4	25.9	42.6	9.2	48.8
	75/25	40.0	70.6	16.9	31.6	71.8	22.6	39.8	14.7	22.7	5.9	24.9
	50/50	20.2	35.7	9.8	16.8	34.0	12.2	28.8	8.0	11.8		
-8	100/0	27.5	46.5	21.0	41.4	101.4	24.8	51.9	19.5	28.4		
	75/25	29.3	53.2	12.1	22.6	51.2	18.5	31.5	12.6	18.2		
-10 / -14 ***	100/0	27.5	46.5	16.6	32.7	80.0	24.8	51.9	19.5	28.4		
	75/25	29.3	53.2	9.6	17.9	40.8	18.5	31.5	12.6	18.2		
-18	100/0	15.2	25.6	2.0	7.0	30.0						
-25	100/0	15.2	25.6	1.0	3.0	15.0						
-28	100/0	15.2	25.6	0.0	1.0	7.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 2-14: TYPE II GENERIC

VERIFICATION TABLE

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*									
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)		Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	13	5	25	13	75	5
+1 / -3 *	100/0	52.8	108.2	25.3	49.9	32.2	60.3	21.2	34.6	8.3	44.9
	75/25	25.4	54.7	13.3	26.3	15.9	38.7	11.2	20.5	4.5	22.5
	50/50	16.1	26.6	5.2	11.4	8.0	14.6	6.8	9.6		
-8	100/0	27.5	46.5	18.3	37.0	18.4	43.3	13.1	18.9		
	75/25	25.2	50.6	10.4	20.7	13.1	24.3	8.1	12.7		
-10 / -14 **	100/0	27.5	46.5	13.1	28.2	18.4	43.3	13.1	18.9		
	75/25	25.2	50.6	8.6	17.5	13.1	24.3	8.1	12.7		
-18	100/0	15.2	25.6	2.0	7.0						
-25	100/0	15.2	25.6	1.0	3.0						

* Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C

** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 3-1: ALLCLEAR AEROCLEAR MAX, APPLIED UNHEATED ON LOW SPEED AIRCRAFT

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions[1]					
		Freezing Fog or Ice Crystals[2]	Snow, Snow Grains or Snow Pellets[3,4]	Freezing Drizzle[2]	Light Freezing Rain[2]	Rain on Cold Soaked Wing[2]	Other
-3 °C and above (27 °F and above)	100/0	I = 2.3532 A = -0.9867	I = 2.4111 A = -0.8236 B = 0.0000	I = 2.2733 A = -0.8172	I = 2.4359 A = -0.9105	I = 2.1350 A = -0.7258	
	75/25	n/a	n/a	n/a	n/a	n/a	
	50/50	n/a	n/a	n/a	n/a		
below -3 to -10°C (below 27 to 14 °F)	100/0	I = 2.2318 A = -0.7815	I = 2.4111 A = -0.8236 B = 0.0000	I = 2.1031 A = -0.6645	I = 2.2245 A = -0.7407	CAUTION: No holdover time guidelines exist	
	75/25	n/a	n/a	n/a	n/a		
below -10 to -16 °C (below 14 to 3 °F)	100/0	I = 2.3342 A = -1.0165	I = 2.4111 A = -0.8236 B = 0.0000				

1 CAUTION: Fluid must be applied unheated on aircraft conforming to the SAE AS5900 low speed aerodynamic test criterion to use these regression coefficients
2 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
3 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
4 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	46.1	113.8	18.2	38.7	104.3	23.1	50.4	14.6	26.4	5.9	42.4
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	50/50	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-10	100/0	48.5	99.2	18.2	38.7	104.3	23.1	43.5	15.5	25.1		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-25	100/0	42.0	106.7	18.2	38.7	104.3						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C

TABLE 3-2: ALLCLEAR AEROCLEAR MAX, APPLIED UNHEATED ON HIGH SPEED AIRCRAFT

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions[1]					
		Freezing Fog or Ice Crystals[2]	Snow, Snow Grains or Snow Pellets[3,4]	Freezing Drizzle[2]	Light Freezing Rain[2]	Rain on Cold Soaked Wing[2]	Other
-3 °C and above (27 °F and above)	100/0	I = 2.3532 A = -0.9867	I = 2.4111 A = -0.8236 B = 0.0000	I = 2.2733 A = -0.8172	I = 2.4359 A = -0.9105	I = 2.1350 A = -0.7258	
	75/25	n/a	n/a	n/a	n/a	n/a	
	50/50	n/a	n/a	n/a	n/a		
below -3 to -10°C (below 27 to 14 °F)	100/0	I = 2.2318 A = -0.7815	I = 2.4111 A = -0.8236 B = 0.0000	I = 2.1031 A = -0.6645	I = 2.2245 A = -0.7407		CAUTION: No holdover time guidelines exist
	75/25	n/a	n/a	n/a	n/a		
below -10 to -25 °C (below 14 to -13 °F)	100/0	I = 2.3342 A = -1.0165	I = 2.4111 A = -0.8236 B = 0.0000				
below -25 to -35 °C (below -13 to -31 °F)	100/0	I = 2.1252 A = -1.0990	I = 2.1551 A = -0.8234 B = 0.0000				

1 CAUTION: Fluid must be applied unheated on aircraft conforming to the SAE AS5900 high speed aerodynamic test criterion to use these regression coefficients
2 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
3 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
4 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	46.1	113.8	18.2	38.7	104.3	23.1	50.4	14.6	26.4	5.9	42.4
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	50/50	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-10	100/0	48.5	99.2	18.2	38.7	104.3	23.1	43.5	15.5	25.1		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-25	100/0	42.0	106.7	18.2	38.7	104.3						
-35	100/0	22.8	62.3	10.1	21.5	57.8						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C

TABLE 4-1: ABAX ECOWING AD-49

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.4713 A = -0.2370	I = 3.0052 A = -0.7148 B = -0.3380	I = 3.0052 A = -0.7148 B = -0.3380	I = 3.0052 A = -0.7148 B = -0.3380	I = 2.3729 A = -0.3927	I = 2.4943 A = -0.5000	I = 2.6531 A = -0.8558	
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
	50/50	n/a	n/a	n/a	n/a	n/a	n/a		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.5177 A = -1.7715	I = 3.0052 A = -0.7148 B = -0.3380	I = 3.0052 A = -0.7148 B = -0.3380	I = 3.0052 A = -0.7148 B = -0.3380	I = 2.8172 A = -1.2681	I = 1.9828 A = -0.5016		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a		CAUTION: No holdover time guidelines exist
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 1.7838 A = -0.5976	I = 2.3257 A = -1.4094 B = 0.0000	I = 2.2682 A = -1.3140 B = 0.0000	I = 2.5957 A = -1.6415 B = 0.0000				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 1.7838 A = -0.5976	I = 2.4506 A = -2.4094 B = 0.0000	I = 1.7911 A = -1.3140 B = 0.0000	I = 1.6761 A = -1.1990 B = 0.0000				
below -25 to -26 °C (below -13 to -15 °F)	100/0	I = 1.7838 A = -0.5976	I = 1.5915 A = -1.2398 B = 0.0000	I = 1.6682 A = -1.3672 B = 0.0000	I = 6.0834 A = -5.7824 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	202.1	251.2	58.8	113.3	267.9	86.2	125.4	62.4	86.6	11.2	113.5
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	50/50	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-8	100/0	19.0	96.5	46.6	89.6	211.9	25.4	85.3	19.1	26.5		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-10 / -14 ***	100/0	19.0	96.5	39.7	76.5	180.8	25.4	85.3	19.1	26.5		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-18	100/0	23.2	40.2	2.0	9.0	45.0						
-25	100/0	23.2	40.2	1.0	3.0	20.0						
-26	100/0	23.2	40.2	0.0	2.0	10.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 4-2: ALLCLEAR CLEARWING EG

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.4808 A = -0.6236	I = 2.7895 A = -0.7766 B = -0.1648	I = 2.7895 A = -0.7766 B = -0.1648	I = 2.7895 A = -0.7766 B = -0.1648	I = 2.2517 A = -0.3764	I = 3.1105 A = -1.1890	I = 2.4690 A = -0.7435	
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
	50/50	n/a	n/a	n/a	n/a	n/a	n/a		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.6368 A = -0.9489	I = 2.7895 A = -0.7766 B = -0.1648	I = 2.7895 A = -0.7766 B = -0.1648	I = 2.7895 A = -0.7766 B = -0.1648	I = 2.1945 A = -0.3445	I = 2.8711 A = -0.9900		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a		CAUTION: No holdover time guidelines exist
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 2.3601 A = -0.9134	I = 2.2480 A = -0.9120 B = 0.0000	I = 2.1544 A = -0.7565 B = 0.0000	I = 2.3979 A = -1.0000 B = 0.0000				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 2.3601 A = -0.9134	I = 2.2685 A = -1.1070 B = 0.0000	I = 2.2465 A = -1.0704 B = 0.0000	I = 2.3751 A = -1.1990 B = 0.0000				
below -25 to -29 °C (below -13 to -20 °F)	100/0	I = 2.3601 A = -0.9134	I = 2.1021 A = -1.1696 B = 0.0000	I = 2.1466 A = -1.2435 B = 0.0000	I = 2.4160 A = -1.5129 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	110.9	196.4	38.8	79.0	201.3	68.0	97.4	28.1	61.1	11.9	89.0
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	50/50	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-8	100/0	94.1	224.5	34.6	70.5	179.5	64.7	89.9	30.7	58.7		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-10 / -14 ***	100/0	94.1	224.5	32.0	65.2	166.2	64.7	89.9	30.7	58.7		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-18	100/0	52.7	121.7	10.0	25.0	65.0						
-25	100/0	52.7	121.7	5.0	15.0	55.0						
-29	100/0	52.7	121.7	2.0	8.0	35.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 4-3: CHEMCO CHEMR EG IV

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.5221 A = -0.6191	I = 2.8018 A = -0.9158 B = 0.0000	I = 2.8018 A = -0.9158 B = 0.0000	I = 2.8018 A = -0.9158 B = 0.0000	I = 2.5776 A = -0.8305	I = 2.3603 A = -0.6816	I = 2.6437 A = -0.8858	
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
	50/50	n/a	n/a	n/a	n/a	n/a	n/a		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.6566 A = -1.0376	I = 2.8018 A = -0.9158 B = 0.0000	I = 2.8018 A = -0.9158 B = 0.0000	I = 2.8018 A = -0.9158 B = 0.0000	I = 2.3439 A = -0.5194	I = 2.3463 A = -0.5867		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a		CAUTION: No holdover time guidelines exist
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 2.1693 A = -0.8359	I = 2.2480 A = -0.9120 B = 0.0000	I = 2.1544 A = -0.7565 B = 0.0000	I = 2.3979 A = -1.0000 B = 0.0000				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 2.1693 A = -0.8359	I = 2.2685 A = -1.1070 B = 0.0000	I = 2.2465 A = -1.0704 B = 0.0000	I = 2.3751 A = -1.1990 B = 0.0000				
below -25 to -27 °C (below -13 to -17 °F)	100/0	I = 2.1693 A = -0.8359	I = 2.1021 A = -1.1696 B = 0.0000	I = 2.1466 A = -1.2435 B = 0.0000	I = 2.4160 A = -1.5129 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	122.8	216.6	33.2	76.9	231.7	44.9	99.3	25.6	39.9	9.6	105.8
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	50/50	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-8	100/0	85.4	220.9	33.2	76.9	231.7	58.3	95.7	33.6	49.3		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-10 / -14 ***	100/0	85.4	220.9	33.2	76.9	231.7	58.3	95.7	33.6	49.3		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-18	100/0	38.5	82.7	10.0	25.0	65.0						
-25	100/0	38.5	82.7	5.0	15.0	55.0						
-27	100/0	38.5	82.7	2.0	8.0	35.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 4-4: CLARIANT MAX FLIGHT 04

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1,4]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.5102 A = -0.4343	I = 3.4634 A = -0.7407 B = -0.7275	I = 3.4634 A = -0.7407 B = -0.7275	I = 3.4634 A = -0.7407 B = -0.7275	I = 2.0949 A = -0.0224	I = 2.4117 A = -0.4124	I = 2.6420 A = -0.6956	
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
	50/50	n/a	n/a	n/a	n/a	n/a	n/a	CAUTION: No holdover time guidelines exist	
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.5385 A = -1.1945	I = 3.4634 A = -0.7407 B = -0.7275	I = 3.4634 A = -0.7407 B = -0.7275	I = 3.4634 A = -0.7407 B = -0.7275	I = 2.8956 A = -1.3456	I = 2.8529 A = -1.1429		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a		
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 1.8804 A = -0.7843	I = 2.3257 A = -1.4094 B = 0.0000	I = 2.2682 A = -1.3140 B = 0.0000	I = 2.5957 A = -1.6415 B = 0.0000				
below -18 to -23.5 °C (below 0 to -10 °F)	100/0	I = 1.8804 A = -0.7843	I = 2.4506 A = -2.4094 B = 0.0000	I = 1.7911 A = -1.3140 B = 0.0000	I = 1.6761 A = -1.1990 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6
4 Freezing drizzle and light freezing rain values were calculated at 12.7 g/dm²/h the year the holdover time table for this fluid was produced. Since they are now calculated at 13.0 g/dm²/h, values in the holdover time table may differ slightly from those calculated using these coefficients.

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	160.9	239.6	83.1	163.8	399.5	117.5	120.0	68.4	89.6	21.8	143.2
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	50/50	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-8	100/0	50.5	151.0	50.2	98.9	241.3	24.9	90.2	18.0	38.0		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-10 / -14 ***	100/0	50.5	151.0	35.6	70.3	171.4	24.9	90.2	18.0	38.0		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-18	100/0	21.5	44.1	2.0	9.0	45.0						
-23.5	100/0	21.5	44.1	1.0	3.0	20.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 4-5: CLARIANT MAX FLIGHT AVIA

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.4864 A = -0.3214	I = 2.8243 A = -0.6182 B = -0.2788	I = 2.8243 A = -0.6182 B = -0.2788	I = 2.8243 A = -0.6182 B = -0.2788	I = 2.5168 A = -0.5284	I = 2.2295 A = -0.3416	I = 2.8870 A = -1.0183	
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
	50/50	n/a	n/a	n/a	n/a	n/a	n/a		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.6347 A = -0.8798	I = 2.8243 A = -0.6182 B = -0.2788	I = 2.8243 A = -0.6182 B = -0.2788	I = 2.8243 A = -0.6182 B = -0.2788	I = 2.5583 A = -0.6474	I = 2.7838 A = -0.7360		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a		CAUTION: No holdover time guidelines exist
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 2.1916 A = -0.8933	I = 2.2480 A = -0.9120 B = 0.0000	I = 2.1544 A = -0.7565 B = 0.0000	I = 2.3979 A = -1.0000 B = 0.0000				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 2.1916 A = -0.8933	I = 2.2685 A = -1.1070 B = 0.0000	I = 2.2465 A = -1.0704 B = 0.0000	I = 2.3751 A = -1.1990 B = 0.0000				
below -25 to -28.5 °C (below -13 to -19 °F)	100/0	I = 2.1916 A = -0.8933	I = 2.1021 A = -1.1696 B = 0.0000	I = 2.1466 A = -1.2435 B = 0.0000	I = 2.4160 A = -1.5129 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*									
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	182.7	245.3	58.2	102.6	216.0	84.8	140.4	56.5	70.6	9.5	149.7
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	50/50	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-8	100/0	104.7	234.3	48.0	84.6	178.1	68.7	127.6	56.9	92.0		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-10 / -14 ***	100/0	104.7	234.3	42.1	74.2	156.2	68.7	127.6	56.9	92.0		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-18	100/0	36.9	83.7	10.0	25.0	65.0						
-25	100/0	36.9	83.7	5.0	15.0	55.0						
-28.5	100/0	36.9	83.7	2.0	8.0	35.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 4-6: CLARIANT MAX FLIGHT SNEG

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.5734 A = -0.5916	I = 2.8863 A = -0.6493 B = -0.3359	I = 2.8863 A = -0.6493 B = -0.3359	I = 2.8863 A = -0.6493 B = -0.3359	I = 2.1201 A = -0.0318	I = 3.1463 A = -1.0213	I = 2.3856 A = -0.6074	
	75/25	I = 2.3956 A = -0.0226	I = 2.6974 A = -0.5329 B = -0.3096	I = 2.6974 A = -0.5329 B = -0.3096	I = 2.6974 A = -0.5329 B = -0.3096	I = 2.3595 A = -0.3733	I = 2.1906 A = -0.2633	I = 2.5045 A = -0.7062	
	50/50	I = 2.6114 A = -0.9560	I = 2.5982 A = -0.9523 B = 0.0000	I = 2.5982 A = -0.9523 B = 0.0000	I = 2.5982 A = -0.9523 B = 0.0000	I = 2.3438 A = -0.7175	I = 2.7427 A = -1.1421		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.5197 A = -1.2481	I = 2.8863 A = -0.6493 B = -0.3359	I = 2.8863 A = -0.6493 B = -0.3359	I = 2.8863 A = -0.6493 B = -0.3359	I = 2.7003 A = -1.0853	I = 2.6961 A = -0.9598		
	75/25	I = 2.2989 A = -1.2091	I = 2.6974 A = -0.5329 B = -0.3096	I = 2.6974 A = -0.5329 B = -0.3096	I = 2.6974 A = -0.5329 B = -0.3096	I = 2.5864 A = -1.1239	I = 2.7996 A = -1.0818		CAUTION: No holdover time guidelines exist
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 1.9524 A = -0.8898	I = 2.3257 A = -1.4094 B = 0.0000	I = 2.2682 A = -1.3140 B = 0.0000	I = 2.5957 A = -1.6415 B = 0.0000				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 1.9524 A = -0.8898	I = 2.4506 A = -2.4094 B = 0.0000	I = 1.7911 A = -1.3140 B = 0.0000	I = 1.6761 A = -1.1990 B = 0.0000				
below -25 to -29 °C (below -13 to -20 °F)	100/0	I = 1.9524 A = -0.8898	I = 1.5915 A = -1.2398 B = 0.0000	I = 1.6682 A = -1.3672 B = 0.0000	I = 6.0834 A = -5.7824 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*									
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	144.5	248.5	55.4	100.5	219.6	121.5	125.3	52.3	102.0	17.6	91.4
	75/25	239.8	244.8	54.5	88.7	168.6	87.8	125.5	66.5	78.9	15.1	102.5
	50/50	87.7	210.7	18.5	44.2	139.3	35.0	69.5	14.0	29.5		
-8	100/0	44.4	139.3	43.9	79.6	174.0	31.0	87.4	22.6	42.4		
	75/25	28.4	86.1	43.9	71.6	136.0	21.6	63.2	19.4	39.3		
-10 / -14 ***	100/0	44.4	139.3	37.5	68.0	148.6	31.0	87.4	22.6	42.4		
	75/25	28.4	86.1	38.0	61.9	117.6	21.6	63.2	19.4	39.3		
-18	100/0	21.4	48.4	2.0	9.0	45.0						
-25	100/0	21.4	48.4	1.0	3.0	20.0						
-29	100/0	21.4	48.4	0.0	2.0	10.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 4-7: CLARIANT SAFEWING EG IV NORTH

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.5514 A = -0.5862	I = 2.7261 A = -0.6800 B = -0.0814	I = 2.7261 A = -0.6800 B = -0.0814	I = 2.7261 A = -0.6800 B = -0.0814	I = 2.4593 A = -0.4518	I = 2.0514 A = -0.2650	I = 2.7876 A = -0.9859	
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
	50/50	n/a	n/a	n/a	n/a	n/a	n/a		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.6521 A = -0.9130	I = 2.7261 A = -0.6800 B = -0.0814	I = 2.7261 A = -0.6800 B = -0.0814	I = 2.7261 A = -0.6800 B = -0.0814	I = 2.4417 A = -0.5677	I = 2.7481 A = -0.7299		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a		CAUTION: No holdover time guidelines exist
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 2.1343 A = -0.7329	I = 2.2480 A = -0.9120 B = 0.0000	I = 2.1544 A = -0.7565 B = 0.0000	I = 2.3979 A = -1.0000 B = 0.0000				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 2.1343 A = -0.7329	I = 2.2685 A = -1.1070 B = 0.0000	I = 2.2465 A = -1.0704 B = 0.0000	I = 2.3751 A = -1.1990 B = 0.0000				
below -25 to -30 °C (below -13 to -22 °F)	100/0	I = 2.1343 A = -0.7329	I = 2.1021 A = -1.1696 B = 0.0000	I = 2.1466 A = -1.2435 B = 0.0000	I = 2.4160 A = -1.5129 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*									
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	138.6	237.1	52.3	97.5	221.2	90.4	139.2	48.0	57.0	8.7	125.5
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	50/50	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-8	100/0	103.3	238.4	49.4	92.2	209.1	64.5	110.9	53.4	86.1		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-10 / -14 ***	100/0	103.3	238.4	47.6	88.7	201.2	64.5	110.9	53.4	86.1		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-18	100/0	41.9	82.0	10.0	25.0	65.0						
-25	100/0	41.9	82.0	5.0	15.0	55.0						
-30	100/0	41.9	82.0	2.0	8.0	35.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 4-8: CLARIANT SAFEWING MP IV LAUNCH

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.3942 A = 0.0152	I = 2.7218 A = -0.5330 B = -0.2408	I = 2.7218 A = -0.5330 B = -0.2408	I = 2.7218 A = -0.5330 B = -0.2408	I = 2.7789 A = -0.7426	I = 2.9492 A = -0.8489	I = 2.5170 A = -0.7291	
	75/25	I = 2.4388 A = -0.1431	I = 2.7841 A = -0.6180 B = -0.2044	I = 2.7841 A = -0.6180 B = -0.2044	I = 2.7841 A = -0.6180 B = -0.2044	I = 2.7945 A = -0.7101	I = 2.7548 A = -0.7917	I = 2.6192 A = -0.8499	
	50/50	I = 2.4323 A = -0.7333	I = 2.3978 A = -0.6703 B = -0.1021	I = 2.3978 A = -0.6703 B = -0.1021	I = 2.3978 A = -0.6703 B = -0.1021	I = 2.0818 A = -0.5727	I = 1.7686 A = -0.3607	CAUTION: No holdover time guidelines exist	
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.2823 A = -0.7333	I = 2.7218 A = -0.5330 B = -0.2408	I = 2.7218 A = -0.5330 B = -0.2408	I = 2.7218 A = -0.5330 B = -0.2408	I = 2.7424 A = -1.0767	I = 2.6379 A = -0.8846		
	75/25	I = 2.1203 A = -0.7220	I = 2.7841 A = -0.6180 B = -0.2044	I = 2.7841 A = -0.6180 B = -0.2044	I = 2.7841 A = -0.6180 B = -0.2044	I = 2.6204 A = -1.0940	I = 2.4901 A = -0.7708		
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 1.8894 A = -0.6349	I = 6.5565 A = -1.3090 B = -2.9993	I = 6.5565 A = -1.3090 B = -2.9993	I = 6.5565 A = -1.3090 B = -2.9993				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 1.8894 A = -0.6349	I = 6.5565 A = -1.3090 B = -2.9993	I = 6.5565 A = -1.3090 B = -2.9993	I = 6.5565 A = -1.3090 B = -2.9993				
below -25 to -28.5 °C (below -13 to -19 °F)	100/0	I = 1.8894 A = -0.6349	I = 6.5565 A = -1.3090 B = -2.9993	I = 6.5565 A = -1.3090 B = -2.9993	I = 6.5565 A = -1.3090 B = -2.9993				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*									
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	254.0	250.5	64.3	104.8	199.2	89.5	181.9	57.9	100.8	14.1	101.7
	75/25	218.2	248.7	59.9	105.5	222.0	100.8	198.7	44.5	74.6	10.6	106.0
	50/50	83.1	162.8	24.5	45.3	101.5	27.8	48.0	18.4	23.3		
-8	100/0	58.8	115.2	54.4	88.7	168.5	34.9	97.7	25.2	44.9		
	75/25	41.3	80.0	52.0	91.6	192.7	25.2	71.7	25.9	42.8		
-10 / -14 ***	100/0	58.8	115.2	48.6	79.2	150.5	34.9	97.7	25.2	44.9		
	75/25	41.3	80.0	47.2	83.2	175.0	25.2	71.7	25.9	42.8		
-18	100/0	27.9	49.9	6.7	22.1	107.1						
-25	100/0	27.9	49.9	2.7	9.0	43.5						
-28.5	100/0	27.9	49.9	1.9	6.2	30.2						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 4-9: CLARIANT SAFEWING MP IV LAUNCH PLUS

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.3920 A = -0.0283	I = 3.2161 A = -0.8902 B = -0.3284	I = 3.2161 A = -0.8902 B = -0.3284	I = 3.2161 A = -0.8902 B = -0.3284	I = 2.1074 A = -0.0294	I = 3.1822 A = -0.9927	I = 2.5435 A = -0.6674	
	75/25	I = 2.3948 A = -0.0330	I = 3.2776 A = -0.9501 B = -0.3856	I = 3.2776 A = -0.9501 B = -0.3856	I = 3.2776 A = -0.9501 B = -0.3856	I = 2.0839 A = -0.0124	I = 2.0297 A = -0.0872	I = 2.4962 A = -0.6485	
	50/50	I = 2.1682 A = -0.4153	I = 2.6868 A = -0.8488 B = -0.2819	I = 2.6868 A = -0.8488 B = -0.2819	I = 2.6868 A = -0.8488 B = -0.2819	I = 2.4651 A = -0.9953	I = 1.8233 A = -0.4948		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.4166 A = -0.9721	I = 3.2161 A = -0.8902 B = -0.3284	I = 3.2161 A = -0.8902 B = -0.3284	I = 3.2161 A = -0.8902 B = -0.3284	I = 2.8810 A = -1.3058	I = 2.2126 A = -0.5630		
	75/25	I = 2.4251 A = -1.1486	I = 3.2776 A = -0.9501 B = -0.3856	I = 3.2776 A = -0.9501 B = -0.3856	I = 3.2776 A = -0.9501 B = -0.3856	I = 2.5583 A = -1.0902	I = 2.1385 A = -0.5738	CAUTION: No holdover time guidelines exist	
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 1.9339 A = -0.8158	I = 6.5722 A = -1.2696 B = -3.0196	I = 6.5722 A = -1.2696 B = -3.0196	I = 6.5722 A = -1.2696 B = -3.0196				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 1.9339 A = -0.8158	I = 6.5722 A = -1.2696 B = -3.0196	I = 6.5722 A = -1.2696 B = -3.0196	I = 6.5722 A = -1.2696 B = -3.0196				
below -25 to -29 °C (below -13 to -20 °F)	100/0	I = 1.9339 A = -0.8158	I = 6.5722 A = -1.2696 B = -3.0196	I = 6.5722 A = -1.2696 B = -3.0196	I = 6.5722 A = -1.2696 B = -3.0196				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*									
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	235.6	241.8	55.2	124.8	364.6	118.8	122.1	62.3	119.2	19.6	119.4
	75/25	235.4	242.6	47.9	114.3	358.7	117.5	118.9	80.9	85.6	19.1	110.4
	50/50	75.5	110.5	20.1	43.7	121.6	22.7	58.8	13.5	18.7		
-8	100/0	54.6	133.0	44.0	99.4	290.4	26.7	93.0	26.6	38.5		
	75/25	41.9	120.0	36.6	87.5	274.6	22.1	62.6	21.7	31.6		
-10 / -14 ***	100/0	54.6	133.0	37.7	85.2	248.8	26.7	93.0	26.6	38.5		
	75/25	41.9	120.0	30.6	73.0	229.1	22.1	62.6	21.7	31.6		
-18	100/0	23.1	48.8	7.4	23.7	109.1						
-25	100/0	23.1	48.8	3.0	9.6	44.1						
-29	100/0	23.1	48.8	2.0	6.3	29.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 4-10: CRYOTECH POLAR GUARD® ADVANCE

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.5794 A = -0.5025	I = 2.9600 A = -0.5988 B = -0.4378	I = 2.9600 A = -0.5988 B = -0.4378	I = 2.9600 A = -0.5988 B = -0.4378	I = 2.2682 A = -0.2524	I = 2.2584 A = -0.2806	I = 2.6661 A = -0.7999	
	75/25	I = 2.5776 A = -0.5705	I = 2.9905 A = -0.8191 B = -0.3466	I = 2.9905 A = -0.8191 B = -0.3466	I = 2.9905 A = -0.8191 B = -0.3466	I = 2.2204 A = -0.1898	I = 2.8328 A = -0.8896	I = 2.6248 A = -0.8807	
	50/50	I = 2.1254 A = -0.6271	I = 2.8810 A = -1.0631 B = -0.5673	I = 2.8810 A = -1.0631 B = -0.5673	I = 2.8810 A = -1.0631 B = -0.5673	I = 2.2943 A = -0.9086	I = 2.3695 A = -0.9996		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.5101 A = -1.1145	I = 2.9600 A = -0.5988 B = -0.4378	I = 2.9600 A = -0.5988 B = -0.4378	I = 2.9600 A = -0.5988 B = -0.4378	I = 2.7077 A = -1.0390	I = 2.0801 A = -0.3886		
	75/25	I = 2.2594 A = -0.9785	I = 2.9905 A = -0.8191 B = -0.3466	I = 2.9905 A = -0.8191 B = -0.3466	I = 2.9905 A = -0.8191 B = -0.3466	I = 2.4495 A = -0.9076	I = 2.0483 A = -0.3597	CAUTION: No holdover time guidelines exist	
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 1.9253 A = -0.6979	I = 6.4718 A = -1.1603 B = -2.9134	I = 6.4718 A = -1.1603 B = -2.9134	I = 6.4718 A = -1.1603 B = -2.9134				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 1.9253 A = -0.6979	I = 6.4718 A = -1.1603 B = -2.9134	I = 6.4718 A = -1.1603 B = -2.9134	I = 6.4718 A = -1.1603 B = -2.9134				
below -25 to -30.5 °C (below -13 to -23 °F)	100/0	I = 1.9253 A = -0.6979	I = 2.0544 A = -1.1592 B = 0.0000	I = 2.0544 A = -1.1592 B = 0.0000	I = 2.0544 A = -1.1592 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*									
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	169.1	268.0	65.6	113.6	233.5	97.1	123.5	73.5	88.3	14.7	127.9
	75/25	151.0	254.6	40.1	84.9	227.7	102.1	122.4	38.8	69.5	9.4	102.1
	50/50	48.6	86.4	10.0	26.4	94.9	19.2	45.6	9.4	18.0		
-8	100/0	53.8	149.5	48.4	83.8	172.4	35.5	95.8	34.4	44.4		
	75/25	37.6	92.2	31.5	66.8	179.1	27.4	65.3	35.1	44.4		
-10 / -14 ***	100/0	53.8	149.5	39.4	68.2	140.3	35.5	95.8	34.4	44.4		
	75/25	37.6	92.2	26.8	56.8	152.2	27.4	65.3	35.1	44.4		
-18	100/0	27.4	51.9	11.5	33.2	134.2						
-25	100/0	27.4	51.9	4.8	13.8	56.0						
-30.5	100/0	27.4	51.9	2.7	7.9	31.7						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 4-11: CRYOTECH POLAR GUARD® XTEND

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.5325 A = -0.5036	I = 2.9681 A = -0.6559 B = -0.3399	I = 2.9681 A = -0.6559 B = -0.3399	I = 2.9681 A = -0.6559 B = -0.3399	I = 2.0792 A = 0.0000	I = 3.0299 A = -0.8932	I = 2.4479 A = -0.6234	
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
	50/50	n/a	n/a	n/a	n/a	n/a	n/a		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.2661 A = -0.7204	I = 2.9681 A = -0.6559 B = -0.3399	I = 2.9681 A = -0.6559 B = -0.3399	I = 2.9681 A = -0.6559 B = -0.3399	I = 2.7919 A = -1.1481	I = 1.9558 A = -0.1963		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a		CAUTION: No holdover time guidelines exist
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 1.7603 A = -0.5578	I = 2.3257 A = -1.4094 B = 0.0000	I = 2.2682 A = -1.3140 B = 0.0000	I = 2.5957 A = -1.6415 B = 0.0000				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 1.7603 A = -0.5578	I = 2.4506 A = -2.4094 B = 0.0000	I = 1.7911 A = -1.3140 B = 0.0000	I = 1.6761 A = -1.1990 B = 0.0000				
below -25 to -29 °C (below -13 to -20 °F)	100/0	I = 1.7603 A = -0.5578	I = 1.5915 A = -1.2398 B = 0.0000	I = 1.6682 A = -1.3672 B = 0.0000	I = 6.0834 A = -5.7824 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	151.5	240.4	65.1	118.7	261.6	120.0	120.0	60.4	108.4	19.0	102.8
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	50/50	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-8	100/0	57.9	112.0	51.4	93.8	206.7	32.6	97.6	48.0	54.6		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-10 / -14 ***	100/0	57.9	112.0	43.8	80.0	176.1	32.6	97.6	48.0	54.6		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-18	100/0	23.5	39.1	2.0	9.0	45.0						
-25	100/0	23.5	39.1	1.0	3.0	20.0						
-29	100/0	23.5	39.1	0.0	2.0	10.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 4-12: DOW CHEMICAL UCAR™ ENDURANCE EG106

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.4198 A = -0.4664	I = 2.8358 A = -0.7951 B = -0.1996	I = 2.8358 A = -0.7951 B = -0.1996	I = 2.8358 A = -0.7951 B = -0.1996	I = 2.4460 A = -0.5295	I = 2.5011 A = -0.5672	I = 2.5903 A = -0.7102	
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
	50/50	n/a	n/a	n/a	n/a	n/a	n/a		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.4942 A = -0.6588	I = 2.8358 A = -0.7951 B = -0.1996	I = 2.8358 A = -0.7951 B = -0.1996	I = 2.8358 A = -0.7951 B = -0.1996	I = 2.5065 A = -0.6779	I = 2.6525 A = -0.7145		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a		
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 2.0589 A = -0.7941	I = 3.3185 A = -0.8385 B = -0.6048	I = 3.3185 A = -0.8385 B = -0.6048	I = 3.3185 A = -0.8385 B = -0.6048			CAUTION: No holdover time guidelines exist	
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 2.0589 A = -0.7941	I = 3.3185 A = -0.8385 B = -0.6048	I = 3.3185 A = -0.8385 B = -0.6048	I = 3.3185 A = -0.8385 B = -0.6048				
below -25 to -29 °C (below -13 to -20 °F)	100/0	I = 2.0589 A = -0.7941	I = 3.3185 A = -0.8385 B = -0.6048	I = 3.3185 A = -0.8385 B = -0.6048	I = 3.3185 A = -0.8385 B = -0.6048				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*									
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	124.1	190.3	38.4	79.6	207.5	71.8	119.1	51.1	74.0	18.1	124.1
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	50/50	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-8	100/0	108.1	197.6	33.5	69.4	180.7	56.4	107.8	45.0	71.9		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-10 / -14 ***	100/0	108.1	197.6	30.5	63.1	164.5	56.4	107.8	45.0	71.9		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-18	100/0	31.9	66.0	22.9	49.3	135.4						
-25	100/0	31.9	66.0	19.1	41.1	112.9						
-29	100/0	31.9	66.0	17.6	37.8	103.9						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 4-13: DOW CHEMICAL UCAR™ FLIGHTGUARD AD-49

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.4713 A = -0.2370	I = 3.0052 A = -0.7148 B = -0.3380	I = 3.0052 A = -0.7148 B = -0.3380	I = 3.0052 A = -0.7148 B = -0.3380	I = 2.3729 A = -0.3927	I = 2.4943 A = -0.5000	I = 2.6531 A = -0.8558	
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
	50/50	n/a	n/a	n/a	n/a	n/a	n/a		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.5177 A = -1.7715	I = 3.0052 A = -0.7148 B = -0.3380	I = 3.0052 A = -0.7148 B = -0.3380	I = 3.0052 A = -0.7148 B = -0.3380	I = 2.8172 A = -1.2681	I = 1.9828 A = -0.5016		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a		CAUTION: No holdover time guidelines exist
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 1.7838 A = -0.5976	I = 2.3257 A = -1.4094 B = 0.0000	I = 2.2682 A = -1.3140 B = 0.0000	I = 2.5957 A = -1.6415 B = 0.0000				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 1.7838 A = -0.5976	I = 2.4506 A = -2.4094 B = 0.0000	I = 1.7911 A = -1.3140 B = 0.0000	I = 1.6761 A = -1.1990 B = 0.0000				
below -25 to -26 °C (below -13 to -15 °F)	100/0	I = 1.7838 A = -0.5976	I = 1.5915 A = -1.2398 B = 0.0000	I = 1.6682 A = -1.3672 B = 0.0000	I = 6.0834 A = -5.7824 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	202.1	251.2	58.8	113.3	267.9	86.2	125.4	62.4	86.6	11.2	113.5
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	50/50	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-8	100/0	19.0	96.5	46.6	89.6	211.9	25.4	85.3	19.1	26.5		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-10 / -14 ***	100/0	19.0	96.5	39.7	76.5	180.8	25.4	85.3	19.1	26.5		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-18	100/0	23.2	40.2	2.0	9.0	45.0						
-25	100/0	23.2	40.2	1.0	3.0	20.0						
-26	100/0	23.2	40.2	0.0	2.0	10.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 4-14: INLAND TECHNOLOGIES ECO-SHIELD®

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.4628 A = -0.8425	I = 2.6693 A = -0.6224 B = -0.2015	I = 2.6693 A = -0.6224 B = -0.2015	I = 2.6693 A = -0.6224 B = -0.2015	I = 2.5329 A = -0.8434	I = 1.8305 A = -0.1843	I = 2.4740 A = -0.7236	
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
	50/50	n/a	n/a	n/a	n/a	n/a	n/a		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.4493 A = -0.8541	I = 2.6693 A = -0.6224 B = -0.2015	I = 2.6693 A = -0.6224 B = -0.2015	I = 2.6693 A = -0.6224 B = -0.2015	I = 2.3150 A = -0.5411	I = 1.9809 A = -0.3441		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a		CAUTION: No holdover time guidelines exist
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 1.9894 A = -0.6913	I = 2.3257 A = -1.4094 B = 0.0000	I = 2.2682 A = -1.3140 B = 0.0000	I = 2.5957 A = -1.6415 B = 0.0000				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 1.9894 A = -0.6913	I = 2.4506 A = -2.4094 B = 0.0000	I = 1.7911 A = -1.3140 B = 0.0000	I = 1.6761 A = -1.1990 B = 0.0000				
below -25 to -25.5 °C (below -13 to -14 °F)	100/0	I = 1.9894 A = -0.6913	I = 1.5915 A = -1.2398 B = 0.0000	I = 1.6682 A = -1.3672 B = 0.0000	I = 6.0834 A = -5.7824 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	74.8	161.9	45.5	80.5	170.4	39.2	87.8	37.4	42.2	13.1	92.9
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	50/50	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-8	100/0	71.2	155.7	39.6	70.0	148.2	51.6	86.5	31.6	39.6		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-10 / -14 ***	100/0	71.2	155.7	36.0	63.7	134.8	51.6	86.5	31.6	39.6		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-18	100/0	32.1	60.4	2.0	9.0	45.0						
-25	100/0	32.1	60.4	1.0	3.0	20.0						
-25.5	100/0	32.1	60.4	0.0	2.0	10.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 4-15: KILFROST ABC-S PLUS

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.5882 A = -0.6773	I = 2.7997 A = -0.5886 B = -0.1639	I = 2.7997 A = -0.5886 B = -0.1639	I = 2.7997 A = -0.5886 B = -0.1639	I = 2.1349 A = -0.0810	I = 3.2080 A = -1.0102	I = 2.5437 A = -0.6337	
	75/25	I = 2.4204 A = -0.6975	I = 2.5586 A = -0.5815 B = -0.1638	I = 2.5586 A = -0.5815 B = -0.1638	I = 2.5586 A = -0.5815 B = -0.1638	I = 2.1108 A = -0.2951	I = 2.5019 A = -0.7097	I = 2.4230 A = -0.7288	
	50/50	I = 1.8988 A = -0.5888	I = 2.1742 A = -0.6668 B = 0.0000	I = 2.1742 A = -0.6668 B = 0.0000	I = 2.1742 A = -0.6668 B = 0.0000	I = 2.2203 A = -0.8993	I = 1.7490 A = -0.4516		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.7468 A = -1.4224	I = 2.7997 A = -0.5886 B = -0.1639	I = 2.7997 A = -0.5886 B = -0.1639	I = 2.7997 A = -0.5886 B = -0.1639	I = 2.9992 A = -1.4676	I = 2.3542 A = -0.7931		
	75/25	I = 2.3554 A = -1.0359	I = 2.5586 A = -0.5815 B = -0.1638	I = 2.5586 A = -0.5815 B = -0.1638	I = 2.5586 A = -0.5815 B = -0.1638	I = 2.8273 A = -1.3891	I = 2.1553 A = -0.6538	CAUTION: No holdover time guidelines exist	
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 1.9370 A = -0.5185	I = 2.3257 A = -1.4094 B = 0.0000	I = 2.2682 A = -1.3140 B = 0.0000	I = 2.5957 A = -1.6415 B = 0.0000				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 1.9370 A = -0.5185	I = 2.4506 A = -2.4094 B = 0.0000	I = 1.7911 A = -1.3140 B = 0.0000	I = 1.6761 A = -1.1990 B = 0.0000				
below -25 to -28 °C (below -13 to -18 °F)	100/0	I = 1.9370 A = -0.5185	I = 1.5915 A = -1.2398 B = 0.0000	I = 1.6682 A = -1.3672 B = 0.0000	I = 6.0834 A = -5.7824 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	130.3	242.3	72.8	124.9	253.7	110.8	119.8	62.5	121.0	22.7	126.1
	75/25	85.7	162.3	42.8	72.9	146.8	60.5	80.3	32.3	51.4	11.4	82.0
	50/50	30.7	52.7	17.5	32.2	71.8	16.5	39.1	13.1	17.6		
-8	100/0	56.6	208.3	65.0	111.5	226.4	23.1	94.1	17.6	29.6		
	75/25	42.8	110.6	38.2	65.1	131.0	19.1	71.8	17.4	26.7		
-10 / -14 ***	100/0	56.6	208.3	60.2	103.2	209.7	23.1	94.1	17.6	29.6		
	75/25	42.8	110.6	35.4	60.2	121.3	19.1	71.8	17.4	26.7		
-18	100/0	37.5	60.4	2.0	9.0	45.0						
-25	100/0	37.5	60.4	1.0	3.0	20.0						
-28	100/0	37.5	60.4	0.0	2.0	10.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 4-16: LNT SOLUTIONS E450

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.3993 A = -0.5014	I = 2.6188 A = -0.4800 B = -0.2407	I = 2.6188 A = -0.4800 B = -0.2407	I = 2.6188 A = -0.4800 B = -0.2407	I = 2.2934 A = -0.2865	I = 2.4233 A = -0.4763	I = 2.5400 A = -0.6311	
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
	50/50	n/a	n/a	n/a	n/a	n/a	n/a		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.6898 A = -1.0623	I = 2.6188 A = -0.4800 B = -0.2407	I = 2.6188 A = -0.4800 B = -0.2407	I = 2.6188 A = -0.4800 B = -0.2407	I = 2.2217 A = -0.1785	I = 2.7806 A = -0.6994		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a		
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 2.0571 A = -0.7805	I = 6.0090 A = -1.2021 B = -2.3077	I = 6.0090 A = -1.2021 B = -2.3077	I = 6.0090 A = -1.2021 B = -2.3077			CAUTION: No holdover time guidelines exist	
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 2.0571 A = -0.7805	I = 6.0090 A = -1.2021 B = -2.3077	I = 6.0090 A = -1.2021 B = -2.3077	I = 6.0090 A = -1.2021 B = -2.3077				
below -25 to -32.5 °C (below -13 to -27 °F)	100/0	I = 2.0842 A = -1.0003	I = 2.3461 A = -1.2022 B = 0.0000	I = 2.3461 A = -1.2022 B = 0.0000	I = 2.3461 A = -1.2022 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	111.9	177.2	60.2	93.4	166.5	94.2	123.9	57.2	78.1	22.7	125.6
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	50/50	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-8	100/0	88.6	234.4	50.9	79.1	141.0	105.4	125.0	63.5	100.3		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-10 / -14 ***	100/0	88.6	234.4	45.5	70.6	125.9	105.4	125.0	63.5	100.3		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-18	100/0	32.5	66.4	21.2	63.8	271.1						
-25	100/0	32.5	66.4	10.6	31.9	135.6						
-32.5	100/0	24.3	60.7	4.6	13.9	59.2						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 4-17: NEWAVE AEROCHEMICAL FCY 9311

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.6186 A = -0.7874	I = 2.8340 A = -0.7480 B = -0.3361	I = 2.8340 A = -0.7480 B = -0.3361	I = 2.8340 A = -0.7480 B = -0.3361	I = 2.5218 A = -0.6026	I = 2.7035 A = -0.8019	I = 2.4128 A = -0.6988	
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
	50/50	n/a	n/a	n/a	n/a	n/a	n/a		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.4840 A = -1.3099	I = 2.8340 A = -0.7480 B = -0.3361	I = 2.8340 A = -0.7480 B = -0.3361	I = 2.8340 A = -0.7480 B = -0.3361	I = 2.4894 A = -0.8313	I = 2.3272 A = -0.7195		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a		CAUTION: No holdover time guidelines exist
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 1.9261 A = -0.6637	I = 2.3257 A = -1.4094 B = 0.0000	I = 2.2682 A = -1.3140 B = 0.0000	I = 2.5957 A = -1.6415 B = 0.0000				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 1.9261 A = -0.6637	I = 2.4506 A = -2.4094 B = 0.0000	I = 1.7911 A = -1.3140 B = 0.0000	I = 1.6761 A = -1.1990 B = 0.0000				
below -25 to -29.5 °C (below -13 to -21 °F)	100/0	I = 1.9261 A = -0.6637	I = 1.5915 A = -1.2398 B = 0.0000	I = 1.6682 A = -1.3672 B = 0.0000	I = 6.0834 A = -5.7824 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	117.0	240.8	35.8	71.0	174.7	70.9	126.1	38.2	64.6	12.7	84.0
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	50/50	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-8	100/0	37.0	122.9	28.3	56.2	138.4	36.6	81.0	21.0	33.6		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-10 / -14 ***	100/0	37.0	122.9	24.2	48.0	118.1	36.6	81.0	21.0	33.6		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-18	100/0	29.0	53.2	2.0	9.0	45.0						
-25	100/0	29.0	53.2	1.0	3.0	20.0						
-29.5	100/0	29.0	53.2	0.0	2.0	10.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 4-18: OKSAYD DEFROST ECO 4

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.4080 A = -0.6597	I = 2.7595 A = -0.7621 B = -0.1757	I = 2.7595 A = -0.7621 B = -0.1757	I = 2.7595 A = -0.7621 B = -0.1757	I = 2.1497 A = -0.2970	I = 2.5972 A = -0.7187	I = 2.2932 A = -0.6241	
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
	50/50	n/a	n/a	n/a	n/a	n/a	n/a		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.5248 A = -1.1145	I = 2.7595 A = -0.7621 B = -0.1757	I = 2.7595 A = -0.7621 B = -0.1757	I = 2.7595 A = -0.7621 B = -0.1757	I = 2.2310 A = -0.4646	I = 2.2288 A = -0.4780		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a		CAUTION: No holdover time guidelines exist
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 1.8711 A = -0.5814	I = 2.3257 A = -1.4094 B = 0.0000	I = 2.2682 A = -1.3140 B = 0.0000	I = 2.5957 A = -1.6415 B = 0.0000				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 1.8711 A = -0.5814	I = 2.4506 A = -2.4094 B = 0.0000	I = 1.7911 A = -1.3140 B = 0.0000	I = 1.6761 A = -1.1990 B = 0.0000				
below -25 to -25.5 °C (below -13 to -14 °F)	100/0	I = 1.8711 A = -0.5814	I = 1.5915 A = -1.2398 B = 0.0000	I = 1.6682 A = -1.3672 B = 0.0000	I = 6.0834 A = -5.7824 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	88.5	162.0	37.3	74.9	187.5	65.9	87.5	39.1	62.6	13.3	71.9
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	50/50	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-8	100/0	55.7	154.6	33.0	66.3	166.0	51.7	80.6	36.4	49.7		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-10 / -14 ***	100/0	55.7	154.6	30.4	61.1	152.9	51.7	80.6	36.4	49.7		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-18	100/0	29.2	49.7	2.0	9.0	45.0						
-25	100/0	29.2	49.7	1.0	3.0	20.0						
-25.5	100/0	29.2	49.7	0.0	2.0	10.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 4-19: OKSAYD DEFROST EG 4

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.5056 A = -0.4182	I = 2.8844 A = -0.5813 B = -0.1986	I = 2.8844 A = -0.5813 B = -0.1986	I = 2.8844 A = -0.5813 B = -0.1986	I = 2.0792 A = 0.0000	I = 3.0138 A = -0.8899	I = 2.5585 A = -0.6856	
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
	50/50	n/a	n/a	n/a	n/a	n/a	n/a		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.5610 A = -0.6008	I = 2.8844 A = -0.5813 B = -0.1986	I = 2.8844 A = -0.5813 B = -0.1986	I = 2.8844 A = -0.5813 B = -0.1986	I = 2.6052 A = -0.7526	I = 2.5942 A = -0.4974		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a		CAUTION: No holdover time guidelines exist
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 2.5376 A = -1.2454	I = 2.2480 A = -0.9120 B = 0.0000	I = 2.1544 A = -0.7565 B = 0.0000	I = 2.3979 A = -1.0000 B = 0.0000				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 2.5376 A = -1.2454	I = 2.2685 A = -1.1070 B = 0.0000	I = 2.2465 A = -1.0704 B = 0.0000	I = 2.3751 A = -1.1990 B = 0.0000				
below -25 to -26 °C (below -13 to -15 °F)	100/0	I = 2.5376 A = -1.2454	I = 2.1021 A = -1.1696 B = 0.0000	I = 2.1466 A = -1.2435 B = 0.0000	I = 2.4160 A = -1.5129 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	163.4	239.7	85.7	146.0	293.9	120.0	120.0	58.9	105.3	18.7	120.0
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	50/50	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-8	100/0	138.4	240.0	74.7	127.2	256.1	58.5	120.0	79.2	109.7		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-10 / -14 ***	100/0	138.4	240.0	68.0	115.9	233.3	58.5	120.0	79.2	109.7		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-18	100/0	46.5	145.4	10.0	25.0	65.0						
-25	100/0	46.5	145.4	5.0	15.0	55.0						
-26	100/0	46.5	145.4	2.0	8.0	35.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 4-20: SHAANXI CLEANWAY AVIATION CLEANSURFACE IV

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.5037 A = -0.3903	I = 3.3279 A = -0.6974 B = -0.8278	I = 3.3279 A = -0.6974 B = -0.8278	I = 3.3279 A = -0.6974 B = -0.8278	I = 2.2230 A = -0.1299	I = 1.9595 A = -0.0138	I = 2.7249 A = -0.8143	
	75/25	I = 2.5266 A = -0.4875	I = 3.2662 A = -0.8594 B = -0.6150	I = 3.2662 A = -0.8594 B = -0.6150	I = 3.2662 A = -0.8594 B = -0.6150	I = 2.7184 A = -0.9235	I = 1.9155 A = -0.2570	I = 2.4087 A = -0.7760	
	50/50	I = 2.4207 A = -0.8825	I = 2.9686 A = -1.0764 B = -0.4446	I = 2.9686 A = -1.0764 B = -0.4446	I = 2.9686 A = -1.0764 B = -0.4446	I = 2.2650 A = -0.7956	I = 1.7827 A = -0.4609		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.6480 A = -1.2687	I = 3.3279 A = -0.6974 B = -0.8278	I = 3.3279 A = -0.6974 B = -0.8278	I = 3.3279 A = -0.6974 B = -0.8278	I = 2.7839 A = -1.1024	I = 2.4424 A = -0.8195		
	75/25	I = 2.3477 A = -0.9386	I = 3.2662 A = -0.8594 B = -0.6150	I = 3.2662 A = -0.8594 B = -0.6150	I = 3.2662 A = -0.8594 B = -0.6150	I = 2.5842 A = -0.9804	I = 2.3692 A = -0.6948		CAUTION: No holdover time guidelines exist
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 1.9241 A = -0.6900	I = 2.3257 A = -1.4094 B = 0.0000	I = 2.2682 A = -1.3140 B = 0.0000	I = 2.5957 A = -1.6415 B = 0.0000				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 1.9241 A = -0.6900	I = 2.4506 A = -2.4094 B = 0.0000	I = 1.7911 A = -1.3140 B = 0.0000	I = 1.6761 A = -1.1990 B = 0.0000				
below -25 to -28.5 °C (below -13 to -19 °F)	100/0	I = 1.9241 A = -0.6900	I = 1.5915 A = -1.2398 B = 0.0000	I = 1.6682 A = -1.3672 B = 0.0000	I = 6.0834 A = -5.7824 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*									
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	170.2	243.3	59.5	112.7	260.9	119.8	135.6	87.1	87.9	15.8	143.1
	75/25	153.4	239.8	43.1	94.8	266.9	48.9	118.3	36.0	42.6	9.0	73.5
	50/50	63.7	142.9	14.2	38.1	139.4	23.9	51.2	13.8	18.6		
-8	100/0	57.7	184.5	33.5	63.5	147.0	36.0	103.1	19.8	33.8		
	75/25	49.2	116.2	28.2	61.9	174.2	31.1	79.2	25.0	39.4		
-10 / -14 ***	100/0	57.7	184.5	22.7	43.0	99.6	36.0	103.1	19.8	33.8		
	75/25	49.2	116.2	21.1	46.4	130.5	31.1	79.2	25.0	39.4		
-18	100/0	27.7	52.0	2.0	9.0	45.0						
-25	100/0	27.7	52.0	1.0	3.0	20.0						
-28.5	100/0	27.7	52.0	0.0	2.0	10.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 4-21: TYPE IV GENERIC

VERIFICATION TABLE

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	3	13	5	25	13	75	5
+1 / -3 *	100/0	74.8	161.9	33.2	71.0	166.5	39.2	87.5	25.6	39.9	8.7	71.9
	75/25	85.7	162.3	40.1	72.9	146.8	48.9	80.3	32.3	42.6	9.0	73.5
	50/50	30.7	52.7	10.0	26.4	71.8	16.5	39.1	9.4	17.6		
-8	100/0	19.0	96.5	28.3	56.2	138.4	23.1	80.6	17.6	26.5		
	75/25	28.4	80.0	28.2	61.9	131.0	19.1	62.6	17.4	26.7		
-10 / -14 **	100/0	19.0	96.5	22.7	43.0	99.6	23.1	80.6	17.6	26.5		
	75/25	28.4	80.0	21.1	46.4	117.6	19.1	62.6	17.4	26.7		
-18	100/0	21.4	39.1	2.0	9.0	45.0						
-25	100/0	21.4	39.1	1.0	3.0	20.0						

* Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C

** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 5: LOWEST USABLE PRECIPITATION RATES IN SNOW[1]

TYPE II, TYPE III AND TYPE IV FLUIDS[2]

Type II De/Anti-Icing Fluids				
FLUID DILUTION	100/0		75/25	50/50
TEMPERATURE	*-14°C AND ABOVE*	*BELOW -14°C*	*-14°C AND ABOVE*	*-3°C AND ABOVE*
ABAX ECOWING 26	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h
ABAX ECOWING AD-2	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h
Aviation Shaanxi Hi-Tech Cleanwing II	3 g/dm²/h	10 g/dm²/h	3 g/dm²/h	7 g/dm²/h
Beijing Yadilite Aviation YD-102 Type II	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h
Clariant Safewing MP II FLIGHT	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h
Clariant Safewing MP II FLIGHT PLUS	4 g/dm²/h	10 g/dm²/h	3 g/dm²/h	4 g/dm²/h
Cryotech Polar Guard® II	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h
Kilfrost ABC-K Plus	3 g/dm²/h	10 g/dm²/h	4 g/dm²/h	3 g/dm²/h
Kilfrost Ice Clear II	3 g/dm²/h	3 g/dm²/h	not applicable	not applicable
Newave Aerochemical FCY-2	3 g/dm²/h	10 g/dm²/h	3 g/dm²/h	3 g/dm²/h
Newave Aerochemical FCY-2 Bio+	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h
Oksayd Defrost PG 2	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h
ROMCHIM ADD-PROTECT Type II	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h

Type III De/Anti-Icing Fluids				
FLUID DILUTION	100/0		75/25	50/50
TEMPERATURE	*-25°C AND ABOVE*	*BELOW -25°C*	*-10°C AND ABOVE*	*-3°C AND ABOVE*
AllClear AeroClear MAX	3 g/dm²/h	3 g/dm²/h	not applicable	not applicable

1 The lowest precipitation rate to be used as an input to the snow regression equations is constrained by the higher of: (1) the minimum demonstrated precipitation measuring equipment rates in accordance with the Transport Canada exemption document (in no case less than 2.0 g/dm²/h) or (2) the lowest usable precipitation rate (LUPR) for the fluid/dilution/temperature as defined in this table.

2 Type I fluids are limited only by the general precipitation rate limitations set out in the exemption document.

Table 5: Lowest Usable Precipitation Rates in Snow[1] (cont'd)

TYPE II, TYPE III AND TYPE IV FLUIDS[2]

Type IV De/Anti-Icing Fluids				
FLUID DILUTION	**100/0**		**75/25**	**50/50**
TEMPERATURE	***-14°C AND ABOVE***	***BELOW -14°C***	***-14°C AND ABOVE***	***-3°C AND ABOVE***
ABAX ECOWING AD-49	3 g/dm²/h	3 g/dm²/h	not applicable	not applicable
AllClear ClearWing EG	3 g/dm²/h	3 g/dm²/h	not applicable	not applicable
CHEMCO ChemR EG IV	3 g/dm²/h	3 g/dm²/h	not applicable	not applicable
Clariant Max Flight 04	3 g/dm²/h	3 g/dm²/h	not applicable	not applicable
Clariant Max Flight AVIA	3 g/dm²/h	3 g/dm²/h	not applicable	not applicable
Clariant Max Flight SNEG	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h
Clariant Safewing EG IV NORTH	3 g/dm²/h	3 g/dm²/h	not applicable	not applicable
Clariant Safewing MP IV LAUNCH	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h
Clariant Safewing MP IV LAUNCH PLUS	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h
Cryotech Polar Guard® Advance	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h
Cryotech Polar Guard® Xtend	3 g/dm²/h	3 g/dm²/h	not applicable	not applicable
Dow UCAR Endurance EG106	3 g/dm²/h	3 g/dm²/h	not applicable	not applicable
Dow UCAR FlightGuard AD-49	3 g/dm²/h	3 g/dm²/h	not applicable	not applicable
Inland Technologies ECO-SHIELD®	3 g/dm²/h	3 g/dm²/h	not applicable	not applicable
Kilfrost ABC-S Plus	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h
LNT Solutions E450	3 g/dm²/h	3 g/dm²/h	not applicable	not applicable
Newave Aerochemical FCY 9311	3 g/dm²/h	3 g/dm²/h	not applicable	not applicable
Oksayd Defrost ECO 4	3 g/dm²/h	3 g/dm²/h	not applicable	not applicable
Oksayd Defrost EG 4	3 g/dm²/h	3 g/dm²/h	not applicable	not applicable
Shaanxi Cleanway Cleansurface IV	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h

1 The lowest precipitation rate to be used as an input to the snow regression equations is constrained by the higher of: (1) the minimum demonstrated precipitation measuring equipment rates in accordance with the Transport Canada exemption document (in no case less than 2.0 g/dm²/h) or (2) the lowest usable precipitation rate (LUPR) for the fluid/dilution/temperature as defined in this table.

2 Type I fluids are limited only by the general precipitation rate limitations set out in the exemption document.

TABLE 6: HIGHEST USABLE PRECIPITATION RATES IN SNOW[1]

TYPE II, TYPE III AND TYPE IV FLUIDS[2]

Type II De/Anti-Icing Fluids				
FLUID DILUTION	100/0		75/25	50/50
TEMPERATURE	*-14°C AND ABOVE*	*BELOW -14°C*	*-14°C AND ABOVE*	*-3°C AND ABOVE*
ABAX ECOWING 26	50 g/dm²/h	25 g/dm²/h	50 g/dm²/h	50 g/dm²/h
ABAX ECOWING AD-2	50 g/dm²/h	25 g/dm²/h	50 g/dm²/h	50 g/dm²/h
Aviation Shaanxi Hi-Tech Cleanwing II	50 g/dm²/h	25 g/dm²/h	50 g/dm²/h	50 g/dm²/h
Beijing Yadilite Aviation YD-102 Type II	50 g/dm²/h	25 g/dm²/h	50 g/dm²/h	50 g/dm²/h
Clariant Safewing MP II FLIGHT	50 g/dm²/h	25 g/dm²/h	50 g/dm²/h	40 g/dm²/h
Clariant Safewing MP II FLIGHT PLUS	50 g/dm²/h	25 g/dm²/h	50 g/dm²/h	40 g/dm²/h
Cryotech Polar Guard® II	50 g/dm²/h	25 g/dm²/h	50 g/dm²/h	50 g/dm²/h
Kilfrost ABC-K Plus	50 g/dm²/h	25 g/dm²/h	50 g/dm²/h	25 g/dm²/h
Kilfrost Ice Clear II	50 g/dm²/h	25 g/dm²/h	not applicable	not applicable
Newave Aerochemical FCY-2	50 g/dm²/h	25 g/dm²/h	50 g/dm²/h	50 g/dm²/h
Newave Aerochemical FCY-2 Bio+	50 g/dm²/h	25 g/dm²/h	50 g/dm²/h	50 g/dm²/h
Oksayd Defrost PG 2	50 g/dm²/h	25 g/dm²/h	50 g/dm²/h	50 g/dm²/h
ROMCHIM ADD-PROTECT Type II	50 g/dm²/h	25 g/dm²/h	50 g/dm²/h	50 g/dm²/h

Type III De/Anti-Icing Fluids				
FLUID DILUTION	100/0		75/25	50/50
TEMPERATURE	*-25°C AND ABOVE*	*BELOW -25°C*	*-10°C AND ABOVE*	*-3°C AND ABOVE*
AllClear AeroClear MAX	50 g/dm²/h	25 g/dm²/h	not applicable	not applicable

1 The highest precipitation rate to be used as an input to the snow regression equations is constrained by the lower of: (1) the maximum allowable precipitation rate for snow specified in the Transport Canada exemption document (50 g/dm²/h) or (2) the highest usable precipitation rate (HUPR) for the fluid/dilution/temperature as defined in this table.

2 Type I fluids are limited only by the general precipitation rate limitations set out in the exemption document.

TABLE 6: HIGHEST USABLE PRECIPITATION RATES IN SNOW[1] (cont'd)

TYPE II, TYPE III AND TYPE IV FLUIDS[2]

Type IV De/Anti-Icing Fluids				
FLUID DILUTION	100/0		75/25	50/50
TEMPERATURE	*-14°C AND ABOVE*	*BELOW -14°C*	*-14°C AND ABOVE*	*-3°C AND ABOVE*
ABAX ECOWING AD-49	50 g/dm²/h	25 g/dm²/h	not applicable	not applicable
AllClear ClearWing EG	50 g/dm²/h	25 g/dm²/h	not applicable	not applicable
CHEMCO ChemR EG IV	50 g/dm²/h	25 g/dm²/h	not applicable	not applicable
Clariant Max Flight 04	50 g/dm²/h	25 g/dm²/h	not applicable	not applicable
Clariant Max Flight AVIA	50 g/dm²/h	25 g/dm²/h	not applicable	not applicable
Clariant Max Flight SNEG	50 g/dm²/h	25 g/dm²/h	50 g/dm²/h	50 g/dm²/h
Clariant Safewing EG IV NORTH	50 g/dm²/h	25 g/dm²/h	not applicable	not applicable
Clariant Safewing MP IV LAUNCH	50 g/dm²/h	25 g/dm²/h	50 g/dm²/h	50 g/dm²/h
Clariant Safewing MP IV LAUNCH PLUS	50 g/dm²/h	25 g/dm²/h	50 g/dm²/h	50 g/dm²/h
Cryotech Polar Guard® Advance	50 g/dm²/h	25 g/dm²/h	50 g/dm²/h	50 g/dm²/h
Cryotech Polar Guard® Xtend	50 g/dm²/h	25 g/dm²/h	not applicable	not applicable
Dow UCAR Endurance EG106	50 g/dm²/h	25 g/dm²/h	not applicable	not applicable
Dow UCAR FlightGuard AD-49	50 g/dm²/h	25 g/dm²/h	not applicable	not applicable
Inland Technologies ECO-SHIELD®	50 g/dm²/h	25 g/dm²/h	not applicable	not applicable
Kilfrost ABC-S Plus	50 g/dm²/h	25 g/dm²/h	50 g/dm²/h	50 g/dm²/h
LNT Solutions E450	50 g/dm²/h	25 g/dm²/h	not applicable	not applicable
Newave Aerochemical FCY 9311	50 g/dm²/h	25 g/dm²/h	not applicable	not applicable
Oksayd Defrost ECO 4	50 g/dm²/h	25 g/dm²/h	not applicable	not applicable
Oksayd Defrost EG 4	50 g/dm²/h	25 g/dm²/h	not applicable	not applicable
Shaanxi Cleanway Cleansurface IV	50 g/dm²/h	25 g/dm²/h	50 g/dm²/h	50 g/dm²/h

1 The highest precipitation rate to be used as an input to the snow regression equations is constrained by the lower of: (1) the maximum allowable precipitation rate for snow specified in the Transport Canada exemption document (50 g/dm²/h) or (2) the highest usable precipitation rate (HUPR) for the fluid/dilution/temperature as defined in this table.

2 Type I fluids are limited only by the general precipitation rate limitations set out in the exemption document.

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WINTER 2019-2020

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REGRESSION INFORMATION

WINTER 2019-2020

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The content of this document is the official FAA winter 2019-2020 holdover time guidelines regression information.

Questions concerning FAA aircraft ground de/anti-icing requirements or Flight Standards policies should be addressed to charles.j.enders@faa.gov or 202-267-4557.

Questions on the technical content of the holdover time tables or regression information should be addressed to warren.underwood@faa.gov or 404-305-7267.

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TABLE OF CONTENTS

Change Control Records 2
Table of Contents 3
List of Tables 4
Highlights and Changes for Winter 2019-2020 5
Guidance for Using Regression Information 6
Regression Information Tables for Winter 2019-2020 9

LIST OF TABLES

Table 1-1: Generic Type I (Aluminum Wing Surfaces) 10
Table 1-2: Generic Type I (Composite Wing Surfaces) 11
Table 2-1: ABAX ECOWING 26 12
Table 2-2: ABAX ECOWING AD-2 13
Table 2-3: Aviation Shaanxi Hi-Tech Cleanwing II 14
Table 2-4: Beijing Yadilite Aviation YD-102 Type II 15
Table 2-5: Clariant Safewing MP II FLIGHT 16
Table 2-6: Clariant Safewing MP II FLIGHT PLUS 17
Table 2-7: Cryotech Polar Guard® II 18
Table 2-8: Kilfrost ABC-K Plus 19
Table 2-9: Kilfrost Ice Clear II 20
Table 2-10: Newave Aerochemical FCY-2 21
Table 2-11: Newave Aerochemical FCY-2 Bio+ 22
Table 2-12: Oksayd Defrost PG 2 23
Table 2-13: ROMCHIM ADD-PROTECT Type II 24
Table 2-14: Type II Generic 25
Table 3-1: AllClear AeroClear MAX, Applied Unheated on Low Speed Aircraft 26
Table 3-2: AllClear AeroClear MAX, Applied Unheated on High Speed Aircraft 27
Table 4-1: ABAX ECOWING AD-49 28
Table 4-2: AllClear ClearWing EG 29
Table 4-3: CHEMCO ChemR EG IV 30
Table 4-4: Clariant Max Flight 04 31
Table 4-5: Clariant Max Flight AVIA 32
Table 4-6: Clariant Max Flight SNEG 33
Table 4-7: Clariant Safewing EG IV NORTH 34
Table 4-8: Clariant Safewing MP IV LAUNCH 35
Table 4-9: Clariant Safewing MP IV LAUNCH PLUS 36
Table 4-10: Cryotech Polar Guard® Advance 37
Table 4-11: Cryotech Polar Guard® Xtend 38
Table 4-12: Dow Chemical UCAR™ Endurance EG106 39
Table 4-13: Dow Chemical UCAR™ FlightGuard AD-49 40
Table 4-14: Inland Technologies ECO-SHIELD® 41
Table 4-15: Kilfrost ABC-S Plus 42
Table 4-16: LNT Solutions E450 43
Table 4-17: Newave Aerochemical FCY 9311 44
Table 4-18: Oksayd Defrost ECO 4 45
Table 4-19: Oksayd Defrost EG 4 46
Table 4-20: Shaanxi Cleanway Aviation Cleansurface IV 47
Table 4-21: Type IV Generic 48
Table 5: Lowest Usable Precipitation Rates in Snow 49
Table 6: Highest Usable Precipitation Rates in Snow 51

HIGHLIGHTS AND CHANGES FOR WINTER 2019-2020

The principal changes from the previous year are briefly indicated herein.

Type I Fluid

- The Type I regression coefficients are unchanged.

Type II Fluid

- A regression coefficients table and verification table have been added for ROMCHIM ADD-PROTECT TYPE II, a new Type II fluid added to the holdover time (HOT) guidelines for winter 2019-2020.
- Snow holdover times at temperatures below -14°C have been updated for all Type II fluids that have not undergone fluid-specific very cold snow testing. The associated regression coefficients have been updated.
- Several changes were made to the Type II generic holdover times for winter 2019-2020. The Type II generic verification table has been updated accordingly.

Type III Fluid

- The Type III regression coefficients are unchanged.

Type IV Fluid

- Regression coefficients tables and verification tables have been added for two new Type IV fluids added to the HOT guidelines for winter 2019-2020: AllClear Clearwing EG and Cryotech Polar Guard® Xtend.
- Snow holdover times at temperatures below -14°C have been updated for all Type IV fluids that have not undergone fluid-specific very cold snow testing. The associated regression coefficients have been updated accordingly.
- Supplemental testing with LNT Solutions E450 (100/0) resulted in a change to its LOUT (decreased from -22.5°C to -32.5°C) and to some of its holdover times at colder temperatures. Changes have been made to this fluid's regression coefficients and verification tables accordingly.
- Several changes were made to the Type IV generic holdover times for winter 2019-2020. The Type IV generic verification table has been updated accordingly.

Guidance

- Minor changes have been made to the guidance section.

GUIDANCE FOR USING REGRESSION INFORMATION

In recent years, several companies have been developing systems that measure precipitation rate in real-time. These systems, referred to as liquid water equivalent systems (LWES), can be used by check-time determination systems (CTDS) and holdover time determination systems (HOTDS) to calculate more precise holdover times than can be obtained from the holdover time guidelines. They do this using the weather data they collect and the regression information underlying the holdover time guidelines.

As a result of the development of LWES, CTDS and HOTDS, the FAA is making the regression coefficients and equations underlying the holdover time tables available to users. The purpose of this document is to provide the holdover time guidelines regression information for the 2019-2020 holdover time guidelines and to provide guidance on its usage.

The sources of the regression data, along with a history of the publication of regression information, are documented in the Transport Canada report, *Regression Coefficients and Equations Used to Develop the Winter 2019-20 Aircraft Ground Deicing Holdover Time Tables*. This document can be referenced for further information if required.

Use of these systems is authorized through the FAA Advisory Circular (AC) 120-112 *Use of Liquid Water Equivalent System (LWES) to Determine Holdover Times or Check Times for Anti-icing Fluids* (latest version). Throughout this document, AC 120-112 is referred as the FAA LWES AC. For further information contact AFS-220 Ground Deicing Focal Charles J. Enders, phone 202-267-4557, email charles.j.enders@faa.gov.

Interpreting Regression Coefficients Tables

Regression information is provided in this document in a series of regression coefficients tables. Each regression coefficients table shows the regression coefficients and equations that are to be used to calculate holdover times at specific outside air temperatures, under specific precipitation types, with specific fluid dilutions (as applicable for Type II/III/IV fluids).

Each regression coefficients table is presented in the format of its corresponding holdover time table. (One exception is the Type II and Type IV regression coefficients tables, which have a single temperature band (below -3 to -14°C) which provides the regression coefficients for both the below -3 to -8°C and below -8 to -14°C temperature bands in the Type II and Type IV holdover time tables.) A footnote is provided at the top of each column to indicate the form of the regression equation for the cells in that column. The regression coefficients required for the equation are given in the corresponding cells below.

The coefficients provided in each table cell are valid only for the conditions (temperature, precipitation type, fluid dilution) of that cell. In cells where no temperature coefficient (coefficient “B”) is provided, temperature is not an input into the equation.

Applicability of Regression Coefficients Tables

The Type I generic regression coefficients tables are applicable for all Type I fluids. Fluid-specific regression coefficients tables are available and applicable for all Type II, Type III, and Type IV fluids. If the specific fluid being used is not known, the methodology for calculating Type II or Type IV generic holdover times must be followed (see next page).

To use the regression information provided in this document to obtain holdover times that are valid for operations in which flaps/slats are deployed prior to de/anti-icing: use the regression information applicable to the fluid and weather condition and multiply the result obtained by 76%.

Calculating Type II and Type IV Generic Holdover Times

Generic Type II and Type IV holdover times are used when a flight crew is unaware of the specific fluid that has been used to de/anti-ice their aircraft. The generic values represent the shortest possible holdover time of either

all Type II or all Type IV fluids available. The following methodologies must be applied to CTDS/HOTDS programming to enable the systems to determine generic Type II and Type IV holdover times.

Type II: To calculate Type II generic holdover times, the CTDS/HOTDS must be programmed to calculate the holdover time for each Type II fluid on the FAA list of fluids tested for anti-icing performance and aerodynamic acceptance and return the shortest holdover time calculated. This is the generic Type II holdover time.

Type IV: To calculate Type IV generic holdover times, the CTDS/HOTDS must be programmed to calculate the holdover time for each Type IV fluid on the FAA list of fluids tested for anti-icing performance and aerodynamic acceptance and return the shortest holdover time calculated. This is the generic Type IV holdover time.

Verification Tables

Verification tables are provided for each of the regression coefficients tables and also for the generic Type II and generic Type IV holdover times. Each verification table provides verification values for select boundary conditions in the associated holdover time table. For Type II, III and IV fluids, the verification tables also include verification values for the lowest usable precipitation rate in snow.

NOTE: CTDS/HOTDS manufacturers may find it useful to use these verification tables as an aid in verifying the implementation of their software algorithms. However, CTDS/HOTDS manufacturers are cautioned that these tables are not all encompassing and that they must develop comprehensive verification and validation methods to ensure the adequacy of their software algorithms.

Lowest and Highest Usable Precipitation Rates in Snow (Table 5 and Table 6)

Snow test data for some fluids is not sufficient to support extrapolation of the regression curves to very low and/or very high rates of precipitation. The lowest usable precipitation rates (LUPRs) and highest usable precipitation rates (HUPRs) in snow have been identified and are included in Table 5 (LUPRs) and Table 6 (HUPRs) for Type II, III and IV fluids (Type I fluids are not affected). The LUPRs and HUPRs differ by fluid brand, fluid dilution and temperature.

NOTE: At this time LUPRs and HUPRs are provided for snow only; LUPRs and HUPRs are not provided for any other precipitation type. The lowest and highest precipitation rates that can be used in other precipitation types are specified in the FAA LWES AC.

Limitations of Regression Information

Users are cautioned that care must be taken in the application of the regression information. There are a number of rules, exceptions and cautions detailed in this document, the holdover time guidelines, and the FAA LWES AC that must be considered.

Several limitations on the usage of the regression information are listed below.

- The regression coefficients can only be used with liquid water equivalent information that is provided by a CTDS or HOTDS in accordance with the FAA LWES AC.
- Regression equations which include a temperature coefficient cannot be populated with temperature data greater than or equal to 2°C. This is a limitation of the form of the equation. The FAA LWES AC instructs that 0°C be input into the equation when temperature is above 0°C.
- Regression data is developed for specific fluid dilutions. The data cannot be interpolated to determine holdover times for use with dilutions other than the standard 100/0, 75/25 and 50/50 mixtures.
- The regression coefficients are based on best-fit power-law curves and the shape of these curves can result in extreme values outside the precipitation rate limits at which endurance time tests are conducted. Therefore, these values are not necessarily accurate. Caution must therefore be exercised when using

the regression equations to calculate holdover times outside of the precipitation rate limits used in the development of holdover time tables, especially at precipitation rates below the lower precipitation rate limit, where the power-law curves give much longer holdover times.

- The lowest precipitation rate to be used as an input to the snow regression equations (this does not apply to other precipitation types) is constrained by the higher of the following:

    1. Minimum demonstrated precipitation measuring equipment rates in accordance with the FAA LWES AC (which shall not be less than 2.0 g/dm²/h); and

    2. Lowest usable precipitation rate (LUPR) for each fluid/dilution/temperature as defined in Table 5 of this document. The LUPR is the lowest precipitation rate for which sufficient snow data exists to support use of the regression coefficients.

- The highest precipitation rate to be used as an input to the snow regression equations (this does not apply to other precipitation types) is constrained by the lower of the following:

    1. The highest precipitation rate for snow stated in the FAA LWES AC (50 g/dm²/h); and

    2. The highest usable precipitation rate (HUPR) for each fluid/dilution/temperature as defined in Table 6 of this document. The HUPR is the highest precipitation rate for which sufficient snow data exists to support use of the regression coefficients.

- All other lowest and highest precipitation rates to be used as inputs to the regression equations are precipitation type dependent and provided in the FAA LWES AC.

- As regression coefficients and equations are not currently used in the determination of frost holdover times, regression coefficient information is not provided for frost.

- As regression coefficients and equations are not used in the determination of the allowance times provided for ice pellets, small hail and ice pellets mixed with other types of precipitation, regression coefficient information is not provided for allowance times.

REGRESSION INFORMATION TABLES FOR WINTER 2019-2020

The regression information for winter 2019-2020 is presented in a series of tables on the following pages. The regression information tables are presented first and are followed by the tables of highest and lowest usable precipitation rates.

The regression information tables are sorted by fluid type (Type I, then Type II, then Type III, then Type IV). Within each fluid type group, the tables are arranged in alphabetical order. The tables are as follows:

- Tables 1-1 to 1-2: Type I Fluid Regression Information Tables
- Tables 2-1 to 2-14: Type II Fluid Regression Information Tables
- Tables 3-1 to 3-2: Type III Fluid Regression Information Tables
- Tables 4-1 to 4-21: Type IV Fluid Regression Information Tables

The tables of highest and lowest usable precipitation rates are presented following the regression information. The tables are as follows:

- Table 5: Lowest Usable Precipitation Rates
- Table 6: Highest Usable Precipitation Rates

TABLE 1-1: GENERIC TYPE I (ALUMINUM WING SURFACES)

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions					
	Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]	Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
-3 °C and above (27 °F and above)	I = 1.3735 A = -0.4751	I = 2.0072 A = -0.5752 B = -0.5585	I = 1.3829 A = -0.3848	I = 2.2598 A = -1.4012	I = 0.9355 A = -0.3384	
below -3 to -6 °C (below 27 to 21 °F)	I = 1.2734 A = -0.5299	I = 2.0072 A = -0.5752 B = -0.5585	I = 1.3842 A = -0.6152	I = 2.2598 A = -1.4012		
below -6 to -10 °C (below 21 to 14 °F)	I = 1.1678 A = -0.5575	I = 2.0072 A = -0.5752 B = -0.5585	I = 1.2545 A = -0.5857	I = 2.2598 A = -1.4012	CAUTION: No holdover time guidelines exist	
below -10 °C (below 14 °F)	I = 1.1473 A = -0.6415	I = 2.0072 A = -0.5752 B = -0.5585				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 Type I aluminum snow values are rounded down to the nearest one minute (e.g. 6.5 mins = 6 mins, 18.6 mins = 18 mins) to determine holdover time table values

Outside Air Temp. (°C)	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
	Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
	5	2	25	10	4	13	5	25	13	75	5
+1 / -3 *	11.0	17.0	6.5	11.0	18.6	9.0	13.0	2.0	5.0	2.0	5.0
-6	8.0	13.0	5.0	8.5	14.3	5.0	9.0	2.0	5.0		
-10	6.0	10.0	4.0	6.7	11.4	4.0	7.0	2.0	5.0		
-25	5.0	9.0	2.5	4.3	7.3						

* Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C

TABLE 1-2: GENERIC TYPE I (COMPOSITE WING SURFACES)

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions					
	Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]	Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
-3 °C and above (27 °F and above)	I = 1.3931 A = -0.6279	I = 1.6656 A = -0.7424 B = -0.2094	I = 1.4691 A = -0.5081	I = 2.2598 A = -1.4012	I = 1.1144 A = -0.5943	
below -3 to -6 °C (below 27 to 21 °F)	I = 0.9976 A = -0.3140	I = 1.6656 A = -0.7424 B = -0.2094	I = 1.3842 A = -0.6152	I = 2.2598 A = -1.4012		
below -6 to -10 °C (below 21 to 14 °F)	I = 1.1308 A = -0.7565	I = 1.6656 A = -0.7424 B = -0.2094	I = 1.2545 A = -0.5857	I = 2.2598 A = -1.4012		CAUTION: No holdover time guidelines exist
below -10 °C (below 14 °F)	I = 1.0289 A = -0.6107	I = 2.0072 A = -0.5752 B = -0.5585				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 Type I composite snow values below 10 mins are rounded down to the nearest one minute (e.g. 2.5 mins = 2 mins) to determine holdover time table values

Outside Air Temp. (°C)	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
	Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
	5	2	25	10	3	13	5	25	13	75	5
+1 / -3 *	9.0	16.0	3.0	6.0	14.6	8.0	13.0	2.0	5.0	1.0	5.0
-6	6.0	8.0	2.7	5.4	13.3	5.0	9.0	2.0	5.0		
-10	4.0	8.0	2.5	5.0	12.2	4.0	7.0	2.0	5.0		
-25	4.0	7.0	2.5	4.3	8.6						

* Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C

TABLE 2-1: ABAX ECOWING 26

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1,4]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.3810 A = -0.6352	I = 2.3598 A = -0.5098 B = -0.0978	I = 2.3598 A = -0.5098 B = -0.0978	I = 2.3598 A = -0.5098 B = -0.0978	I = 2.4589 A = -0.6723	I = 2.0131 A = -0.2946	I = 2.3224 A = -0.5535	
	75/25	I = 2.2439 A = -0.6073	I = 2.5394 A = -0.7194 B = -0.2887	I = 2.5394 A = -0.7194 B = -0.2887	I = 2.5394 A = -0.7194 B = -0.2887	I = 2.1009 A = -0.4085	I = 2.0488 A = -0.4806	I = 2.2032 A = -0.6072	
	50/50	I = 1.7955 A = -0.5090	I = 2.4646 A = -0.9041 B = -0.4545	I = 2.4646 A = -0.9041 B = -0.4545	I = 2.4646 A = -0.9041 B = -0.4545	I = 1.7327 A = -0.5413	I = 1.6166 A = -0.5058	CAUTION: No holdover time guidelines exist	
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.5006 A = -1.2335	I = 2.3598 A = -0.5098 B = -0.0978	I = 2.3598 A = -0.5098 B = -0.0978	I = 2.3598 A = -0.5098 B = -0.0978	I = 2.4044 A = -0.8101	I = 2.7587 A = -1.1217		
	75/25	I = 2.1380 A = -0.8452	I = 2.5394 A = -0.7194 B = -0.2887	I = 2.5394 A = -0.7194 B = -0.2887	I = 2.5394 A = -0.7194 B = -0.2887	I = 2.2768 A = -0.8445	I = 2.3760 A = -0.8759		
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 1.8682 A = -0.6972	I = 2.1496 A = -1.4094 B = 0.0000	I = 1.9908 A = -1.1457 B = 0.0000	I = 2.2123 A = -1.3672 B = 0.0000				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 1.8682 A = -0.6972	I = 2.0233 A = -1.7757 B = 0.0000	I = 1.6761 A = -1.1990 B = 0.0000	I = 1.6761 A = -1.1990 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6
4 Freezing drizzle and light freezing rain values were calculated at 12.7 g/dm²/h the year the holdover time table for this fluid was produced. Since they are now calculated at 13.0 g/dm²/h, values in the holdover time table may differ slightly from those calculated using these coefficients.

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	86.5	154.8	37.9	60.5	111.7	51.3	97.5	39.9	48.4	19.3	86.2
	75/25	66.0	115.1	21.5	41.5	98.7	44.2	65.4	23.8	32.6	11.6	60.1
	50/50	27.5	43.9	7.6	17.5	51.9	13.5	22.6	8.1	11.3		
-8	100/0	43.5	134.7	35.4	56.5	104.4	31.8	68.9	15.5	32.3		
	75/25	35.3	76.5	17.6	34.0	80.8	21.7	48.6	14.2	25.1		
-10 / -14 ***	100/0	43.5	134.7	33.8	54.0	99.7	31.8	68.9	15.5	32.3		
	75/25	35.3	76.5	15.3	29.7	70.6	21.7	48.6	14.2	25.1		
-18	100/0	24.0	45.5	2.0	7.0	30.0						
-25	100/0	24.0	45.5	1.0	3.0	15.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 2-2: ABAX ECOWING AD-2

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.5300 A = -0.8946	I = 2.7889 A = -0.7155 B = -0.2871	I = 2.7889 A = -0.7155 B = -0.2871	I = 2.7889 A = -0.7155 B = -0.2871	I = 2.6240 A = -0.8987	I = 2.5285 A = -0.7682	I = 2.4977 A = -0.8034	
	75/25	I = 1.9838 A = -0.1716	I = 2.5435 A = -0.7664 B = -0.0812	I = 2.5435 A = -0.7664 B = -0.0812	I = 2.5435 A = -0.7664 B = -0.0812	I = 2.2055 A = -0.5820	I = 2.2411 A = -0.6851	I = 2.3107 A = -0.8650	
	50/50	I = 1.6478 A = -0.5976	I = 2.0999 A = -0.7867 B = -0.1524	I = 2.0999 A = -0.7867 B = -0.1524	I = 2.0999 A = -0.7867 B = -0.1524	I = 1.6770 A = -0.6366	I = 1.5734 A = -0.5302	CAUTION: No holdover time guidelines exist	
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.5699 A = -1.2862	I = 2.7889 A = -0.7155 B = -0.2871	I = 2.7889 A = -0.7155 B = -0.2871	I = 2.7889 A = -0.7155 B = -0.2871	I = 2.6096 A = -1.0768	I = 2.3302 A = -0.7561		
	75/25	I = 2.4425 A = -1.2784	I = 2.5435 A = -0.7664 B = -0.0812	I = 2.5435 A = -0.7664 B = -0.0812	I = 2.5435 A = -0.7664 B = -0.0812	I = 2.7079 A = -1.3713	I = 2.3728 A = -0.7324		
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 1.8390 A = -0.8725	I = 2.1496 A = -1.4094 B = 0.0000	I = 1.9908 A = -1.1457 B = 0.0000	I = 2.2123 A = -1.3672 B = 0.0000				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 1.8390 A = -0.8725	I = 2.0233 A = -1.7757 B = 0.0000	I = 1.6761 A = -1.1990 B = 0.0000	I = 1.6761 A = -1.1990 B = 0.0000				
below -25 to -27 °C (below -13 to -17 °F)	100/0	I = 1.8390 A = -0.8725	I = 1.4031 A = -1.1696 B = 0.0000	I = 1.7565 A = -1.7565 B = 0.0000	I = 5.0259 A = -5.0259 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*									
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	80.3	182.3	38.7	74.6	176.5	42.0	99.0	28.5	47.1	9.8	86.3
	75/25	73.1	85.5	26.0	52.5	132.2	36.1	62.9	19.2	30.1	4.9	50.8
	50/50	17.0	29.4	7.8	16.1	41.5	9.3	17.1	6.8	9.6		
-8	100/0	46.9	152.3	31.7	61.1	144.7	25.7	71.9	18.8	30.8		
	75/25	35.4	114.2	24.6	49.6	124.9	15.1	56.2	22.3	36.1		
-10 / -14 ***	100/0	46.9	152.3	27.7	53.4	126.4	25.7	71.9	18.8	30.8		
	75/25	35.4	114.2	23.7	47.8	120.2	15.1	56.2	22.3	36.1		
-18	100/0	16.9	37.7	2.0	7.0	30.0						
-25	100/0	16.9	37.7	1.0	3.0	15.0						
-27	100/0	16.9	37.7	0.0	1.0	7.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 2-3: AVIATION SHAANXI HI-TECH CLEANWING II

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions					
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]	Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
-3 °C and above (27 °F and above)	100/0	I = 2.2573 A = -0.7407	I = 2.4007 A = -0.6714 B = 0.0000	I = 2.1979 A = -0.5728	I = 2.2567 A = -0.6317	I = 2.1512 A = -0.6064	
	75/25	I = 2.0742 A = -0.5411	I = 2.3510 A = -0.6986 B = 0.0000	I = 2.1475 A = -0.5338	I = 2.2158 A = -0.6683	I = 2.1568 A = -0.6861	
	50/50	I = 1.9836 A = -0.6276	I = 2.3242 A = -0.6725 B = -0.2889	I = 2.0341 A = -0.6288	I = 2.1847 A = -0.7830		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.3283 A = -0.9431	I = 2.4007 A = -0.6714 B = 0.0000	I = 2.1441 A = -0.6033	I = 1.8282 A = -0.4021		
	75/25	I = 2.3328 A = -1.0611	I = 2.3510 A = -0.6986 B = 0.0000	I = 1.6685 A = -0.1061	I = 1.7474 A = -0.3274		CAUTION: No holdover time guidelines exist
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 1.9950 A = -0.9540	I = 2.2123 A = -1.3672 B = 0.0000				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 1.9950 A = -0.9540	I = 1.6761 A = -1.1990 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	54.9	108.2	29.0	53.6	120.3	36.3	62.7	23.6	35.7	10.3	53.4
	75/25	49.7	81.5	23.7	44.9	104.2	35.7	59.5	19.1	29.6	7.4	47.6
	50/50	35.1	62.3	15.2	28.2	35.8	21.6	39.3	12.3	20.5		
-8	100/0	46.7	110.8	29.0	53.6	120.3	29.7	52.8	18.5	24.0		
	75/25	39.0	103.1	23.7	44.9	85.2	35.5	39.3	19.5	24.1		
-10 / -14 ***	100/0	46.7	110.8	29.0	53.6	120.3	29.7	52.8	18.5	24.0		
	75/25	39.0	103.1	23.7	44.9	85.2	35.5	39.3	19.5	24.1		
-18	100/0	21.3	51.0	2.0	7.0	7.0						
-25	100/0	21.3	51.0	1.0	3.0	3.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 2-4: BEIJING YADILITE AVIATION YD-102 TYPE II

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.2562 A = -0.5977	I = 2.7385 A = -0.7402 B = -0.4299	I = 2.7385 A = -0.7402 B = -0.4299	I = 2.7385 A = -0.7402 B = -0.4299	I = 2.3920 A = -0.7249	I = 1.9465 A = -0.3059	I = 2.2622 A = -0.6682	
	75/25	I = 1.9892 A = -0.8353	I = 2.4080 A = -0.7439 B = -0.3491	I = 2.4080 A = -0.7439 B = -0.3491	I = 2.4080 A = -0.7439 B = -0.3491	I = 2.2407 A = -0.9340	I = 2.3425 A = -0.9259	I = 1.7678 A = -0.5942	
	50/50	I = 1.5895 A = -0.5473	I = 2.1960 A = -0.8600 B = -0.3992	I = 2.1960 A = -0.8600 B = -0.3992	I = 2.1960 A = -0.8600 B = -0.3992	I = 1.6035 A = -0.6300	I = 1.5230 A = -0.4848		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.1988 A = -0.7861	I = 2.7385 A = -0.7402 B = -0.4299	I = 2.7385 A = -0.7402 B = -0.4299	I = 2.7385 A = -0.7402 B = -0.4299	I = 2.0314 A = -0.4651	I = 1.4027 A = 0.0002		
	75/25	I = 1.8916 A = -0.6222	I = 2.4080 A = -0.7439 B = -0.3491	I = 2.4080 A = -0.7439 B = -0.3491	I = 2.4080 A = -0.7439 B = -0.3491	I = 1.8407 A = -0.6501	I = 1.5490 A = -0.3996		CAUTION: No holdover time guidelines exist
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 1.9202 A = -0.8505	I = 2.1496 A = -1.4094 B = 0.0000	I = 1.9908 A = -1.1457 B = 0.0000	I = 2.2123 A = -1.3672 B = 0.0000				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 1.9202 A = -0.8505	I = 2.0233 A = -1.7757 B = 0.0000	I = 1.6761 A = -1.1990 B = 0.0000	I = 1.6761 A = -1.1990 B = 0.0000				
below -25 to -29 °C (below -13 to -20 °F)	100/0	I = 1.9202 A = -0.8505	I = 1.4031 A = -1.1696 B = 0.0000	I = 1.7565 A = -1.7565 B = 0.0000	I = 5.0259 A = -5.0259 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*									
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	68.9	119.2	25.3	49.9	121.6	38.4	76.8	33.0	40.3	10.2	62.4
	75/25	25.4	54.7	13.3	26.3	64.4	15.9	38.7	11.2	20.5	4.5	22.5
	50/50	16.1	26.6	5.2	11.4	32.1	8.0	14.6	7.0	9.6		
-8	100/0	44.6	91.7	18.8	37.0	90.2	32.6	50.9	25.3	25.3		
	75/25	28.6	50.6	10.4	20.7	50.6	13.1	24.3	9.8	12.7		
-10 / -14 ***	100/0	44.6	91.7	15.3	30.2	73.7	32.6	50.9	25.3	25.3		
	75/25	28.6	50.6	8.9	17.5	42.9	13.1	24.3	9.8	12.7		
-18	100/0	21.2	46.2	2.0	7.0	30.0						
-25	100/0	21.2	46.2	1.0	3.0	15.0						
-29	100/0	21.2	46.2	0.0	1.0	7.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 2-5: CLARIANT SAFEWING MP II FLIGHT

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.4369 A = -0.1630	I = 2.7425 A = -0.5435 B = -0.3120	I = 2.7425 A = -0.5435 B = -0.3120	I = 2.7425 A = -0.5435 B = -0.3120	I = 2.6541 A = -0.6697	I = 2.9080 A = -0.8860	I = 2.4810 A = -0.7583	
	75/25	I = 2.3415 A = -0.4326	I = 3.0163 A = -0.7162 B = -0.5615	I = 3.0163 A = -0.7162 B = -0.5615	I = 3.0163 A = -0.7162 B = -0.5615	I = 2.1306 A = -0.2689	I = 2.5596 A = -0.7512	I = 2.5884 A = -0.9638 or[4] I = 2.2277 A = -0.7375	
	50/50	I = 2.2250 A = -0.6732	I = 2.2879 A = -0.7080 B = -0.2971	I = 2.2879 A = -0.7080 B = -0.2971	I = 2.2879 A = -0.7080 B = -0.2971	I = 1.7413 A = -0.3693	I = 1.9070 A = -0.6463		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.2233 A = -0.6827	I = 2.7425 A = -0.5435 B = -0.3120	I = 2.7425 A = -0.5435 B = -0.3120	I = 2.7425 A = -0.5435 B = -0.3120	I = 2.6220 A = -0.9557	I = 2.5701 A = -0.8095		
	75/25	I = 2.1182 A = -1.0244	I = 3.0163 A = -0.7162 B = -0.5615	I = 3.0163 A = -0.7162 B = -0.5615	I = 3.0163 A = -0.7162 B = -0.5615	I = 2.6085 A = -1.0800 or[4] I = 2.7141 A = -1.2023	I = 2.3076 A = -0.6932		CAUTION: No holdover time guidelines exist
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 1.8996 A = -0.6356	I = 6.2483 A = -1.1556 B = -2.8476	I = 6.2483 A = -1.1556 B = -2.8476	I = 6.2483 A = -1.1556 B = -2.8476				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 1.8996 A = -0.6356	I = 6.2483 A = -1.1556 B = -2.8476	I = 6.2483 A = -1.1556 B = -2.8476	I = 6.2483 A = -1.1556 B = -2.8476				
below -25 to -29 °C (below -13 to -20 °F)	100/0	I = 1.8996 A = -0.6356	I = 6.2483 A = -1.1556 B = -2.8476	I = 6.2483 A = -1.1556 B = -2.8476	I = 6.2483 A = -1.1556 B = -2.8476				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2-T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6
4 Calculate value using both sets of coefficients; take shortest holdover time calculated

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	210.4	244.2	58.2	95.7	184.1	80.9	153.5	46.7	83.4	11.5	89.3
	75/25	109.4	162.7	41.9	80.8	191.5	67.8	87.6	32.3	52.8	6.0	51.5
	50/50	56.8	105.3	12.3	23.6	55.3	21.4	30.4	10.1	15.4		
-8	100/0	55.7	104.2	46.9	77.1	148.3	36.1	89.9	27.4	46.6		
	75/25	25.2	64.5	28.4	54.8	129.7	23.7	71.4	21.8	34.3		
-10 / -14 ***	100/0	55.7	104.2	40.5	66.6	128.1	36.1	89.9	27.4	46.6		
	75/25	25.2	64.5	21.8	42.1	99.6	23.7	71.4	21.8	34.3		
-18	100/0	28.5	51.1	8.5	24.4	98.2						
-25	100/0	28.5	51.1	3.6	10.4	41.8						
-29	100/0	28.5	51.1	2.4	7.0	28.2						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 2-6: CLARIANT SAFEWING MP II FLIGHT PLUS

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions					
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]	Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
-3 °C and above (27 °F and above)	100/0	I = 2.5234 A = -0.4612	I = 3.1605 A = -0.8880 B = -0.3275	I = 2.4469 A = -0.4650	I = 2.2484 A = -0.4093	I = 2.6707 A = -0.8193	
	75/25	I = 2.5521 A = -0.5255	I = 2.6834 A = -0.6171 B = -0.0598	I = 2.3720 A = -0.3524	I = 2.6120 A = -0.6593	I = 2.3026 A = -0.5932	
	50/50	I = 2.4106 A = -0.8778	I = 2.6120 A = -0.6769 B = -0.7145	I = 2.3447 A = -0.7750	I = 1.8799 A = -0.5318		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.5312 A = -1.2991	I = 3.1605 A = -0.8880 B = -0.3275	I = 2.6242 A = -0.9778	I = 2.5660 A = -0.7490		
	75/25	I = 2.4057 A = -1.2869	I = 2.6834 A = -0.6171 B = -0.0598	I = 2.5280 A = -0.9864	I = 2.1271 A = -0.4438		CAUTION: No holdover time guidelines exist
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 1.8877 A = -0.8771	I = 2.2123 A = -1.3672 B = 0.0000				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 1.8877 A = -0.8771	I = 1.6761 A = -1.1990 B = 0.0000				
below -25 to -29 °C (below -13 to -20 °F)	100/0	I = 1.8877 A = -0.8771	I = 5.0259 A = -5.0259 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	158.9	242.4	49.0	110.6	249.4	84.9	132.4	47.4	62.0	13.6	125.3
	75/25	153.0	247.7	60.1	105.8	222.4	95.4	133.6	49.0	75.4	15.5	77.3
	50/50	62.7	140.1	14.7	27.3	50.7	30.3	63.5	13.7	19.4		
-8	100/0	42.0	138.1	39.1	88.1	198.8	34.3	87.2	33.0	53.9		
	75/25	32.1	104.3	57.7	101.5	213.4	26.9	69.0	32.1	42.9		
-10 / -14 ***	100/0	42.0	138.1	33.5	75.5	170.4	34.3	87.2	33.0	53.9		
	75/25	32.1	104.3	56.1	98.7	207.5	26.9	69.0	32.1	42.9		
-18	100/0	18.8	42.0	2.0	7.0	7.0						
-25	100/0	18.8	42.0	1.0	3.0	3.0						
-29	100/0	18.8	42.0	0.0	1.0	1.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 2-7: CRYOTECH POLAR GUARD® II

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.5794 A = -0.5025	I = 2.9600 A = -0.5988 B = -0.4378	I = 2.9600 A = -0.5988 B = -0.4378	I = 2.9600 A = -0.5988 B = -0.4378	I = 2.2682 A = -0.2524	I = 2.2584 A = -0.2806	I = 2.6661 A = -0.7999	
	75/25	I = 2.5776 A = -0.5705	I = 2.9905 A = -0.8191 B = -0.3466	I = 2.9905 A = -0.8191 B = -0.3466	I = 2.9905 A = -0.8191 B = -0.3466	I = 2.2204 A = -0.1898	I = 2.8328 A = -0.8896	I = 2.6248 A = -0.8807	
	50/50	I = 2.1254 A = -0.6271	I = 2.8810 A = -1.0631 B = -0.5673	I = 2.8810 A = -1.0631 B = -0.5673	I = 2.8810 A = -1.0631 B = -0.5673	I = 2.2943 A = -0.9086	I = 2.3695 A = -0.9996	CAUTION: No holdover time guidelines exist	
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.5101 A = -1.1145	I = 2.9600 A = -0.5988 B = -0.4378	I = 2.9600 A = -0.5988 B = -0.4378	I = 2.9600 A = -0.5988 B = -0.4378	I = 2.7077 A = -1.0390	I = 2.0801 A = -0.3886		
	75/25	I = 2.2594 A = -0.9785	I = 2.9905 A = -0.8191 B = -0.3466	I = 2.9905 A = -0.8191 B = -0.3466	I = 2.9905 A = -0.8191 B = -0.3466	I = 2.4495 A = -0.9076	I = 2.0483 A = -0.3597		
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 1.9253 A = -0.6979	I = 6.4718 A = -1.1603 B = -2.9134	I = 6.4718 A = -1.1603 B = -2.9134	I = 6.4718 A = -1.1603 B = -2.9134				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 1.9253 A = -0.6979	I = 6.4718 A = -1.1603 B = -2.9134	I = 6.4718 A = -1.1603 B = -2.9134	I = 6.4718 A = -1.1603 B = -2.9134				
below -25 to -30.5 °C (below -13 to -23 °F)	100/0	I = 1.9253 A = -0.6979	I = 2.0544 A = -1.1592 B = 0.0000	I = 2.0544 A = -1.1592 B = 0.0000	I = 2.0544 A = -1.1592 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*									
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	169.1	268.0	65.6	113.6	233.5	97.1	123.5	73.5	88.3	14.7	127.9
	75/25	151.0	254.6	40.1	84.9	227.7	102.1	122.4	38.8	69.5	9.4	102.1
	50/50	48.6	86.4	10.0	26.4	94.9	19.2	45.6	9.4	18.0		
-8	100/0	53.8	149.5	48.4	83.8	172.4	35.5	95.8	34.4	44.4		
	75/25	37.6	92.2	31.5	66.8	179.1	27.4	65.3	35.1	44.4		
-10 / -14 ***	100/0	53.8	149.5	39.4	68.2	140.3	35.5	95.8	34.4	44.4		
	75/25	37.6	92.2	26.8	56.8	152.2	27.4	65.3	35.1	44.4		
-18	100/0	27.4	51.9	11.5	33.2	134.2						
-25	100/0	27.4	51.9	4.8	13.8	56.0						
-30.5	100/0	27.4	51.9	2.7	7.9	31.7						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 2-8: KILFROST ABC-K PLUS

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions					
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]	Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
-3 °C and above (27 °F and above)	100/0	I = 2.5148 A = -0.5532	I = 2.6804 A = -0.5771 B = -0.1414	I = 2.2527 A = -0.1978	I = 2.5473 A = -0.5588	I = 2.6523 A = -0.7393	
	75/25	I = 2.3020 A = -0.4342	I = 2.5273 A = -0.6849 B = -0.0149	I = 2.3200 A = -0.3522	I = 2.4709 A = -0.5601	I = 2.5956 A = -0.7470	
	50/50	I = 1.9950 A = -0.6463	I = 2.3972 A = -0.8261 B = -0.5288	I = 1.7256 A = -0.3910	I = 2.0364 A = -0.7354		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.0780 A = -0.8928	I = 2.6804 A = -0.5771 B = -0.1414	I = 2.4865 A = -0.9979	I = 3.2510 A = -1.5260		
	75/25	I = 2.3405 A = -1.3357	I = 2.5273 A = -0.6849 B = -0.0149	I = 2.4921 A = -1.0863	I = 3.6906 A = -1.9574		
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 1.9498 A = -0.6590	I = 2.2123 A = -1.3672 B = 0.0000				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 1.9498 A = -0.6590	I = 1.6761 A = -1.1990 B = 0.0000				
below -25 to -29 °C (below -13 to -20 °F)	100/0	I = 1.9498 A = -0.6590	I = 5.0259 A = -5.0259 B = 0.0000				

CAUTION: No holdover time guidelines exist

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2-T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	134.3	223.0	59.5	101.0	202.4	107.7	130.1	58.4	84.1	18.5	136.6
	75/25	99.7	148.4	36.3	67.9	127.2	84.7	118.5	48.7	70.3	15.7	118.4
	50/50	34.9	63.2	7.5	15.9	43.0	19.5	28.3	10.2	16.5		
-8	100/0	28.4	64.5	54.0	91.6	183.5	23.7	61.5	13.1	35.6		
	75/25	25.5	86.8	35.9	67.2	125.9	19.1	54.1	9.0	32.4		
-10 / -14 ***	100/0	28.4	64.5	50.5	85.7	171.7	23.7	61.5	13.1	35.6		
	75/25	25.5	86.8	35.6	66.8	125.0	19.1	54.1	9.0	32.4		
-18	100/0	30.8	56.4	2.0	7.0	7.0						
-25	100/0	30.8	56.4	1.0	3.0	3.0						
-29	100/0	30.8	56.4	0.0	1.0	1.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 2-9: KILFROST ICE CLEAR II

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.2677 A = -0.6475	I = 2.6141 A = -0.6774 B = -0.1796	I = 2.6141 A = -0.6774 B = -0.1796	I = 2.6141 A = -0.6774 B = -0.1796	I = 2.1865 A = -0.5621	I = 2.3411 A = -0.6851	I = 2.3039 A = -0.6959	
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
	50/50	n/a	n/a	n/a	n/a	n/a	n/a	CAUTION: No holdover time guidelines exist	
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.3107 A = -0.8288	I = 2.6141 A = -0.6774 B = -0.1796	I = 2.6141 A = -0.6774 B = -0.1796	I = 2.6141 A = -0.6774 B = -0.1796	I = 1.9909 A = -0.3307	I = 2.0695 A = -0.5048		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a		
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 1.9438 A = -0.6425	I = 2.1496 A = -1.4094 B = 0.0000	I = 1.9908 A = -1.1457 B = 0.0000	I = 2.2123 A = -1.3672 B = 0.0000				
below -18 to -24 °C (below 0 to -11 °F)	100/0	I = 1.9438 A = -0.6425	I = 2.0233 A = -1.7757 B = 0.0000	I = 1.6761 A = -1.1990 B = 0.0000	I = 1.6761 A = -1.1990 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*									
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	65.3	118.2	34.8	64.7	146.3	36.3	62.2	24.2	37.8	10.0	65.7
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	50/50	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-8	100/0	53.9	115.1	30.7	57.2	129.2	41.9	57.5	23.1	32.2		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-10 / -14 ***	100/0	53.9	115.1	28.2	52.5	118.8	41.9	57.5	23.1	32.2		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-18	100/0	31.2	56.3	2.0	7.0	30.0						
-24	100/0	31.2	56.3	1.0	3.0	15.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 2-10: NEWAVE AEROCHEMICAL FCY-2

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions					
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]	Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
-3 °C and above (27 °F and above)	100/0	I = 2.3831 A = -0.7394	I = 2.7862 A = -0.6652 B = -0.5351	I = 2.3424 A = -0.7349	I = 2.1756 A = -0.5685	I = 2.0886 A = -0.6241	
	75/25	I = 2.1617 A = -0.6765	I = 2.6255 A = -0.6413 B = -0.5531	I = 2.1241 A = -0.6856	I = 2.6154 A = -1.0787	I = 1.8312 A = -0.6039	
	50/50	I = 1.6808 A = -0.3883	I = 2.1561 A = -0.7445 B = 0.0000	I = 1.7656 A = -0.6698	I = 1.6020 A = -0.5128		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.1844 A = -0.7552	I = 2.7862 A = -0.6652 B = -0.5351	I = 2.2637 A = -0.8968	I = 1.6935 A = -0.3738		
	75/25	I = 2.0300 A = -0.7545	I = 2.6255 A = -0.6413 B = -0.5531	I = 2.0031 A = -0.7745	I = 2.0994 A = -0.8524		CAUTION: No holdover time guidelines exist
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 1.7388 A = -0.5485	I = 2.2123 A = -1.3672 B = 0.0000				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 1.7388 A = -0.5485	I = 1.6761 A = -1.1990 B = 0.0000				
below -25 to -28 °C (below -13 to -18 °F)	100/0	I = 1.7388 A = -0.5485	I = 5.0259 A = -5.0259 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	73.5	144.7	30.4	55.8	124.4	33.4	67.4	24.0	34.9	8.3	44.9
	75/25	48.8	90.8	22.0	39.6	85.7	22.9	44.1	12.8	25.9	5.0	25.7
	50/50	25.7	36.6	13.0	25.8	63.2	10.5	19.8	7.7	10.7		
-8	100/0	45.3	90.6	21.0	38.5	85.8	18.4	43.3	14.8	18.9		
	75/25	31.8	63.5	15.0	27.0	58.4	13.8	29.0	8.1	14.1		
-10 / -14 ***	100/0	45.3	90.6	16.3	30.0	66.8	18.4	43.3	14.8	18.9		
	75/25	31.8	63.5	11.6	20.8	45.0	13.8	29.0	8.1	14.1		
-18	100/0	22.7	37.5	2.0	7.0	7.0						
-25	100/0	22.7	37.5	1.0	3.0	3.0						
-28	100/0	22.7	37.5	0.0	1.0	1.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 2-11: NEWAVE AEROCHEMICAL FCY-2 BIO+

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.3819 A = -0.6607	I = 3.1420 A = -0.8361 B = -0.7102	I = 3.1420 A = -0.8361 B = -0.7102	I = 3.1420 A = -0.8361 B = -0.7102	I = 2.2626 A = -0.5057	I = 2.6041 A = -0.8687	I = 2.4390 A = -0.8058	
	75/25	I = 2.0853 A = -0.6218	I = 2.8399 A = -0.7994 B = -0.6556	I = 2.8399 A = -0.7994 B = -0.6556	I = 2.8399 A = -0.7994 B = -0.6556	I = 2.2267 A = -0.7378	I = 1.9393 A = -0.5060	I = 1.9514 A = -0.5966	
	50/50	I = 1.6563 A = -0.6034	I = 1.9658 A = -0.5568 B = -0.3538	I = 1.9658 A = -0.5568 B = -0.3538	I = 1.9658 A = -0.5568 B = -0.3538	I = 1.6641 A = -0.5675	I = 1.7844 A = -0.6234		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.2250 A = -0.8616	I = 3.1420 A = -0.8361 B = -0.7102	I = 3.1420 A = -0.8361 B = -0.7102	I = 3.1420 A = -0.8361 B = -0.7102	I = 2.2571 A = -0.6478	I = 2.4418 A = -0.8745		
	75/25	I = 2.0676 A = -0.8031	I = 2.8399 A = -0.7994 B = -0.6556	I = 2.8399 A = -0.7994 B = -0.6556	I = 2.8399 A = -0.7994 B = -0.6556	I = 1.9065 A = -0.5604	I = 1.8028 A = -0.4737	CAUTION: No holdover time guidelines exist	
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 2.0929 A = -1.0828	I = 2.1496 A = -1.4094 B = 0.0000	I = 1.9908 A = -1.1457 B = 0.0000	I = 2.2123 A = -1.3672 B = 0.0000				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 2.0929 A = -1.0828	I = 2.0233 A = -1.7757 B = 0.0000	I = 1.6761 A = -1.1990 B = 0.0000	I = 1.6761 A = -1.1990 B = 0.0000				
below -25 to -28.5 °C (below -13 to -19 °F)	100/0	I = 2.0929 A = -1.0828	I = 1.4031 A = -1.1696 B = 0.0000	I = 1.7565 A = -1.7565 B = 0.0000	I = 5.0259 A = -5.0259 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*									
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	83.2	152.4	30.0	64.5	176.5	50.0	81.1	24.5	43.3	8.5	75.1
	75/25	44.7	79.1	18.4	38.2	100.1	25.4	51.4	17.1	23.7	6.8	34.2
	50/50	17.2	29.8	8.7	14.5	28.4	10.8	18.5	8.2	12.3		
-8	100/0	42.0	92.4	18.3	39.4	107.9	34.3	63.7	16.6	29.4		
	75/25	32.1	67.0	11.7	24.3	63.5	19.2	32.7	13.8	18.8		
-10 / -14 ***	100/0	42.0	92.4	13.1	28.2	77.3	34.3	63.7	16.6	29.4		
	75/25	32.1	67.0	8.6	17.8	46.7	19.2	32.7	13.8	18.8		
-18	100/0	21.7	58.5	2.0	7.0	30.0						
-25	100/0	21.7	58.5	1.0	3.0	15.0						
-28.5	100/0	21.7	58.5	0.0	1.0	7.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 2-12: OKSAYD DEFROST PG 2

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.2918 A = -0.8145	I = 2.7346 A = -0.7309 B = -0.3571	I = 2.7346 A = -0.7309 B = -0.3571	I = 2.7346 A = -0.7309 B = -0.3571	I = 2.2402 A = -0.6580	I = 2.3748 A = -0.7498	I = 2.4186 A = -0.7567	
	75/25	I = 2.2699 A = -0.6569	I = 2.9389 A = -0.8579 B = -0.5828	I = 2.9389 A = -0.8579 B = -0.5828	I = 2.9389 A = -0.8579 B = -0.5828	I = 2.0887 A = -0.5872	I = 2.4497 A = -0.9006	I = 1.9718 A = -0.6216	
	50/50	I = 2.2311 A = -0.6560	I = 2.7673 A = -0.7928 B = -0.2600	I = 2.7673 A = -0.7928 B = -0.2600	I = 2.7673 A = -0.7928 B = -0.2600	I = 2.1018 A = -0.5878	I = 2.3509 A = -0.8146		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.0963 A = -0.5196	I = 2.7346 A = -0.7309 B = -0.3571	I = 2.7346 A = -0.7309 B = -0.3571	I = 2.7346 A = -0.7309 B = -0.3571	I = 1.9595 A = -0.3909	I = 2.1235 A = -0.5815		
	75/25	I = 2.1158 A = -0.7229	I = 2.9389 A = -0.8579 B = -0.5828	I = 2.9389 A = -0.8579 B = -0.5828	I = 2.9389 A = -0.8579 B = -0.5828	I = 1.9013 A = -0.4425	I = 1.8645 A = -0.4846		CAUTION: No holdover time guidelines exist
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 2.0196 A = -0.6831	I = 2.1496 A = -1.4094 B = 0.0000	I = 1.9908 A = -1.1457 B = 0.0000	I = 2.2123 A = -1.3672 B = 0.0000				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 2.0196 A = -0.6831	I = 2.0233 A = -1.7757 B = 0.0000	I = 1.6761 A = -1.1990 B = 0.0000	I = 1.6761 A = -1.1990 B = 0.0000				
below -25 to -27 °C (below -13 to -17 °F)	100/0	I = 2.0196 A = -0.6831	I = 1.4031 A = -1.1696 B = 0.0000	I = 1.7565 A = -1.7565 B = 0.0000	I = 5.0259 A = -5.0259 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*									
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	52.8	111.3	29.1	56.8	136.9	32.2	60.3	21.2	34.6	10.0	77.6
	75/25	64.7	118.1	21.5	47.2	132.5	27.2	47.7	15.5	28.0	6.4	34.5
	50/50	59.2	108.0	30.0	62.1	161.2	28.0	49.1	16.3	27.8		
-8	100/0	54.1	87.1	22.7	44.3	106.8	33.4	48.6	20.4	29.9		
	75/25	40.8	79.1	14.3	31.5	88.5	25.6	39.1	15.4	21.1		
-10 / -14 ***	100/0	54.1	87.1	19.2	37.5	90.3	33.4	48.6	20.4	29.9		
	75/25	40.8	79.1	10.9	23.9	67.3	25.6	39.1	15.4	21.1		
-18	100/0	34.8	65.2	2.0	7.0	30.0						
-25	100/0	34.8	65.2	1.0	3.0	15.0						
-27	100/0	34.8	65.2	0.0	1.0	7.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 2-13: ROMCHIM ADD-PROTECT TYPE II

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.5740 A = -0.8251	I = 2.8637 A = -0.7431 B = -0.5033	I = 2.8637 A = -0.7431 B = -0.5033	I = 2.8637 A = -0.7431 B = -0.5033	I = 2.6191 A = -0.9213	I = 2.4792 A = -0.7630	I = 2.1185 A = -0.6149	
	75/25	I = 2.0354 A = -0.6203	I = 2.5210 A = -0.6815 B = -0.4862	I = 2.5210 A = -0.6815 B = -0.4862	I = 2.5210 A = -0.6815 B = -0.4862	I = 2.0120 A = -0.5901	I = 2.1011 A = -0.6689	I = 1.7686 A = -0.5325	
	50/50	I = 1.7404 A = -0.6221	I = 1.9864 A = -0.5840 B = -0.2529	I = 1.9864 A = -0.5840 B = -0.2529	I = 1.9864 A = -0.5840 B = -0.2529	I = 2.0897 A = -0.9018	I = 1.7429 A = -0.6010		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 1.8401 A = -0.5735	I = 2.8637 A = -0.7431 B = -0.5033	I = 2.8637 A = -0.7431 B = -0.5033	I = 2.8637 A = -0.7431 B = -0.5033	I = 2.2574 A = -0.7754	I = 2.0901 A = -0.5723		
	75/25	I = 1.9219 A = -0.6509	I = 2.5210 A = -0.6815 B = -0.4862	I = 2.5210 A = -0.6815 B = -0.4862	I = 2.5210 A = -0.6815 B = -0.4862	I = 1.8894 A = -0.5596	I = 1.8836 A = -0.5597		CAUTION: No holdover time guidelines exist
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 1.5810 A = -0.5714	I = 2.1496 A = -1.4094 B = 0.0000	I = 1.9908 A = -1.1457 B = 0.0000	I = 2.2123 A = -1.3672 B = 0.0000				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 1.5810 A = -0.5714	I = 2.0233 A = -1.7757 B = 0.0000	I = 1.6761 A = -1.1990 B = 0.0000	I = 1.6761 A = -1.1990 B = 0.0000				
below -25 to -28 °C (below -13 to -18 °F)	100/0	I = 1.5810 A = -0.5714	I = 1.4031 A = -1.1696 B = 0.0000	I = 1.7565 A = -1.7565 B = 0.0000	I = 5.0259 A = -5.0259 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*									
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	99.4	211.7	29.7	58.7	143.7	39.2	94.4	25.9	42.6	9.2	48.8
	75/25	40.0	70.6	16.9	31.6	71.8	22.6	39.8	14.7	22.7	5.9	24.9
	50/50	20.2	35.7	9.8	16.8	34.0	12.2	28.8	8.0	11.8		
-8	100/0	27.5	46.5	21.0	41.4	101.4	24.8	51.9	19.5	28.4		
	75/25	29.3	53.2	12.1	22.6	51.2	18.5	31.5	12.6	18.2		
-10 / -14 ***	100/0	27.5	46.5	16.6	32.7	80.0	24.8	51.9	19.5	28.4		
	75/25	29.3	53.2	9.6	17.9	40.8	18.5	31.5	12.6	18.2		
-18	100/0	15.2	25.6	2.0	7.0	30.0						
-25	100/0	15.2	25.6	1.0	3.0	15.0						
-28	100/0	15.2	25.6	0.0	1.0	7.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 2-14: TYPE II GENERIC

VERIFICATION TABLE

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*									
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)		Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	13	5	25	13	75	5
+1 / -3 *	100/0	52.8	108.2	25.3	49.9	32.2	60.3	21.2	34.6	8.3	44.9
	75/25	25.4	54.7	13.3	26.3	15.9	38.7	11.2	20.5	4.5	22.5
	50/50	16.1	26.6	5.2	11.4	8.0	14.6	6.8	9.6		
-8	100/0	27.5	46.5	18.3	37.0	18.4	43.3	13.1	18.9		
	75/25	25.2	50.6	10.4	20.7	13.1	24.3	8.1	12.7		
-10 / -14 **	100/0	27.5	46.5	13.1	28.2	18.4	43.3	13.1	18.9		
	75/25	25.2	50.6	8.6	17.5	13.1	24.3	8.1	12.7		
-18	100/0	15.2	25.6	2.0	7.0						
-25	100/0	15.2	25.6	1.0	3.0						

* Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C

** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 3-1: ALLCLEAR AEROCLEAR MAX, APPLIED UNHEATED ON LOW SPEED AIRCRAFT

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions[1]					
		Freezing Fog or Ice Crystals[2]	Snow, Snow Grains or Snow Pellets[3,4]	Freezing Drizzle[2]	Light Freezing Rain[2]	Rain on Cold Soaked Wing[2]	Other
-3 °C and above (27 °F and above)	100/0	I = 2.3532 A = -0.9867	I = 2.4111 A = -0.8236 B = 0.0000	I = 2.2733 A = -0.8172	I = 2.4359 A = -0.9105	I = 2.1350 A = -0.7258	
	75/25	n/a	n/a	n/a	n/a	n/a	
	50/50	n/a	n/a	n/a	n/a		
below -3 to -10°C (below 27 to 14 °F)	100/0	I = 2.2318 A = -0.7815	I = 2.4111 A = -0.8236 B = 0.0000	I = 2.1031 A = -0.6645	I = 2.2245 A = -0.7407	CAUTION: No holdover time guidelines exist	
	75/25	n/a	n/a	n/a	n/a		
below -10 to -16 °C (below 14 to 3 °F)	100/0	I = 2.3342 A = -1.0165	I = 2.4111 A = -0.8236 B = 0.0000				

1 CAUTION: Fluid must be applied unheated on aircraft conforming to the SAE AS5900 low speed aerodynamic test criterion to use these regression coefficients
2 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
3 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
4 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	46.1	113.8	18.2	38.7	104.3	23.1	50.4	14.6	26.4	5.9	42.4
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	50/50	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-10	100/0	48.5	99.2	18.2	38.7	104.3	23.1	43.5	15.5	25.1		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-25	100/0	42.0	106.7	18.2	38.7	104.3						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C

TABLE 3-2: ALLCLEAR AEROCLEAR MAX, APPLIED UNHEATED ON HIGH SPEED AIRCRAFT

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions[1]					
		Freezing Fog or Ice Crystals[2]	Snow, Snow Grains or Snow Pellets[3,4]	Freezing Drizzle[2]	Light Freezing Rain[2]	Rain on Cold Soaked Wing[2]	Other
-3 °C and above (27 °F and above)	100/0	I = 2.3532 A = -0.9867	I = 2.4111 A = -0.8236 B = 0.0000	I = 2.2733 A = -0.8172	I = 2.4359 A = -0.9105	I = 2.1350 A = -0.7258	
	75/25	n/a	n/a	n/a	n/a	n/a	
	50/50	n/a	n/a	n/a	n/a		
below -3 to -10°C (below 27 to 14 °F)	100/0	I = 2.2318 A = -0.7815	I = 2.4111 A = -0.8236 B = 0.0000	I = 2.1031 A = -0.6645	I = 2.2245 A = -0.7407		CAUTION: No holdover time guidelines exist
	75/25	n/a	n/a	n/a	n/a		
below -10 to -25 °C (below 14 to -13 °F)	100/0	I = 2.3342 A = -1.0165	I = 2.4111 A = -0.8236 B = 0.0000				
below -25 to -35 °C (below -13 to -31 °F)	100/0	I = 2.1252 A = -1.0990	I = 2.1551 A = -0.8234 B = 0.0000				

1 CAUTION: Fluid must be applied unheated on aircraft conforming to the SAE AS5900 high speed aerodynamic test criterion to use these regression coefficients
2 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
3 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
4 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	46.1	113.8	18.2	38.7	104.3	23.1	50.4	14.6	26.4	5.9	42.4
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	50/50	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-10	100/0	48.5	99.2	18.2	38.7	104.3	23.1	43.5	15.5	25.1		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-25	100/0	42.0	106.7	18.2	38.7	104.3						
-35	100/0	22.8	62.3	10.1	21.5	57.8						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C

TABLE 4-1: ABAX ECOWING AD-49

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.4713 A = -0.2370	I = 3.0052 A = -0.7148 B = -0.3380	I = 3.0052 A = -0.7148 B = -0.3380	I = 3.0052 A = -0.7148 B = -0.3380	I = 2.3729 A = -0.3927	I = 2.4943 A = -0.5000	I = 2.6531 A = -0.8558	
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
	50/50	n/a	n/a	n/a	n/a	n/a	n/a		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.5177 A = -1.7715	I = 3.0052 A = -0.7148 B = -0.3380	I = 3.0052 A = -0.7148 B = -0.3380	I = 3.0052 A = -0.7148 B = -0.3380	I = 2.8172 A = -1.2681	I = 1.9828 A = -0.5016		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a		CAUTION: No holdover time guidelines exist
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 1.7838 A = -0.5976	I = 2.3257 A = -1.4094 B = 0.0000	I = 2.2682 A = -1.3140 B = 0.0000	I = 2.5957 A = -1.6415 B = 0.0000				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 1.7838 A = -0.5976	I = 2.4506 A = -2.4094 B = 0.0000	I = 1.7911 A = -1.3140 B = 0.0000	I = 1.6761 A = -1.1990 B = 0.0000				
below -25 to -26 °C (below -13 to -15 °F)	100/0	I = 1.7838 A = -0.5976	I = 1.5915 A = -1.2398 B = 0.0000	I = 1.6682 A = -1.3672 B = 0.0000	I = 6.0834 A = -5.7824 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	202.1	251.2	58.8	113.3	267.9	86.2	125.4	62.4	86.6	11.2	113.5
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	50/50	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-8	100/0	19.0	96.5	46.6	89.6	211.9	25.4	85.3	19.1	26.5		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-10 / -14 ***	100/0	19.0	96.5	39.7	76.5	180.8	25.4	85.3	19.1	26.5		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-18	100/0	23.2	40.2	2.0	9.0	45.0						
-25	100/0	23.2	40.2	1.0	3.0	20.0						
-26	100/0	23.2	40.2	0.0	2.0	10.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 4-2: ALLCLEAR CLEARWING EG

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.4808 A = -0.6236	I = 2.7895 A = -0.7766 B = -0.1648	I = 2.7895 A = -0.7766 B = -0.1648	I = 2.7895 A = -0.7766 B = -0.1648	I = 2.2517 A = -0.3764	I = 3.1105 A = -1.1890	I = 2.4690 A = -0.7435	
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
	50/50	n/a	n/a	n/a	n/a	n/a	n/a		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.6368 A = -0.9489	I = 2.7895 A = -0.7766 B = -0.1648	I = 2.7895 A = -0.7766 B = -0.1648	I = 2.7895 A = -0.7766 B = -0.1648	I = 2.1945 A = -0.3445	I = 2.8711 A = -0.9900		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a		CAUTION: No holdover time guidelines exist
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 2.3601 A = -0.9134	I = 2.2480 A = -0.9120 B = 0.0000	I = 2.1544 A = -0.7565 B = 0.0000	I = 2.3979 A = -1.0000 B = 0.0000				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 2.3601 A = -0.9134	I = 2.2685 A = -1.1070 B = 0.0000	I = 2.2465 A = -1.0704 B = 0.0000	I = 2.3751 A = -1.1990 B = 0.0000				
below -25 to -29 °C (below -13 to -20 °F)	100/0	I = 2.3601 A = -0.9134	I = 2.1021 A = -1.1696 B = 0.0000	I = 2.1466 A = -1.2435 B = 0.0000	I = 2.4160 A = -1.5129 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	110.9	196.4	38.8	79.0	201.3	68.0	97.4	28.1	61.1	11.9	89.0
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	50/50	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-8	100/0	94.1	224.5	34.6	70.5	179.5	64.7	89.9	30.7	58.7		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-10 / -14 ***	100/0	94.1	224.5	32.0	65.2	166.2	64.7	89.9	30.7	58.7		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-18	100/0	52.7	121.7	10.0	25.0	65.0						
-25	100/0	52.7	121.7	5.0	15.0	55.0						
-29	100/0	52.7	121.7	2.0	8.0	35.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 4-3: CHEMCO CHEMR EG IV

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.5221 A = -0.6191	I = 2.8018 A = -0.9158 B = 0.0000	I = 2.8018 A = -0.9158 B = 0.0000	I = 2.8018 A = -0.9158 B = 0.0000	I = 2.5776 A = -0.8305	I = 2.3603 A = -0.6816	I = 2.6437 A = -0.8858	
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
	50/50	n/a	n/a	n/a	n/a	n/a	n/a		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.6566 A = -1.0376	I = 2.8018 A = -0.9158 B = 0.0000	I = 2.8018 A = -0.9158 B = 0.0000	I = 2.8018 A = -0.9158 B = 0.0000	I = 2.3439 A = -0.5194	I = 2.3463 A = -0.5867		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a		CAUTION: No holdover time guidelines exist
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 2.1693 A = -0.8359	I = 2.2480 A = -0.9120 B = 0.0000	I = 2.1544 A = -0.7565 B = 0.0000	I = 2.3979 A = -1.0000 B = 0.0000				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 2.1693 A = -0.8359	I = 2.2685 A = -1.1070 B = 0.0000	I = 2.2465 A = -1.0704 B = 0.0000	I = 2.3751 A = -1.1990 B = 0.0000				
below -25 to -27 °C (below -13 to -17 °F)	100/0	I = 2.1693 A = -0.8359	I = 2.1021 A = -1.1696 B = 0.0000	I = 2.1466 A = -1.2435 B = 0.0000	I = 2.4160 A = -1.5129 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	122.8	216.6	33.2	76.9	231.7	44.9	99.3	25.6	39.9	9.6	105.8
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	50/50	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-8	100/0	85.4	220.9	33.2	76.9	231.7	58.3	95.7	33.6	49.3		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-10 / -14 ***	100/0	85.4	220.9	33.2	76.9	231.7	58.3	95.7	33.6	49.3		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-18	100/0	38.5	82.7	10.0	25.0	65.0						
-25	100/0	38.5	82.7	5.0	15.0	55.0						
-27	100/0	38.5	82.7	2.0	8.0	35.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 4-4: CLARIANT MAX FLIGHT 04

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1,4]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.5102 A = -0.4343	I = 3.4634 A = -0.7407 B = -0.7275	I = 3.4634 A = -0.7407 B = -0.7275	I = 3.4634 A = -0.7407 B = -0.7275	I = 2.0949 A = -0.0224	I = 2.4117 A = -0.4124	I = 2.6420 A = -0.6956	
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
	50/50	n/a	n/a	n/a	n/a	n/a	n/a		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.5385 A = -1.1945	I = 3.4634 A = -0.7407 B = -0.7275	I = 3.4634 A = -0.7407 B = -0.7275	I = 3.4634 A = -0.7407 B = -0.7275	I = 2.8956 A = -1.3456	I = 2.8529 A = -1.1429		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	CAUTION: No holdover time guidelines exist	
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 1.8804 A = -0.7843	I = 2.3257 A = -1.4094 B = 0.0000	I = 2.2682 A = -1.3140 B = 0.0000	I = 2.5957 A = -1.6415 B = 0.0000				
below -18 to -23.5 °C (below 0 to -10 °F)	100/0	I = 1.8804 A = -0.7843	I = 2.4506 A = -2.4094 B = 0.0000	I = 1.7911 A = -1.3140 B = 0.0000	I = 1.6761 A = -1.1990 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6
4 Freezing drizzle and light freezing rain values were calculated at 12.7 g/dm²/h the year the holdover time table for this fluid was produced. Since they are now calculated at 13.0 g/dm²/h, values in the holdover time table may differ slightly from those calculated using these coefficients.

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	160.9	239.6	83.1	163.8	399.5	117.5	120.0	68.4	89.6	21.8	143.2
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	50/50	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-8	100/0	50.5	151.0	50.2	98.9	241.3	24.9	90.2	18.0	38.0		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-10 / -14 ***	100/0	50.5	151.0	35.6	70.3	171.4	24.9	90.2	18.0	38.0		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-18	100/0	21.5	44.1	2.0	9.0	45.0						
-23.5	100/0	21.5	44.1	1.0	3.0	20.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 4-5: CLARIANT MAX FLIGHT AVIA

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.4864 A = -0.3214	I = 2.8243 A = -0.6182 B = -0.2788	I = 2.8243 A = -0.6182 B = -0.2788	I = 2.8243 A = -0.6182 B = -0.2788	I = 2.5168 A = -0.5284	I = 2.2295 A = -0.3416	I = 2.8870 A = -1.0183	
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
	50/50	n/a	n/a	n/a	n/a	n/a	n/a		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.6347 A = -0.8798	I = 2.8243 A = -0.6182 B = -0.2788	I = 2.8243 A = -0.6182 B = -0.2788	I = 2.8243 A = -0.6182 B = -0.2788	I = 2.5583 A = -0.6474	I = 2.7838 A = -0.7360		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a		
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 2.1916 A = -0.8933	I = 2.2480 A = -0.9120 B = 0.0000	I = 2.1544 A = -0.7565 B = 0.0000	I = 2.3979 A = -1.0000 B = 0.0000			CAUTION: No holdover time guidelines exist	
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 2.1916 A = -0.8933	I = 2.2685 A = -1.1070 B = 0.0000	I = 2.2465 A = -1.0704 B = 0.0000	I = 2.3751 A = -1.1990 B = 0.0000				
below -25 to -28.5 °C (below -13 to -19 °F)	100/0	I = 2.1916 A = -0.8933	I = 2.1021 A = -1.1696 B = 0.0000	I = 2.1466 A = -1.2435 B = 0.0000	I = 2.4160 A = -1.5129 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*									
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	182.7	245.3	58.2	102.6	216.0	84.8	140.4	56.5	70.6	9.5	149.7
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	50/50	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-8	100/0	104.7	234.3	48.0	84.6	178.1	68.7	127.6	56.9	92.0		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-10 / -14 ***	100/0	104.7	234.3	42.1	74.2	156.2	68.7	127.6	56.9	92.0		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-18	100/0	36.9	83.7	10.0	25.0	65.0						
-25	100/0	36.9	83.7	5.0	15.0	55.0						
-28.5	100/0	36.9	83.7	2.0	8.0	35.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 4-6: CLARIANT MAX FLIGHT SNEG

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.5734 A = -0.5916	I = 2.8863 A = -0.6493 B = -0.3359	I = 2.8863 A = -0.6493 B = -0.3359	I = 2.8863 A = -0.6493 B = -0.3359	I = 2.1201 A = -0.0318	I = 3.1463 A = -1.0213	I = 2.3856 A = -0.6074	
	75/25	I = 2.3956 A = -0.0226	I = 2.6974 A = -0.5329 B = -0.3096	I = 2.6974 A = -0.5329 B = -0.3096	I = 2.6974 A = -0.5329 B = -0.3096	I = 2.3595 A = -0.3733	I = 2.1906 A = -0.2633	I = 2.5045 A = -0.7062	
	50/50	I = 2.6114 A = -0.9560	I = 2.5982 A = -0.9523 B = 0.0000	I = 2.5982 A = -0.9523 B = 0.0000	I = 2.5982 A = -0.9523 B = 0.0000	I = 2.3438 A = -0.7175	I = 2.7427 A = -1.1421		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.5197 A = -1.2481	I = 2.8863 A = -0.6493 B = -0.3359	I = 2.8863 A = -0.6493 B = -0.3359	I = 2.8863 A = -0.6493 B = -0.3359	I = 2.7003 A = -1.0853	I = 2.6961 A = -0.9598		
	75/25	I = 2.2989 A = -1.2091	I = 2.6974 A = -0.5329 B = -0.3096	I = 2.6974 A = -0.5329 B = -0.3096	I = 2.6974 A = -0.5329 B = -0.3096	I = 2.5864 A = -1.1239	I = 2.7996 A = -1.0818		CAUTION: No holdover time guidelines exist
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 1.9524 A = -0.8898	I = 2.3257 A = -1.4094 B = 0.0000	I = 2.2682 A = -1.3140 B = 0.0000	I = 2.5957 A = -1.6415 B = 0.0000				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 1.9524 A = -0.8898	I = 2.4506 A = -2.4094 B = 0.0000	I = 1.7911 A = -1.3140 B = 0.0000	I = 1.6761 A = -1.1990 B = 0.0000				
below -25 to -29 °C (below -13 to -20 °F)	100/0	I = 1.9524 A = -0.8898	I = 1.5915 A = -1.2398 B = 0.0000	I = 1.6682 A = -1.3672 B = 0.0000	I = 6.0834 A = -5.7824 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*									
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	144.5	248.5	55.4	100.5	219.6	121.5	125.3	52.3	102.0	17.6	91.4
	75/25	239.8	244.8	54.5	88.7	168.6	87.8	125.5	66.5	78.9	15.1	102.5
	50/50	87.7	210.7	18.5	44.2	139.3	35.0	69.5	14.0	29.5		
-8	100/0	44.4	139.3	43.9	79.6	174.0	31.0	87.4	22.6	42.4		
	75/25	28.4	86.1	43.9	71.6	136.0	21.6	63.2	19.4	39.3		
-10 / -14 ***	100/0	44.4	139.3	37.5	68.0	148.6	31.0	87.4	22.6	42.4		
	75/25	28.4	86.1	38.0	61.9	117.6	21.6	63.2	19.4	39.3		
-18	100/0	21.4	48.4	2.0	9.0	45.0						
-25	100/0	21.4	48.4	1.0	3.0	20.0						
-29	100/0	21.4	48.4	0.0	2.0	10.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 4-7: CLARIANT SAFEWING EG IV NORTH

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.5514 A = -0.5862	I = 2.7261 A = -0.6800 B = -0.0814	I = 2.7261 A = -0.6800 B = -0.0814	I = 2.7261 A = -0.6800 B = -0.0814	I = 2.4593 A = -0.4518	I = 2.0514 A = -0.2650	I = 2.7876 A = -0.9859	
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
	50/50	n/a	n/a	n/a	n/a	n/a	n/a		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.6521 A = -0.9130	I = 2.7261 A = -0.6800 B = -0.0814	I = 2.7261 A = -0.6800 B = -0.0814	I = 2.7261 A = -0.6800 B = -0.0814	I = 2.4417 A = -0.5677	I = 2.7481 A = -0.7299		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a		CAUTION: No holdover time guidelines exist
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 2.1343 A = -0.7329	I = 2.2480 A = -0.9120 B = 0.0000	I = 2.1544 A = -0.7565 B = 0.0000	I = 2.3979 A = -1.0000 B = 0.0000				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 2.1343 A = -0.7329	I = 2.2685 A = -1.1070 B = 0.0000	I = 2.2465 A = -1.0704 B = 0.0000	I = 2.3751 A = -1.1990 B = 0.0000				
below -25 to -30 °C (below -13 to -22 °F)	100/0	I = 2.1343 A = -0.7329	I = 2.1021 A = -1.1696 B = 0.0000	I = 2.1466 A = -1.2435 B = 0.0000	I = 2.4160 A = -1.5129 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*									
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	138.6	237.1	52.3	97.5	221.2	90.4	139.2	48.0	57.0	8.7	125.5
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	50/50	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-8	100/0	103.3	238.4	49.4	92.2	209.1	64.5	110.9	53.4	86.1		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-10 / -14 ***	100/0	103.3	238.4	47.6	88.7	201.2	64.5	110.9	53.4	86.1		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-18	100/0	41.9	82.0	10.0	25.0	65.0						
-25	100/0	41.9	82.0	5.0	15.0	55.0						
-30	100/0	41.9	82.0	2.0	8.0	35.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 4-8: CLARIANT SAFEWING MP IV LAUNCH

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.3942 A = 0.0152	I = 2.7218 A = -0.5330 B = -0.2408	I = 2.7218 A = -0.5330 B = -0.2408	I = 2.7218 A = -0.5330 B = -0.2408	I = 2.7789 A = -0.7426	I = 2.9492 A = -0.8489	I = 2.5170 A = -0.7291	
	75/25	I = 2.4388 A = -0.1431	I = 2.7841 A = -0.6180 B = -0.2044	I = 2.7841 A = -0.6180 B = -0.2044	I = 2.7841 A = -0.6180 B = -0.2044	I = 2.7945 A = -0.7101	I = 2.7548 A = -0.7917	I = 2.6192 A = -0.8499	
	50/50	I = 2.4323 A = -0.7333	I = 2.3978 A = -0.6703 B = -0.1021	I = 2.3978 A = -0.6703 B = -0.1021	I = 2.3978 A = -0.6703 B = -0.1021	I = 2.0818 A = -0.5727	I = 1.7686 A = -0.3607	CAUTION: No holdover time guidelines exist	
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.2823 A = -0.7333	I = 2.7218 A = -0.5330 B = -0.2408	I = 2.7218 A = -0.5330 B = -0.2408	I = 2.7218 A = -0.5330 B = -0.2408	I = 2.7424 A = -1.0767	I = 2.6379 A = -0.8846		
	75/25	I = 2.1203 A = -0.7220	I = 2.7841 A = -0.6180 B = -0.2044	I = 2.7841 A = -0.6180 B = -0.2044	I = 2.7841 A = -0.6180 B = -0.2044	I = 2.6204 A = -1.0940	I = 2.4901 A = -0.7708		
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 1.8894 A = -0.6349	I = 6.5565 A = -1.3090 B = -2.9993	I = 6.5565 A = -1.3090 B = -2.9993	I = 6.5565 A = -1.3090 B = -2.9993				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 1.8894 A = -0.6349	I = 6.5565 A = -1.3090 B = -2.9993	I = 6.5565 A = -1.3090 B = -2.9993	I = 6.5565 A = -1.3090 B = -2.9993				
below -25 to -28.5 °C (below -13 to -19 °F)	100/0	I = 1.8894 A = -0.6349	I = 6.5565 A = -1.3090 B = -2.9993	I = 6.5565 A = -1.3090 B = -2.9993	I = 6.5565 A = -1.3090 B = -2.9993				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*									
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	254.0	250.5	64.3	104.8	199.2	89.5	181.9	57.9	100.8	14.1	101.7
	75/25	218.2	248.7	59.9	105.5	222.0	100.8	198.7	44.5	74.6	10.6	106.0
	50/50	83.1	162.8	24.5	45.3	101.5	27.8	48.0	18.4	23.3		
-8	100/0	58.8	115.2	54.4	88.7	168.5	34.9	97.7	25.2	44.9		
	75/25	41.3	80.0	52.0	91.6	192.7	25.2	71.7	25.9	42.8		
-10 / -14 ***	100/0	58.8	115.2	48.6	79.2	150.5	34.9	97.7	25.2	44.9		
	75/25	41.3	80.0	47.2	83.2	175.0	25.2	71.7	25.9	42.8		
-18	100/0	27.9	49.9	6.7	22.1	107.1						
-25	100/0	27.9	49.9	2.7	9.0	43.5						
-28.5	100/0	27.9	49.9	1.9	6.2	30.2						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 4-9: CLARIANT SAFEWING MP IV LAUNCH PLUS

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.3920 A = -0.0283	I = 3.2161 A = -0.8902 B = -0.3284	I = 3.2161 A = -0.8902 B = -0.3284	I = 3.2161 A = -0.8902 B = -0.3284	I = 2.1074 A = -0.0294	I = 3.1822 A = -0.9927	I = 2.5435 A = -0.6674	
	75/25	I = 2.3948 A = -0.0330	I = 3.2776 A = -0.9501 B = -0.3856	I = 3.2776 A = -0.9501 B = -0.3856	I = 3.2776 A = -0.9501 B = -0.3856	I = 2.0839 A = -0.0124	I = 2.0297 A = -0.0872	I = 2.4962 A = -0.6485	
	50/50	I = 2.1682 A = -0.4153	I = 2.6868 A = -0.8488 B = -0.2819	I = 2.6868 A = -0.8488 B = -0.2819	I = 2.6868 A = -0.8488 B = -0.2819	I = 2.4651 A = -0.9953	I = 1.8233 A = -0.4948		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.4166 A = -0.9721	I = 3.2161 A = -0.8902 B = -0.3284	I = 3.2161 A = -0.8902 B = -0.3284	I = 3.2161 A = -0.8902 B = -0.3284	I = 2.8810 A = -1.3058	I = 2.2126 A = -0.5630		
	75/25	I = 2.4251 A = -1.1486	I = 3.2776 A = -0.9501 B = -0.3856	I = 3.2776 A = -0.9501 B = -0.3856	I = 3.2776 A = -0.9501 B = -0.3856	I = 2.5583 A = -1.0902	I = 2.1385 A = -0.5738	CAUTION: No holdover time guidelines exist	
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 1.9339 A = -0.8158	I = 6.5722 A = -1.2696 B = -3.0196	I = 6.5722 A = -1.2696 B = -3.0196	I = 6.5722 A = -1.2696 B = -3.0196				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 1.9339 A = -0.8158	I = 6.5722 A = -1.2696 B = -3.0196	I = 6.5722 A = -1.2696 B = -3.0196	I = 6.5722 A = -1.2696 B = -3.0196				
below -25 to -29 °C (below -13 to -20 °F)	100/0	I = 1.9339 A = -0.8158	I = 6.5722 A = -1.2696 B = -3.0196	I = 6.5722 A = -1.2696 B = -3.0196	I = 6.5722 A = -1.2696 B = -3.0196				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*									
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	235.6	241.8	55.2	124.8	364.6	118.8	122.1	62.3	119.2	19.6	119.4
	75/25	235.4	242.6	47.9	114.3	358.7	117.5	118.9	80.9	85.6	19.1	110.4
	50/50	75.5	110.5	20.1	43.7	121.6	22.7	58.8	13.5	18.7		
-8	100/0	54.6	133.0	44.0	99.4	290.4	26.7	93.0	26.6	38.5		
	75/25	41.9	120.0	36.6	87.5	274.6	22.1	62.6	21.7	31.6		
-10 / -14 ***	100/0	54.6	133.0	37.7	85.2	248.8	26.7	93.0	26.6	38.5		
	75/25	41.9	120.0	30.6	73.0	229.1	22.1	62.6	21.7	31.6		
-18	100/0	23.1	48.8	7.4	23.7	109.1						
-25	100/0	23.1	48.8	3.0	9.6	44.1						
-29	100/0	23.1	48.8	2.0	6.3	29.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 4-10: CRYOTECH POLAR GUARD® ADVANCE

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.5794 A = -0.5025	I = 2.9600 A = -0.5988 B = -0.4378	I = 2.9600 A = -0.5988 B = -0.4378	I = 2.9600 A = -0.5988 B = -0.4378	I = 2.2682 A = -0.2524	I = 2.2584 A = -0.2806	I = 2.6661 A = -0.7999	
	75/25	I = 2.5776 A = -0.5705	I = 2.9905 A = -0.8191 B = -0.3466	I = 2.9905 A = -0.8191 B = -0.3466	I = 2.9905 A = -0.8191 B = -0.3466	I = 2.2204 A = -0.1898	I = 2.8328 A = -0.8896	I = 2.6248 A = -0.8807	
	50/50	I = 2.1254 A = -0.6271	I = 2.8810 A = -1.0631 B = -0.5673	I = 2.8810 A = -1.0631 B = -0.5673	I = 2.8810 A = -1.0631 B = -0.5673	I = 2.2943 A = -0.9086	I = 2.3695 A = -0.9996		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.5101 A = -1.1145	I = 2.9600 A = -0.5988 B = -0.4378	I = 2.9600 A = -0.5988 B = -0.4378	I = 2.9600 A = -0.5988 B = -0.4378	I = 2.7077 A = -1.0390	I = 2.0801 A = -0.3886		
	75/25	I = 2.2594 A = -0.9785	I = 2.9905 A = -0.8191 B = -0.3466	I = 2.9905 A = -0.8191 B = -0.3466	I = 2.9905 A = -0.8191 B = -0.3466	I = 2.4495 A = -0.9076	I = 2.0483 A = -0.3597		CAUTION: No holdover time guidelines exist
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 1.9253 A = -0.6979	I = 6.4718 A = -1.1603 B = -2.9134	I = 6.4718 A = -1.1603 B = -2.9134	I = 6.4718 A = -1.1603 B = -2.9134				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 1.9253 A = -0.6979	I = 6.4718 A = -1.1603 B = -2.9134	I = 6.4718 A = -1.1603 B = -2.9134	I = 6.4718 A = -1.1603 B = -2.9134				
below -25 to -30.5 °C (below -13 to -23 °F)	100/0	I = 1.9253 A = -0.6979	I = 2.0544 A = -1.1592 B = 0.0000	I = 2.0544 A = -1.1592 B = 0.0000	I = 2.0544 A = -1.1592 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2-T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*									
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	169.1	268.0	65.6	113.6	233.5	97.1	123.5	73.5	88.3	14.7	127.9
	75/25	151.0	254.6	40.1	84.9	227.7	102.1	122.4	38.8	69.5	9.4	102.1
	50/50	48.6	86.4	10.0	26.4	94.9	19.2	45.6	9.4	18.0		
-8	100/0	53.8	149.5	48.4	83.8	172.4	35.5	95.8	34.4	44.4		
	75/25	37.6	92.2	31.5	66.8	179.1	27.4	65.3	35.1	44.4		
-10 / -14 ***	100/0	53.8	149.5	39.4	68.2	140.3	35.5	95.8	34.4	44.4		
	75/25	37.6	92.2	26.8	56.8	152.2	27.4	65.3	35.1	44.4		
-18	100/0	27.4	51.9	11.5	33.2	134.2						
-25	100/0	27.4	51.9	4.8	13.8	56.0						
-30.5	100/0	27.4	51.9	2.7	7.9	31.7						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 4-11: CRYOTECH POLAR GUARD® XTEND

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.5325 A = -0.5036	I = 2.9681 A = -0.6559 B = -0.3399	I = 2.9681 A = -0.6559 B = -0.3399	I = 2.9681 A = -0.6559 B = -0.3399	I = 2.0792 A = 0.0000	I = 3.0299 A = -0.8932	I = 2.4479 A = -0.6234	
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
	50/50	n/a	n/a	n/a	n/a	n/a	n/a		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.2661 A = -0.7204	I = 2.9681 A = -0.6559 B = -0.3399	I = 2.9681 A = -0.6559 B = -0.3399	I = 2.9681 A = -0.6559 B = -0.3399	I = 2.7919 A = -1.1481	I = 1.9558 A = -0.1963		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a		CAUTION: No holdover time guidelines exist
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 1.7603 A = -0.5578	I = 2.3257 A = -1.4094 B = 0.0000	I = 2.2682 A = -1.3140 B = 0.0000	I = 2.5957 A = -1.6415 B = 0.0000				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 1.7603 A = -0.5578	I = 2.4506 A = -2.4094 B = 0.0000	I = 1.7911 A = -1.3140 B = 0.0000	I = 1.6761 A = -1.1990 B = 0.0000				
below -25 to -29 °C (below -13 to -20 °F)	100/0	I = 1.7603 A = -0.5578	I = 1.5915 A = -1.2398 B = 0.0000	I = 1.6682 A = -1.3672 B = 0.0000	I = 6.0834 A = -5.7824 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	151.5	240.4	65.1	118.7	261.6	120.0	120.0	60.4	108.4	19.0	102.8
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	50/50	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-8	100/0	57.9	112.0	51.4	93.8	206.7	32.6	97.6	48.0	54.6		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-10 / -14 ***	100/0	57.9	112.0	43.8	80.0	176.1	32.6	97.6	48.0	54.6		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-18	100/0	23.5	39.1	2.0	9.0	45.0						
-25	100/0	23.5	39.1	1.0	3.0	20.0						
-29	100/0	23.5	39.1	0.0	2.0	10.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 4-12: DOW CHEMICAL UCAR™ ENDURANCE EG106

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.4198 A = -0.4664	I = 2.8358 A = -0.7951 B = -0.1996	I = 2.8358 A = -0.7951 B = -0.1996	I = 2.8358 A = -0.7951 B = -0.1996	I = 2.4460 A = -0.5295	I = 2.5011 A = -0.5672	I = 2.5903 A = -0.7102	
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
	50/50	n/a	n/a	n/a	n/a	n/a	n/a		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.4942 A = -0.6588	I = 2.8358 A = -0.7951 B = -0.1996	I = 2.8358 A = -0.7951 B = -0.1996	I = 2.8358 A = -0.7951 B = -0.1996	I = 2.5065 A = -0.6779	I = 2.6525 A = -0.7145		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a		CAUTION: No holdover time guidelines exist
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 2.0589 A = -0.7941	I = 3.3185 A = -0.8385 B = -0.6048	I = 3.3185 A = -0.8385 B = -0.6048	I = 3.3185 A = -0.8385 B = -0.6048				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 2.0589 A = -0.7941	I = 3.3185 A = -0.8385 B = -0.6048	I = 3.3185 A = -0.8385 B = -0.6048	I = 3.3185 A = -0.8385 B = -0.6048				
below -25 to -29 °C (below -13 to -20 °F)	100/0	I = 2.0589 A = -0.7941	I = 3.3185 A = -0.8385 B = -0.6048	I = 3.3185 A = -0.8385 B = -0.6048	I = 3.3185 A = -0.8385 B = -0.6048				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*									
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	124.1	190.3	38.4	79.6	207.5	71.8	119.1	51.1	74.0	18.1	124.1
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	50/50	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-8	100/0	108.1	197.6	33.5	69.4	180.7	56.4	107.8	45.0	71.9		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-10 / -14 ***	100/0	108.1	197.6	30.5	63.1	164.5	56.4	107.8	45.0	71.9		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-18	100/0	31.9	66.0	22.9	49.3	135.4						
-25	100/0	31.9	66.0	19.1	41.1	112.9						
-29	100/0	31.9	66.0	17.6	37.8	103.9						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 4-13: DOW CHEMICAL UCAR™ FLIGHTGUARD AD-49

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.4713 A = -0.2370	I = 3.0052 A = -0.7148 B = -0.3380	I = 3.0052 A = -0.7148 B = -0.3380	I = 3.0052 A = -0.7148 B = -0.3380	I = 2.3729 A = -0.3927	I = 2.4943 A = -0.5000	I = 2.6531 A = -0.8558	
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
	50/50	n/a	n/a	n/a	n/a	n/a	n/a		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.5177 A = -1.7715	I = 3.0052 A = -0.7148 B = -0.3380	I = 3.0052 A = -0.7148 B = -0.3380	I = 3.0052 A = -0.7148 B = -0.3380	I = 2.8172 A = -1.2681	I = 1.9828 A = -0.5016		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a		CAUTION: No holdover time guidelines exist
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 1.7838 A = -0.5976	I = 2.3257 A = -1.4094 B = 0.0000	I = 2.2682 A = -1.3140 B = 0.0000	I = 2.5957 A = -1.6415 B = 0.0000				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 1.7838 A = -0.5976	I = 2.4506 A = -2.4094 B = 0.0000	I = 1.7911 A = -1.3140 B = 0.0000	I = 1.6761 A = -1.1990 B = 0.0000				
below -25 to -26 °C (below -13 to -15 °F)	100/0	I = 1.7838 A = -0.5976	I = 1.5915 A = -1.2398 B = 0.0000	I = 1.6682 A = -1.3672 B = 0.0000	I = 6.0834 A = -5.7824 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	202.1	251.2	58.8	113.3	267.9	86.2	125.4	62.4	86.6	11.2	113.5
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	50/50	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-8	100/0	19.0	96.5	46.6	89.6	211.9	25.4	85.3	19.1	26.5		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-10 / -14 ***	100/0	19.0	96.5	39.7	76.5	180.8	25.4	85.3	19.1	26.5		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-18	100/0	23.2	40.2	2.0	9.0	45.0						
-25	100/0	23.2	40.2	1.0	3.0	20.0						
-26	100/0	23.2	40.2	0.0	2.0	10.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 4-14: INLAND TECHNOLOGIES ECO-SHIELD®

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.4628 A = -0.8425	I = 2.6693 A = -0.6224 B = -0.2015	I = 2.6693 A = -0.6224 B = -0.2015	I = 2.6693 A = -0.6224 B = -0.2015	I = 2.5329 A = -0.8434	I = 1.8305 A = -0.1843	I = 2.4740 A = -0.7236	
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
	50/50	n/a	n/a	n/a	n/a	n/a	n/a		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.4493 A = -0.8541	I = 2.6693 A = -0.6224 B = -0.2015	I = 2.6693 A = -0.6224 B = -0.2015	I = 2.6693 A = -0.6224 B = -0.2015	I = 2.3150 A = -0.5411	I = 1.9809 A = -0.3441		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a		CAUTION: No holdover time guidelines exist
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 1.9894 A = -0.6913	I = 2.3257 A = -1.4094 B = 0.0000	I = 2.2682 A = -1.3140 B = 0.0000	I = 2.5957 A = -1.6415 B = 0.0000				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 1.9894 A = -0.6913	I = 2.4506 A = -2.4094 B = 0.0000	I = 1.7911 A = -1.3140 B = 0.0000	I = 1.6761 A = -1.1990 B = 0.0000				
below -25 to -25.5 °C (below -13 to -14 °F)	100/0	I = 1.9894 A = -0.6913	I = 1.5915 A = -1.2398 B = 0.0000	I = 1.6682 A = -1.3672 B = 0.0000	I = 6.0834 A = -5.7824 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	74.8	161.9	45.5	80.5	170.4	39.2	87.8	37.4	42.2	13.1	92.9
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	50/50	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-8	100/0	71.2	155.7	39.6	70.0	148.2	51.6	86.5	31.6	39.6		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-10 / -14 ***	100/0	71.2	155.7	36.0	63.7	134.8	51.6	86.5	31.6	39.6		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-18	100/0	32.1	60.4	2.0	9.0	45.0						
-25	100/0	32.1	60.4	1.0	3.0	20.0						
-25.5	100/0	32.1	60.4	0.0	2.0	10.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 4-15: KILFROST ABC-S PLUS

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.5882 A = -0.6773	I = 2.7997 A = -0.5886 B = -0.1639	I = 2.7997 A = -0.5886 B = -0.1639	I = 2.7997 A = -0.5886 B = -0.1639	I = 2.1349 A = -0.0810	I = 3.2080 A = -1.0102	I = 2.5437 A = -0.6337	
	75/25	I = 2.4204 A = -0.6975	I = 2.5586 A = -0.5815 B = -0.1638	I = 2.5586 A = -0.5815 B = -0.1638	I = 2.5586 A = -0.5815 B = -0.1638	I = 2.1108 A = -0.2951	I = 2.5019 A = -0.7097	I = 2.4230 A = -0.7288	
	50/50	I = 1.8988 A = -0.5888	I = 2.1742 A = -0.6668 B = 0.0000	I = 2.1742 A = -0.6668 B = 0.0000	I = 2.1742 A = -0.6668 B = 0.0000	I = 2.2203 A = -0.8993	I = 1.7490 A = -0.4516		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.7468 A = -1.4224	I = 2.7997 A = -0.5886 B = -0.1639	I = 2.7997 A = -0.5886 B = -0.1639	I = 2.7997 A = -0.5886 B = -0.1639	I = 2.9992 A = -1.4676	I = 2.3542 A = -0.7931		
	75/25	I = 2.3554 A = -1.0359	I = 2.5586 A = -0.5815 B = -0.1638	I = 2.5586 A = -0.5815 B = -0.1638	I = 2.5586 A = -0.5815 B = -0.1638	I = 2.8273 A = -1.3891	I = 2.1553 A = -0.6538	CAUTION: No holdover time guidelines exist	
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 1.9370 A = -0.5185	I = 2.3257 A = -1.4094 B = 0.0000	I = 2.2682 A = -1.3140 B = 0.0000	I = 2.5957 A = -1.6415 B = 0.0000				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 1.9370 A = -0.5185	I = 2.4506 A = -2.4094 B = 0.0000	I = 1.7911 A = -1.3140 B = 0.0000	I = 1.6761 A = -1.1990 B = 0.0000				
below -25 to -28 °C (below -13 to -18 °F)	100/0	I = 1.9370 A = -0.5185	I = 1.5915 A = -1.2398 B = 0.0000	I = 1.6682 A = -1.3672 B = 0.0000	I = 6.0834 A = -5.7824 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	130.3	242.3	72.8	124.9	253.7	110.8	119.8	62.5	121.0	22.7	126.1
	75/25	85.7	162.3	42.8	72.9	146.8	60.5	80.3	32.3	51.4	11.4	82.0
	50/50	30.7	52.7	17.5	32.2	71.8	16.5	39.1	13.1	17.6		
-8	100/0	56.6	208.3	65.0	111.5	226.4	23.1	94.1	17.6	29.6		
	75/25	42.8	110.6	38.2	65.1	131.0	19.1	71.8	17.4	26.7		
-10 / -14 ***	100/0	56.6	208.3	60.2	103.2	209.7	23.1	94.1	17.6	29.6		
	75/25	42.8	110.6	35.4	60.2	121.3	19.1	71.8	17.4	26.7		
-18	100/0	37.5	60.4	2.0	9.0	45.0						
-25	100/0	37.5	60.4	1.0	3.0	20.0						
-28	100/0	37.5	60.4	0.0	2.0	10.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 4-16: LNT SOLUTIONS E450

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.3993 A = -0.5014	I = 2.6188 A = -0.4800 B = -0.2407	I = 2.6188 A = -0.4800 B = -0.2407	I = 2.6188 A = -0.4800 B = -0.2407	I = 2.2934 A = -0.2865	I = 2.4233 A = -0.4763	I = 2.5400 A = -0.6311	
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
	50/50	n/a	n/a	n/a	n/a	n/a	n/a		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.6898 A = -1.0623	I = 2.6188 A = -0.4800 B = -0.2407	I = 2.6188 A = -0.4800 B = -0.2407	I = 2.6188 A = -0.4800 B = -0.2407	I = 2.2217 A = -0.1785	I = 2.7806 A = -0.6994		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a		
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 2.0571 A = -0.7805	I = 6.0090 A = -1.2021 B = -2.3077	I = 6.0090 A = -1.2021 B = -2.3077	I = 6.0090 A = -1.2021 B = -2.3077			CAUTION: No holdover time guidelines exist	
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 2.0571 A = -0.7805	I = 6.0090 A = -1.2021 B = -2.3077	I = 6.0090 A = -1.2021 B = -2.3077	I = 6.0090 A = -1.2021 B = -2.3077				
below -25 to -32.5 °C (below -13 to -27 °F)	100/0	I = 2.0842 A = -1.0003	I = 2.3461 A = -1.2022 B = 0.0000	I = 2.3461 A = -1.2022 B = 0.0000	I = 2.3461 A = -1.2022 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*									
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	111.9	177.2	60.2	93.4	166.5	94.2	123.9	57.2	78.1	22.7	125.6
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	50/50	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-8	100/0	88.6	234.4	50.9	79.1	141.0	105.4	125.0	63.5	100.3		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-10 / -14 ***	100/0	88.6	234.4	45.5	70.6	125.9	105.4	125.0	63.5	100.3		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-18	100/0	32.5	66.4	21.2	63.8	271.1						
-25	100/0	32.5	66.4	10.6	31.9	135.6						
-32.5	100/0	24.3	60.7	4.6	13.9	59.2						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 4-17: NEWAVE AEROCHEMICAL FCY 9311

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.6186 A = -0.7874	I = 2.8340 A = -0.7480 B = -0.3361	I = 2.8340 A = -0.7480 B = -0.3361	I = 2.8340 A = -0.7480 B = -0.3361	I = 2.5218 A = -0.6026	I = 2.7035 A = -0.8019	I = 2.4128 A = -0.6988	
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
	50/50	n/a	n/a	n/a	n/a	n/a	n/a		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.4840 A = -1.3099	I = 2.8340 A = -0.7480 B = -0.3361	I = 2.8340 A = -0.7480 B = -0.3361	I = 2.8340 A = -0.7480 B = -0.3361	I = 2.4894 A = -0.8313	I = 2.3272 A = -0.7195		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a		CAUTION: No holdover time guidelines exist
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 1.9261 A = -0.6637	I = 2.3257 A = -1.4094 B = 0.0000	I = 2.2682 A = -1.3140 B = 0.0000	I = 2.5957 A = -1.6415 B = 0.0000				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 1.9261 A = -0.6637	I = 2.4506 A = -2.4094 B = 0.0000	I = 1.7911 A = -1.3140 B = 0.0000	I = 1.6761 A = -1.1990 B = 0.0000				
below -25 to -29.5 °C (below -13 to -21 °F)	100/0	I = 1.9261 A = -0.6637	I = 1.5915 A = -1.2398 B = 0.0000	I = 1.6682 A = -1.3672 B = 0.0000	I = 6.0834 A = -5.7824 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	117.0	240.8	35.8	71.0	174.7	70.9	126.1	38.2	64.6	12.7	84.0
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	50/50	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-8	100/0	37.0	122.9	28.3	56.2	138.4	36.6	81.0	21.0	33.6		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-10 / -14 ***	100/0	37.0	122.9	24.2	48.0	118.1	36.6	81.0	21.0	33.6		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-18	100/0	29.0	53.2	2.0	9.0	45.0						
-25	100/0	29.0	53.2	1.0	3.0	20.0						
-29.5	100/0	29.0	53.2	0.0	2.0	10.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 4-18: OKSAYD DEFROST ECO 4

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.4080 A = -0.6597	I = 2.7595 A = -0.7621 B = -0.1757	I = 2.7595 A = -0.7621 B = -0.1757	I = 2.7595 A = -0.7621 B = -0.1757	I = 2.1497 A = -0.2970	I = 2.5972 A = -0.7187	I = 2.2932 A = -0.6241	
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
	50/50	n/a	n/a	n/a	n/a	n/a	n/a		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.5248 A = -1.1145	I = 2.7595 A = -0.7621 B = -0.1757	I = 2.7595 A = -0.7621 B = -0.1757	I = 2.7595 A = -0.7621 B = -0.1757	I = 2.2310 A = -0.4646	I = 2.2288 A = -0.4780		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a		CAUTION: No holdover time guidelines exist
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 1.8711 A = -0.5814	I = 2.3257 A = -1.4094 B = 0.0000	I = 2.2682 A = -1.3140 B = 0.0000	I = 2.5957 A = -1.6415 B = 0.0000				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 1.8711 A = -0.5814	I = 2.4506 A = -2.4094 B = 0.0000	I = 1.7911 A = -1.3140 B = 0.0000	I = 1.6761 A = -1.1990 B = 0.0000				
below -25 to -25.5 °C (below -13 to -14 °F)	100/0	I = 1.8711 A = -0.5814	I = 1.5915 A = -1.2398 B = 0.0000	I = 1.6682 A = -1.3672 B = 0.0000	I = 6.0834 A = -5.7824 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	88.5	162.0	37.3	74.9	187.5	65.9	87.5	39.1	62.6	13.3	71.9
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	50/50	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-8	100/0	55.7	154.6	33.0	66.3	166.0	51.7	80.6	36.4	49.7		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-10 / -14 ***	100/0	55.7	154.6	30.4	61.1	152.9	51.7	80.6	36.4	49.7		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-18	100/0	29.2	49.7	2.0	9.0	45.0						
-25	100/0	29.2	49.7	1.0	3.0	20.0						
-25.5	100/0	29.2	49.7	0.0	2.0	10.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 4-19: OKSAYD DEFROST EG 4

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.5056 A = -0.4182	I = 2.8844 A = -0.5813 B = -0.1986	I = 2.8844 A = -0.5813 B = -0.1986	I = 2.8844 A = -0.5813 B = -0.1986	I = 2.0792 A = 0.0000	I = 3.0138 A = -0.8899	I = 2.5585 A = -0.6856	
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
	50/50	n/a	n/a	n/a	n/a	n/a	n/a		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.5610 A = -0.6008	I = 2.8844 A = -0.5813 B = -0.1986	I = 2.8844 A = -0.5813 B = -0.1986	I = 2.8844 A = -0.5813 B = -0.1986	I = 2.6052 A = -0.7526	I = 2.5942 A = -0.4974		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a		CAUTION: No holdover time guidelines exist
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 2.5376 A = -1.2454	I = 2.2480 A = -0.9120 B = 0.0000	I = 2.1544 A = -0.7565 B = 0.0000	I = 2.3979 A = -1.0000 B = 0.0000				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 2.5376 A = -1.2454	I = 2.2685 A = -1.1070 B = 0.0000	I = 2.2465 A = -1.0704 B = 0.0000	I = 2.3751 A = -1.1990 B = 0.0000				
below -25 to -26 °C (below -13 to -15 °F)	100/0	I = 2.5376 A = -1.2454	I = 2.1021 A = -1.1696 B = 0.0000	I = 2.1466 A = -1.2435 B = 0.0000	I = 2.4160 A = -1.5129 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*									
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	163.4	239.7	85.7	146.0	293.9	120.0	120.0	58.9	105.3	18.7	120.0
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	50/50	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-8	100/0	138.4	240.0	74.7	127.2	256.1	58.5	120.0	79.2	109.7		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-10 / -14 ***	100/0	138.4	240.0	68.0	115.9	233.3	58.5	120.0	79.2	109.7		
	75/25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
-18	100/0	46.5	145.4	10.0	25.0	65.0						
-25	100/0	46.5	145.4	5.0	15.0	55.0						
-26	100/0	46.5	145.4	2.0	8.0	35.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 4-20: SHAANXI CLEANWAY AVIATION CLEANSURFACE IV

REGRESSION COEFFICIENTS TABLE AND VERIFICATION TABLE

Outside Air Temperature	Fluid Dilution	Regression Coefficients for Calculating Holdover Times Under Various Weather Conditions							
		Freezing Fog or Ice Crystals[1]	Snow, Snow Grains or Snow Pellets[2,3]			Freezing Drizzle[1]	Light Freezing Rain[1]	Rain on Cold Soaked Wing[1]	Other
			< 4 g/dm²/h	4 to <10 g/dm²/h	≥ 10 g/dm²/h				
-3 °C and above (27 °F and above)	100/0	I = 2.5037 A = -0.3903	I = 3.3279 A = -0.6974 B = -0.8278	I = 3.3279 A = -0.6974 B = -0.8278	I = 3.3279 A = -0.6974 B = -0.8278	I = 2.2230 A = -0.1299	I = 1.9595 A = -0.0138	I = 2.7249 A = -0.8143	
	75/25	I = 2.5266 A = -0.4875	I = 3.2662 A = -0.8594 B = -0.6150	I = 3.2662 A = -0.8594 B = -0.6150	I = 3.2662 A = -0.8594 B = -0.6150	I = 2.7184 A = -0.9235	I = 1.9155 A = -0.2570	I = 2.4087 A = -0.7760	
	50/50	I = 2.4207 A = -0.8825	I = 2.9686 A = -1.0764 B = -0.4446	I = 2.9686 A = -1.0764 B = -0.4446	I = 2.9686 A = -1.0764 B = -0.4446	I = 2.2650 A = -0.7956	I = 1.7827 A = -0.4609		
below -3 to -14 °C (below 27 to 7 °F)	100/0	I = 2.6480 A = -1.2687	I = 3.3279 A = -0.6974 B = -0.8278	I = 3.3279 A = -0.6974 B = -0.8278	I = 3.3279 A = -0.6974 B = -0.8278	I = 2.7839 A = -1.1024	I = 2.4424 A = -0.8195		
	75/25	I = 2.3477 A = -0.9386	I = 3.2662 A = -0.8594 B = -0.6150	I = 3.2662 A = -0.8594 B = -0.6150	I = 3.2662 A = -0.8594 B = -0.6150	I = 2.5842 A = -0.9804	I = 2.3692 A = -0.6948		CAUTION: No holdover time guidelines exist
below -14 to -18 °C (below 7 to 0 °F)	100/0	I = 1.9241 A = -0.6900	I = 2.3257 A = -1.4094 B = 0.0000	I = 2.2682 A = -1.3140 B = 0.0000	I = 2.5957 A = -1.6415 B = 0.0000				
below -18 to -25 °C (below 0 to -13 °F)	100/0	I = 1.9241 A = -0.6900	I = 2.4506 A = -2.4094 B = 0.0000	I = 1.7911 A = -1.3140 B = 0.0000	I = 1.6761 A = -1.1990 B = 0.0000				
below -25 to -28.5 °C (below -13 to -19 °F)	100/0	I = 1.9241 A = -0.6900	I = 1.5915 A = -1.2398 B = 0.0000	I = 1.6682 A = -1.3672 B = 0.0000	I = 6.0834 A = -5.7824 B = 0.0000				

1 Regression Equation: $t = 10^{I} R^{A}$, where t = holdover time (minutes) and R = precipitation rate (g/dm²/h)
2 Regression Equation: $t = 10^{I} R^{A} (2\text{-}T)^{B}$, where t = holdover time (minutes), R = precipitation rate (g/dm²/h) and T = temperature (°C)
3 CAUTION: Use of these coefficients is limited by the lowest usable precipitation rates provided in Table 5 and the highest usable precipitation rates provided in Table 6

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	LUPR*	13	5	25	13	75	5
+1 / -3 **	100/0	170.2	243.3	59.5	112.7	260.9	119.8	135.6	87.1	87.9	15.8	143.1
	75/25	153.4	239.8	43.1	94.8	266.9	48.9	118.3	36.0	42.6	9.0	73.5
	50/50	63.7	142.9	14.2	38.1	139.4	23.9	51.2	13.8	18.6		
-8	100/0	57.7	184.5	33.5	63.5	147.0	36.0	103.1	19.8	33.8		
	75/25	49.2	116.2	28.2	61.9	174.2	31.1	79.2	25.0	39.4		
-10 / -14 ***	100/0	57.7	184.5	22.7	43.0	99.6	36.0	103.1	19.8	33.8		
	75/25	49.2	116.2	21.1	46.4	130.5	31.1	79.2	25.0	39.4		
-18	100/0	27.7	52.0	2.0	9.0	45.0						
-25	100/0	27.7	52.0	1.0	3.0	20.0						
-28.5	100/0	27.7	52.0	0.0	2.0	10.0						

* Refer to Table 5 for the lowest usable precipitation rates in snow
** Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C
*** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 4-21: TYPE IV GENERIC

VERIFICATION TABLE

Outside Air Temp. (°C)	Fluid Dilution	HOTDS Verification Times Under Various Weather Conditions (minutes) *As Calculated from Regression Coefficients*										
		Freezing Fog or Ice Crystals (g/dm²/h)		Snow, Snow Grains or Snow Pellets (g/dm²/h)			Freezing Drizzle (g/dm²/h)		Light Freezing Rain (g/dm²/h)		Rain on Cold Soaked Wing (g/dm²/h)	
		5	2	25	10	3	13	5	25	13	75	5
+1 / -3 *	100/0	74.8	161.9	33.2	71.0	166.5	39.2	87.5	25.6	39.9	8.7	71.9
	75/25	85.7	162.3	40.1	72.9	146.8	48.9	80.3	32.3	42.6	9.0	73.5
	50/50	30.7	52.7	10.0	26.4	71.8	16.5	39.1	9.4	17.6		
-8	100/0	19.0	96.5	28.3	56.2	138.4	23.1	80.6	17.6	26.5		
	75/25	28.4	80.0	28.2	61.9	131.0	19.1	62.6	17.4	26.7		
-10 / -14 **	100/0	19.0	96.5	22.7	43.0	99.6	23.1	80.6	17.6	26.5		
	75/25	28.4	80.0	21.1	46.4	117.6	19.1	62.6	17.4	26.7		
-18	100/0	21.4	39.1	2.0	9.0	45.0						
-25	100/0	21.4	39.1	1.0	3.0	20.0						

* Rain on cold soaked wing calculated at +1°C; all other conditions calculated at -3°C

** Freezing fog and snow calculated at -14°C; freezing drizzle and light freezing rain calculated at -10°C

TABLE 5: LOWEST USABLE PRECIPITATION RATES IN SNOW[1]

TYPE II, TYPE III AND TYPE IV FLUIDS[2]

Type II De/Anti-Icing Fluids				
FLUID DILUTION	100/0		75/25	50/50
TEMPERATURE	*-14°C AND ABOVE*	*BELOW -14°C*	*-14°C AND ABOVE*	*-3°C AND ABOVE*
ABAX ECOWING 26	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h
ABAX ECOWING AD-2	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h
Aviation Shaanxi Hi-Tech Cleanwing II	3 g/dm²/h	10 g/dm²/h	3 g/dm²/h	7 g/dm²/h
Beijing Yadilite Aviation YD-102 Type II	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h
Clariant Safewing MP II FLIGHT	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h
Clariant Safewing MP II FLIGHT PLUS	4 g/dm²/h	10 g/dm²/h	3 g/dm²/h	4 g/dm²/h
Cryotech Polar Guard® II	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h
Kilfrost ABC-K Plus	3 g/dm²/h	10 g/dm²/h	4 g/dm²/h	3 g/dm²/h
Kilfrost Ice Clear II	3 g/dm²/h	3 g/dm²/h	not applicable	not applicable
Newave Aerochemical FCY-2	3 g/dm²/h	10 g/dm²/h	3 g/dm²/h	3 g/dm²/h
Newave Aerochemical FCY-2 Bio+	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h
Oksayd Defrost PG 2	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h
ROMCHIM ADD-PROTECT Type II	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h

Type III De/Anti-Icing Fluids				
FLUID DILUTION	100/0		75/25	50/50
TEMPERATURE	*-25°C AND ABOVE*	*BELOW -25°C*	*-10°C AND ABOVE*	*-3°C AND ABOVE*
AllClear AeroClear MAX	3 g/dm²/h	3 g/dm²/h	not applicable	not applicable

1 The lowest precipitation rate to be used as an input to the snow regression equations is constrained by the higher of: (1) the minimum demonstrated precipitation measuring equipment rates in accordance with the FAA LWES AC (in no case less than 2.0 g/dm²/h) or (2) the lowest usable precipitation rate (LUPR) for the fluid/dilution/temperature as defined in this table.

2 Type I fluids are limited only by the general precipitation rate limitations set out in the FAA LWES AC.

TABLE 5: LOWEST USABLE PRECIPITATION RATES IN SNOW[1] (cont'd)

TYPE II, TYPE III AND TYPE IV FLUIDS[2]

Type IV De/Anti-Icing Fluids				
FLUID DILUTION	100/0		75/25	50/50
TEMPERATURE	*-14°C AND ABOVE*	*BELOW -14°C*	*-14°C AND ABOVE*	*-3°C AND ABOVE*
ABAX ECOWING AD-49	3 g/dm²/h	3 g/dm²/h	not applicable	not applicable
AllClear ClearWing EG	3 g/dm²/h	3 g/dm²/h	not applicable	not applicable
CHEMCO ChemR EG IV	3 g/dm²/h	3 g/dm²/h	not applicable	not applicable
Clariant Max Flight 04	3 g/dm²/h	3 g/dm²/h	not applicable	not applicable
Clariant Max Flight AVIA	3 g/dm²/h	3 g/dm²/h	not applicable	not applicable
Clariant Max Flight SNEG	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h
Clariant Safewing EG IV NORTH	3 g/dm²/h	3 g/dm²/h	not applicable	not applicable
Clariant Safewing MP IV LAUNCH	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h
Clariant Safewing MP IV LAUNCH PLUS	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h
Cryotech Polar Guard® Advance	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h
Cryotech Polar Guard® Xtend	3 g/dm²/h	3 g/dm²/h	not applicable	not applicable
Dow UCAR Endurance EG106	3 g/dm²/h	3 g/dm²/h	not applicable	not applicable
Dow UCAR FlightGuard AD-49	3 g/dm²/h	3 g/dm²/h	not applicable	not applicable
Inland Technologies ECO-SHIELD®	3 g/dm²/h	3 g/dm²/h	not applicable	not applicable
Kilfrost ABC-S Plus	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h
LNT Solutions E450	3 g/dm²/h	3 g/dm²/h	not applicable	not applicable
Newave Aerochemical FCY 9311	3 g/dm²/h	3 g/dm²/h	not applicable	not applicable
Oksayd Defrost ECO 4	3 g/dm²/h	3 g/dm²/h	not applicable	not applicable
Oksayd Defrost EG 4	3 g/dm²/h	3 g/dm²/h	not applicable	not applicable
Shaanxi Cleanway Cleansurface IV	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h	3 g/dm²/h

1 The lowest precipitation rate to be used as an input to the snow regression equations is constrained by the higher of: (1) the minimum demonstrated precipitation measuring equipment rates in accordance with the FAA LWES AC (in no case less than 2.0 g/dm²/h) or (2) the lowest usable precipitation rate (LUPR) for the fluid/dilution/temperature as defined in this table.

2 Type I fluids are limited only by the general precipitation rate limitations set out in the FAA LWES AC.

TABLE 6: HIGHEST USABLE PRECIPITATION RATES IN SNOW[1]

TYPE II, TYPE III AND TYPE IV FLUIDS[2]

Type II De/Anti-Icing Fluids				
FLUID DILUTION	100/0		75/25	50/50
TEMPERATURE	*-14°C AND ABOVE*	*BELOW -14°C*	*-14°C AND ABOVE*	*-3°C AND ABOVE*
ABAX ECOWING 26	50 g/dm²/h	25 g/dm²/h	50 g/dm²/h	50 g/dm²/h
ABAX ECOWING AD-2	50 g/dm²/h	25 g/dm²/h	50 g/dm²/h	50 g/dm²/h
Aviation Shaanxi Hi-Tech Cleanwing II	50 g/dm²/h	25 g/dm²/h	50 g/dm²/h	50 g/dm²/h
Beijing Yadilite Aviation YD-102 Type II	50 g/dm²/h	25 g/dm²/h	50 g/dm²/h	50 g/dm²/h
Clariant Safewing MP II FLIGHT	50 g/dm²/h	25 g/dm²/h	50 g/dm²/h	40 g/dm²/h
Clariant Safewing MP II FLIGHT PLUS	50 g/dm²/h	25 g/dm²/h	50 g/dm²/h	40 g/dm²/h
Cryotech Polar Guard® II	50 g/dm²/h	25 g/dm²/h	50 g/dm²/h	50 g/dm²/h
Kilfrost ABC-K Plus	50 g/dm²/h	25 g/dm²/h	50 g/dm²/h	25 g/dm²/h
Kilfrost Ice Clear II	50 g/dm²/h	25 g/dm²/h	not applicable	not applicable
Newave Aerochemical FCY-2	50 g/dm²/h	25 g/dm²/h	50 g/dm²/h	50 g/dm²/h
Newave Aerochemical FCY-2 Bio+	50 g/dm²/h	25 g/dm²/h	50 g/dm²/h	50 g/dm²/h
Oksayd Defrost PG 2	50 g/dm²/h	25 g/dm²/h	50 g/dm²/h	50 g/dm²/h
ROMCHIM ADD-PROTECT Type II	50 g/dm²/h	25 g/dm²/h	50 g/dm²/h	50 g/dm²/h

Type III De/Anti-Icing Fluids				
FLUID DILUTION	100/0		75/25	50/50
TEMPERATURE	*-25°C AND ABOVE*	*BELOW -25°C*	*-10°C AND ABOVE*	*-3°C AND ABOVE*
AllClear AeroClear MAX	50 g/dm²/h	25 g/dm²/h	not applicable	not applicable

1 The highest precipitation rate to be used as an input to the snow regression equations is constrained by the lower of: (1) the maximum allowable precipitation rate for snow specified in the FAA LWES AC (50 g/dm²/h) or (2) the highest usable precipitation rate (HUPR) for the fluid/dilution/temperature as defined in this table.

2 Type I fluids are limited only by the general precipitation rate limitations set out in the FAA LWES AC.

TABLE 6: HIGHEST USABLE PRECIPITATION RATES IN SNOW[1] (cont'd)

TYPE II, TYPE III AND TYPE IV FLUIDS[2]

Type IV De/Anti-Icing Fluids				
FLUID DILUTION	100/0		75/25	50/50
TEMPERATURE	*-14°C AND ABOVE*	*BELOW -14°C*	*-14°C AND ABOVE*	*-3°C AND ABOVE*
ABAX ECOWING AD-49	50 g/dm²/h	25 g/dm²/h	not applicable	not applicable
AllClear ClearWing EG	50 g/dm²/h	25 g/dm²/h	not applicable	not applicable
CHEMCO ChemR EG IV	50 g/dm²/h	25 g/dm²/h	not applicable	not applicable
Clariant Max Flight 04	50 g/dm²/h	25 g/dm²/h	not applicable	not applicable
Clariant Max Flight AVIA	50 g/dm²/h	25 g/dm²/h	not applicable	not applicable
Clariant Max Flight SNEG	50 g/dm²/h	25 g/dm²/h	50 g/dm²/h	50 g/dm²/h
Clariant Safewing EG IV NORTH	50 g/dm²/h	25 g/dm²/h	not applicable	not applicable
Clariant Safewing MP IV LAUNCH	50 g/dm²/h	25 g/dm²/h	50 g/dm²/h	50 g/dm²/h
Clariant Safewing MP IV LAUNCH PLUS	50 g/dm²/h	25 g/dm²/h	50 g/dm²/h	50 g/dm²/h
Cryotech Polar Guard® Advance	50 g/dm²/h	25 g/dm²/h	50 g/dm²/h	50 g/dm²/h
Cryotech Polar Guard® Xtend	50 g/dm²/h	25 g/dm²/h	not applicable	not applicable
Dow UCAR Endurance EG106	50 g/dm²/h	25 g/dm²/h	not applicable	not applicable
Dow UCAR FlightGuard AD-49	50 g/dm²/h	25 g/dm²/h	not applicable	not applicable
Inland Technologies ECO-SHIELD®	50 g/dm²/h	25 g/dm²/h	not applicable	not applicable
Kilfrost ABC-S Plus	50 g/dm²/h	25 g/dm²/h	50 g/dm²/h	50 g/dm²/h
LNT Solutions E450	50 g/dm²/h	25 g/dm²/h	not applicable	not applicable
Newave Aerochemical FCY 9311	50 g/dm²/h	25 g/dm²/h	not applicable	not applicable
Oksayd Defrost ECO 4	50 g/dm²/h	25 g/dm²/h	not applicable	not applicable
Oksayd Defrost EG 4	50 g/dm²/h	25 g/dm²/h	not applicable	not applicable
Shaanxi Cleanway Cleansurface IV	50 g/dm²/h	25 g/dm²/h	50 g/dm²/h	50 g/dm²/h

1 The highest precipitation rate to be used as an input to the snow regression equations is constrained by the lower of: (1) the maximum allowable precipitation rate for snow specified in the FAA LWES AC (50 g/dm²/h) or (2) the highest usable precipitation rate (HUPR) for the fluid/dilution/temperature as defined in this table.

2 Type I fluids are limited only by the general precipitation rate limitations set out in the FAA LWES AC.