TP 15156E

Aircraft Ground De/Anti-Icing Fluid Holdover Time Development Program for the 2010-11 Winter


Prepared for

Transportation Development Centre

In cooperation with

Civil Aviation
Transport Canada

and

The Federal Aviation Administration
William J. Hughes Technical Center

Prepared by

APS Aviation Inc.

January 2012
Final Version 1.0

TP 15156E

Aircraft Ground De/Anti-Icing Fluid Holdover Time Development Program for the 2010-11 Winter

by

Stephanie Bendickson

APS Aviation Inc.

January 2012
Final Version 1.0

The contents of this report reflect the views of APS Aviation Inc. and not necessarily the official view or opinions of the Transportation Development Centre of Transport Canada.

The Transportation Development Centre does not endorse products or manufacturers. Trade or manufacturers' names appear in this report only because they are essential to its objectives.

DOCUMENT ORIGIN AND APPROVAL RECORD

Prepared by:

Oct. 9, 2019

Stephanie Bendickson, B.Comm. — Date
Project Analyst

Reviewed by:

Oct. 11, 2019

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

Approved by: **

John Detombe — Date
Chief Engineer
ADGA Group Consultant Inc.

Un sommaire français se trouve avant la table des matières.

This report was first provided to Transport Canada as Final Draft 1.0 in January 2012.
It has been published as Final Version 1.0 in October 2019.

***Final Draft 1.0 of this report was signed and provided to Transport Canada in January 2012. A Transport Canada technical and editorial review was subsequently completed and the report was finalized in October 2019; John Detombe was not available to participate in the final review or to sign the current version of the report.*

PREFACE

Under contract to the Transportation Development Centre of Transport Canada with support from the Federal Aviation Administration, APS Aviation Inc. has undertaken a research program to advance aircraft ground de/anti-icing technology. The specific objectives of the APS Aviation Inc. test program are the following:

- To develop holdover time data for all newly-qualified de/anti-icing fluids and update and maintain the website for the holdover time guidelines;
- To evaluate weather data from previous winters that can have an impact on the format of the holdover time guidelines;
- To conduct general and exploratory de/anti-icing research;
- To conduct endurance time tests simulating vertical stabilizer anti-icing;
- To conduct endurance time tests simulating deployed flaps;
- To conduct endurance time tests with a snow machine in an attempt to refine the current test protocol;
- To conduct full-scale tests on aircraft in order to validate the composite holdover times;
- To conduct endurance time tests in heavy snow conditions;
- To support Federal Aviation Administration and Transport Canada in the development of an advisory circular for the implementation of a HOTDS system;
- To evaluate the use of sensors in determining active frost conditions;
- To initiate research for development of ice detection capabilities for pre-deicing, engine deicing and departing aircraft at the runway threshold;
- To evaluate frost holdover times for use during cold-soaked wing frost conditions;
- To evaluate degraded fluid performance following contamination with runway deicer fluid;
- To update the regression coefficient report with the newly-qualified de/anti-icing fluids;
- To conduct endurance time tests on surfaces treated with ice phobic products;
- To evaluate holdover times for anti-icing in a hangar;
- To conduct research at the National Research Council Canada wind tunnel to further develop and expand ice pellet allowance times;
- To compile a list of lowest operational use temperatures for all de/anti-icing fluids in the holdover guidelines; and
- To conduct various aerodynamic research activities at the National Research Council Canada wind tunnel.

The research activities of the program conducted on behalf of Transport Canada during the winter of 2010-11 are documented in five reports. The titles of the reports are as follows:

- TP 15156E Aircraft Ground De/Anti-Icing Fluid Holdover Time Development Program for the 2010-11 Winter;
- TP 15157E Winter Weather Impact on Holdover Time Table Format (1995-2011);
- TP 15158E Aircraft Ground Icing General Research Activities During the 2010-11 Winter;
- TP 15159E Regression Coefficients and Equations Used to Develop the Winter 2011-12 Aircraft Ground Deicing Holdover Time Tables; and
- TP 15160E Exploratory Wind Tunnel Aerodynamic Research: Examination of Contaminated Anti-Icing Fluid Flow-Off Characteristics Winter 2010-11.

In addition, the following two interim reports are being prepared:

- *Evaluation of De/Anti-Icing Fluid Endurance Times on Extended Flaps and Slats; and*
- *Further Development of Ice Pellet Allowance Times: Wind Tunnel Trials to Examine Anti-Icing Fluid Flow-Off Characteristics Winter 2010-11*

In addition, an interim report entitled *Evaluation of Endurance Times on Extended Flaps and Slats* will be written.

This report, TP15156E, has the following objective:

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

The 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 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 Transport Canada with support from the Federal Aviation Administration, William J. Hughes Technical Center, Atlantic City, NJ. This program could not have been accomplished without the participation of many organizations. APS Aviation Inc. would therefore like to thank the Transportation Development Centre of Transport Canada, the Federal Aviation Administration, National Research Council Canada, the Meteorological Service of Canada, and several fluid manufacturers.

APS Aviation Inc. would also like to acknowledge the dedication of the research team, whose performance was crucial to the acquisition of hard data. This includes the following people: Stephanie Bendickson, Michael Black, Geoffrey Clarke, John D'Avirro, Jesse Dybka, Benjamin Guthrie, Michael Hawdur, Arthur Hughes, Michael Jones, Michelle Pineau, Marco Ruggi, James Smyth, Michal Warchol, David Youssef and Victoria Zoitakis.

Special thanks are extended to Howard Posluns, Yvan Chabot, Yagusha Bodnar, Doug Ingold and Warren Underwood, who on behalf of the Transportation Development Centre 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 a location for outdoor testing; and the fluid manufacturers for providing support and funding.

This page intentionally left blank.

Transport Canada Transports Canada

PUBLICATION DATA FORM

1. Transport Canada Publication No. TP 15156E	2. Project No. B14W	3. Recipient's Catalogue No.
4. Title and Subtitle Aircraft Ground De/Anti-Icing Fluid Holdover Time Development Program for the 2010-11 Winter		5. Publication Date January 2012 6. Performing Organization Document No. CM2169.003
7. Author(s) Stephanie Bendickson		8. Transport Canada File No. 2450-BP-14
9. Performing Organization Name and Address APS Aviation Inc. 6700 Côte-de-Liesse Rd., Suite 105 Montreal, Quebec, H4T 2B5		10. PWGSC File No. TOR-4-37170 11. PWGSC or Transport Canada Contract No. T8156-140243/001/TOR
12. Sponsoring Agency Name and Address Transportation Development Centre Transport Canada 330 Sparks St., 26th Floor Ottawa, Ontario, K1A 0N5		13. Type of Publication and Period Covered Final 14. Project Officer Antoine Lacroix for Howard Posluns

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. These are available from the Transportation Development 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 2010-11 holdover time test program was to evaluate the performance of new deicing and anti-icing fluids over the entire range of conditions encompassed by the holdover time guidelines. The objective was met by conducting endurance time tests. The procedure for these tests consisted of pouring fluids onto clean aluminum and composite material test surfaces inclined at 10º. The onset of failure was recorded as a function of time in natural snow and artificial conditions, including simulated freezing fog, freezing drizzle, light freezing rain, and rain on a cold-soaked wing. A total of 420 tests were conducted with seven fluids.

Changes to the holdover time guidelines for the winter of 2011-12 include:

- A fluid-specific holdover time table was added for Cryotech Polar Guard Advance (new Type IV fluid);
- Octagon MaxFlo and Clariant Safewing MP IV 2012 Protect were removed from the guidelines, resulting to 16 increases to the generic Type IV holdover times;
- Minor increases/decreases ranging from 1 to 4 minutes were made to all eight Type II fluid-specific HOT tables, six Type IV fluid-specific HOT tables and to the generic Type II and Type IV HOT tables as a result of changes made to the Type II/IV HOT rounding protocol;
- The lower limit of the lowest temperature band in the Type II and Type IV fluid specific HOT tables was changed from "-25°C or LOUT" to the actual numeric LOUT value for each fluid;
- The Type I HOT table was divided into two tables: one table containing holdover times for aluminum wing surfaces and a separate table for the holdover times for composite wing surfaces;
- The upper value in the Octagon Max-Flight 04 75/25 below -3 to -14°C snow cell was increased from 1:20 to 1:25 due to a rounding error;
- Additional information was added to the Lowest Operational Use Temperatures (LOUT) table; and
- The Frost table was reformatted to clarify that dilutions apply only to Type II, III and IV fluids.

It is recommended that any new Type I, Type II, Type III or Type IV fluids be evaluated over the entire range of conditions in the holdover time tables. It is also recommended that the development of fluid-specific and fluid application temperature specific guidelines for Type III fluids be initiated in the winter of 2011-12.

17. Key Words Anti-icing, deicing, deicing fluid, holdover times, precipitation, endurance times, Type I, Type II, Type III, Type IV, aircraft, ground, test, winter	18. Distribution Statement Limited number of copies available from the Transportation Development Centre

19. Security Classification (of this publication)	20. Security Classification (of this page)	21. Declassification (date)	22. No. of Pages	23. Price
Unclassified	Unclassified	—	xx, 82 apps	—

CDT/TDC 79-005
Rev. 96

Canada

Transports Canada Transport Canada

FORMULE DE DONNÉES POUR PUBLICATION

1. N° de la publication de Transports Canada TP 15156E	2. N° de l'étude B14W	3. N° de catalogue du destinataire
4. Titre et sous-titre Aircraft Ground De/Anti-Icing Fluid Holdover Time Development Program for the 2010-11 Winter		5. Date de la publication Janvier 2012 6. N° de document de l'organisme exécutant CM2169.003
7. Auteur(s) Stephanie Bendickson		8. N° de dossier - Transports Canada 2450-BP-14
9. Nom et adresse de l'organisme exécutant APS Aviation Inc. 6700, Chemin de la Côte-de-Liesse, Bureau 105 Montréal (Québec) H4T 2B5		10. N° de dossier - TPSGC TOR-4-37170 11. N° de contrat - TPSGC ou Transports Canada T8156-140243/001/TOR
12. Nom et adresse de l'organisme parrain Centre de développement des transports Transports Canada 330, rue Sparks, 26ième étage Ottawa (Ontario) K1A 0N5		13. Genre de publication et période visée Final 14. Agent de projet Antoine Lacroix pour Howard Posluns

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. Ils sont disponibles au Centre de développement des transports. 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 2010-2011 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 la neige naturelle 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 420 essais ont été menés, avec sept liquides.

Parmi les changements apportés aux lignes directrices relatives aux durées d'efficacité pour l'hiver 2011-2012, on note ce qui suit :

- Un tableau des durées d'efficacité spécifique au liquide Cryotech Polar Guard Advance (un nouveau liquide de type IV) a été ajouté ;
- Les liquides Octagon MaxFlo et Clariant Safewing MP IV 2012 Protect ont été retirés des lignes directrices, ce qui a entraîné l'augmentation, dans 16 cas, des durées d'efficacité génériques des liquides de type IV ;
- Des augmentations ou diminutions mineures, allant de 1 à 4 minutes, ont été appliquées à l'ensemble des huit tableaux des durées d'efficacité spécifiques aux liquides de type II et à six tableaux des durées d'efficacité spécifiques aux liquides de type IV, ainsi qu'aux tableaux génériques des durées d'efficacité des liquides de type II et de type IV, en raison des changements apportés au protocole régissant l'arrondissement des durées d'efficacité des liquides de type II ou de type IV ;
- La limite inférieure de la plus basse plage de température des tableaux des durées d'efficacité spécifiques aux liquides de type II et de type IV est passée de « -25 °C ou LOUT » à la valeur numérique réelle de la température minimale d'utilisation opérationnelle (LOUT) pour chacun des liquides ;
- Le tableau des durées d'efficacité des liquides de type I a été divisé en deux tableaux, l'un renfermant les durées d'efficacité qui s'appliquent aux ailes dont les surfaces sont en aluminium et l'autre, distinct, contenant les durées d'efficacité qui s'appliquent aux ailes dont les surfaces sont en matériaux composites ;
- La valeur supérieure de la cellule « neige, au-dessous de -3 à -14 °C » du tableau du liquide Octagon Max-Flight 04 75/25 a été augmentée de 1:20 à 1:25 en raison d'une erreur d'arrondissement ;
- Des informations supplémentaires ont été ajoutées au tableau des températures minimales d'utilisation opérationnelle (LOUT) ; et
- Le tableau des durées d'efficacité dans des conditions de givre a été reformaté pour préciser que les dilutions ne s'appliquent qu'aux liquides de types II, III et IV.

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. Il est également recommandé que l'élaboration de lignes directrices spécifiques aux liquides de type III et à leurs températures d'application soit amorcée au cours de l'hiver 2011-2012.

17. Mots clés Antigivrage, dégivrage, liquide de dégivrage, durées d'efficacité, précipitation, temps d'endurance, type I, type II, type III, type IV, aéronef, sol, essai, hiver	18. Diffusion Le Centre de développement des transports dispose d'un nombre limité d'exemplaires

19. Classification de sécurité (de cette publication) Non classifiée	20. Classification de sécurité (de cette page) Non classifiée	21. Déclassification (date) —	22. Nombre de pages xx, 82 ann.	23. Prix —

CDT/TDC 79-005
Rev. 96

Canada

EXECUTIVE SUMMARY

Under contract to the Transportation Development Centre of Transport Canada, 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 holdover time tests with several de/anti-icing fluids. This report also documents all changes made to the HOT guidelines for the winter of 2011-12.

Test Procedures

Test conditions, test parameters, and test bed specifications were determined based on the requirements of Aerospace Recommended Practice (ARP) 5485 and ARP5495, which were developed by the SAE International (SAE) G-12 HOT Committee 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 and composite material 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 measured during testing included: failure time, type of precipitation, rate of precipitation, visibility, wind speed, wind direction, ambient temperature, test surface temperature, fluid brand, fluid type, and fluid concentration.

Data Collection and Testing

During the 2010-11 test season, data was collected during natural snow events at the APS test site at Montreal-Trudeau Airport in Montreal and in simulated precipitation conditions, including freezing drizzle, light freezing rain, freezing fog, and rain on cold-soaked surfaces, at the National Research Council Canada (NRC) Climatic Engineering Facility (CEF) in Ottawa.

APS conducted 420 tests in the winter of 2010-11. The results of testing were incorporated into the winter 2011-12 HOT guidelines.

Changes to the HOT Guidelines

The changes below were made to the HOT guidelines for Winter 2011-12.

1. A new fluid-specific HOT table was added to the Type IV guidelines for new fluid Cryotech Polar Guard Advance. The addition of the new table did not affect the generic holdover times.

2. Clariant Safewing MP IV 2012 Protect and Octagon MaxFlo were removed from the Type IV guidelines as per the protocol for removing obsolete data. The removal of these fluids resulted in 16 increases being made to the generic Type IV holdover times.

3. Minor increases/decreases ranging from 1 to 4 minutes were made to all eight Type II fluid-specific HOT tables, six Type IV fluid-specific HOT tables and to the generic Type II and Type IV HOT tables as a result of changes made to the Type II/IV HOT rounding protocol.

4. The lower limit of the lowest temperature band in the Type II and Type IV fluid-specific HOT tables was changed from "-25°C or LOUT" to the actual numeric lowest operational use temperature (LOUT) value for each fluid.

5. The Type I HOT table was divided into two tables: one table containing holdover times for aluminum wing surfaces and a separate table for the holdover times for composite wing surfaces.

6. The upper value in the Octagon Max-Flight 04 75/25 below -3 to -14°C snow cell was increased from 1:20 to 1:25 due to a rounding error.

7. Additional information was added to the LOUT table.

8. The Frost table was reformatted to clarify that dilutions apply only to Type II, III and IV fluids.

Recommendations

It is recommended that any new Type I, Type II, Type III or Type IV fluids be evaluated over the entire range of conditions encompassed by the HOT tables. It is also recommended that fluid-specific and fluid application temperature specific HOT guidelines for Type III fluids be developed in the winter of 2011-12.

SOMMAIRE

En vertu d'un contrat avec le Centre de développement des transports de Transports Canada, 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 2011-2012.

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 ARP5485 et ARP5495, élaborées par le comité G-12 de la SAE International (SAE) sur les durées d'efficacité pour les liquides de types II/III/IV et 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, 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 2010-2011 concernaient des tests sous neige naturelle menés à l'installation d'essai d'APS, à l'aéroport Montréal-Trudeau, à Montréal dans des conditions de précipitations simulées incluant de la bruine verglaçante, de la pluie verglaçante faible, du brouillard verglaçant et de la 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 2010-2011, un total de 420 essais ont été menés par APS. Les résultats des essais effectués ont été inclus dans les lignes directrices relatives aux durées d'efficacité pour l'hiver 2011-2012.

Changements aux lignes directrices sur les durées d'efficacité

Les changements ci-dessous ont été apportés aux lignes directrices relatives aux durées d'efficacité pour l'hiver 2011-2012.

1. Un nouveau tableau des durées d'efficacité spécifique au liquide de type IV Cryotech Polar Guard Advance a été ajouté aux lignes directrices. L'ajout de ce nouveau tableau n'a eu aucune incidence sur les durées d'efficacité génériques.
2. Les liquides Clariant Safewing MP IV 2012 Protect et Octagon MaxFlo ont été retirés des lignes directrices relatives aux liquides de type IV, conformément au protocole régissant le retrait des données obsolètes. Le retrait de ces liquides a entraîné l'augmentation, dans 16 cas, des durées d'efficacité génériques des liquides de type IV.
3. Des augmentations ou diminutions mineures, allant de 1 à 4 minutes, ont été appliquées à l'ensemble des huit tableaux des durées d'efficacité spécifiques aux liquides de type II et à six tableaux des durées d'efficacité spécifiques aux liquides de type IV, ainsi qu'aux tableaux génériques des durées d'efficacité des liquides de type II et de type IV, en raison des changements apportés au protocole régissant l'arrondissement des durées d'efficacité des liquides de type II ou de type IV.
4. La limite inférieure de la plus basse plage de température des tableaux des durées d'efficacité spécifiques aux liquides de type II et de type IV est passée de « -25 °C ou LOUT » à la valeur numérique réelle de la température minimale d'utilisation opérationnelle (LOUT) pour chacun des liquides.
5. Le tableau des durées d'efficacité des liquides de type I a été divisé en deux tableaux, l'un renfermant les durées d'efficacité qui s'appliquent aux ailes dont les surfaces sont en aluminium et l'autre, distinct, contenant les durées d'efficacité qui s'appliquent aux ailes dont les surfaces sont en matériaux composites.
6. La valeur supérieure de la cellule « neige, au-dessous de -3 à -14 °C » du tableau du liquide Octagon Max-Flight 04 75/25 a été augmentée de 1:20 à 1:25 en raison d'une erreur d'arrondissement.
7. Des informations supplémentaires ont été ajoutées au tableau des températures minimales d'utilisation opérationnelle.

8. Le tableau des durées d'efficacité dans des conditions de givre a été reformaté pour préciser que les dilutions ne s'appliquent qu'aux liquides de types II, III et IV.

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. Il est également recommandé que l'élaboration de lignes directrices spécifiques aux liquides de type III et à leurs températures d'application soit amorcée au cours de l'hiver 2011-2012.

This page intentionally left blank.

CONTENTS

Page

LIST OF APPENDICES

LIST OF TABLES **Page**

GLOSSARY

AMS	Aerospace Material Specification
APS	APS Aviation Inc.
ARP	Aerospace Recommended Practice
CEF	Climatic Engineering Facility
FAA	Federal Aviation Administration
HOT	Holdover Time
LOUT	Lower Operational Use Temperature
MSC	Meteorological Service of Canada
NRC	National Research Council Canada
SAE	SAE International
TDC	Transportation Development Centre
WSET	Water Spray Endurance Test

This page intentionally left blank.

1. INTRODUCTION

Under winter precipitation conditions, aircraft are cleaned with a freezing point depressant fluid and protected against further accumulation by an additional application of such a fluid, possibly thickened to extend the protection time. Aircraft ground deicing had, until recently, never been researched and there is still an incomplete understanding of the hazard and of what can be done to reduce the risks posed by the operation of aircraft in winter precipitation conditions. This "winter operations contaminated aircraft – ground" program of research is aimed at overcoming this lack of knowledge.

Since the early 1990s, the Transportation Development Centre (TDC) of Transport Canada has managed and conducted de/anti-icing related tests at various sites in Canada; it has also coordinated worldwide testing and evaluation of evolving technologies related to de/anti-icing operations with the co-operation of the United States Federal Aviation Administration (FAA), the National Research Council Canada (NRC), the Meteorological Service of Canada (MSC), several major airlines, and deicing fluid manufacturers. The TDC is continuing its research, development, testing and evaluation program.

Under contract to the TDC, with financial support from the FAA, APS Aviation Inc. (APS) has undertaken research activities to further advance aircraft ground de/anti-icing technology.

1.1 Background

APS has completed considerable testing related to de/anti-icing fluids on behalf of Transport Canada over the past two decades. Specifically, research has been conducted to determine fluid holdover times, to substantiate holdover time (HOT) tables, and to further the knowledge and development of deicing technology. A summary of the holdover time related research activities completed by APS is provided in Table 1.1.

1.2 Objectives

The primary objectives of the 2010-11 holdover time 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 2011-12.

The detailed objectives of the 2010-11 test program are provided in the work statement given in Appendix A.

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 (100/0)	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) • Simulated Snow (prelim)	• Type I • Type II (100/0) • 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)	• Primarily: Type II (75/25, 50/50) • Also: Type I, Type II (100/0)	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 (100/0) • 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 • Simulated Snow	• Type I • Type II • Type IV (LV)	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 • Simulated Snow • Preliminary Frost	• Type I • Type II • Type IV	Montreal Ottawa (NRC) Varennes (IREQ)
2000-01	TP 13826E	• Natural Snow • Simulated Freezing Drizzle • Simulated Light Freezing Rain • Simulated Freezing Fog (indoor) • Rain on a Cold-Soaked Surface • Simulated Snow • Preliminary Frost	• Type I • Type II • Type IV	Montreal Ottawa (NRC) Varennes (IREQ)

M:\Groups\CM2169.003 (10-11)\Reports\HOT\Working Documents\Table 1.1

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

Year	TDC Publication #	Conditions Tested	Fluids Tested	Test Locations
2001-02	TP 13991E	• Natural Snow • Simulated Freezing Drizzle • Simulated Light Freezing Rain • Simulated Freezing Fog (indoor) • Rain on a Cold-Soaked Surface • Simulated Snow • Preliminary Frost	• Type I • Type II • Type IV	Montreal Ottawa (NRC) Val D'Or North Bay Thompson, MB
2002-03	TP 14144E	• Natural Snow • Simulated Freezing Drizzle • Simulated Light Freezing Rain • Simulated Freezing Fog (indoor) • Rain on a Cold-Soaked Surface • Simulated Snow • Preliminary Frost	• Type I • Type II • Type IV	Montreal Ottawa (NRC) Varennes (IREQ) St-Alexis
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 • Simulated Snow	• Type II • Type III	Montreal Ottawa (NRC) Val d'Or Ste-Adele
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 / Ice Pellet 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 • Simulated Snow • Ice Pellets / Ice Pellet Mixed Conditions	• Type I • Type II • Type IV	Montreal Ottawa (NRC)
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 • Simulated Snow • Ice Pellets / Ice Pellet Mixed Conditions • Snow Pellets	• Type II • Type III • 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
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 / Ice Pellet 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 / Ice Pellet Mixed Conditions • Snow Pellets	• Type I • Type II • Type IV	Montreal Val d'Or Dolbeau-Mistassini Thetford Mines St-Sauveur Ottawa (NRC)
2010-11	TP 15156E	• Natural Snow • Simulated Freezing Drizzle • Simulated Light Freezing Rain • Simulated Freezing Fog (indoor) • Rain on a Cold-Soaked Surface • Simulated Snow • Ice Pellets / Ice Pellet Mixed Conditions	• Type I • Type II • Type IV	Montreal Ottawa (NRC)

M:\Groups\CM2169.003 (10-11)\Reports\HOT\Working Documents\Table 1.1

1.3 Content of this Report

APS has written a report on the holdover time 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 over the previous year's report. Key changes are listed below.

- Removal of the detailed methodology section. For this information the reader is directed to the 2002-03 report on holdover time testing, Transport Canada report, TP 14144E, *Aircraft Ground De/Anti-Icing Fluid Holdover Time Development Program for the 2002-03 Winter* (1). Any changes from the 2002-03 methodology are addressed in the current report.

- Removal of individual fluid data. This information is included in the individual fluid reports provided to the fluid manufacturers. Reports for any fluids that are qualified or expected to be qualified are included as appendices to the HOT report.

- Removal of the fluid thickness section. This information is included in the individual fluid reports provided to the fluid manufacturers.

In the winter of 2009-10, a decision was made to include detailed test information in this report only for fluids that are expected to be qualified and commercialized.

The 2010-11 report is presented as described above.

1.4 Report Format

The subsequent sections of this report contain the following:

a) Section 2 summarizes 2010-11 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 presents conclusions derived from the test program; and

g) Section 8 lists recommendations for future testing.

1.5 Publication of HOT Guidelines

The HOT guidelines are currently published on the following Transport Canada website:

- http://www.tc.gc.ca/eng/civilaviation/standards/commerce-holdovertime-menu-1877.htm

For a thorough understanding of the subject matter, the HOT guidelines should be used in conjunction with TP 14052E, *Guidelines for Aircraft Ground Icing Operations (Second Edition)* (2), which includes reference material related to ground icing operations. TP 14052E (2) is also available on the Transport Canada website.

This page intentionally left blank.

2. TESTING IN 2010-11

2.1 Procedures

Test procedures for holdover time testing of Type II, III and IV fluids were developed in accordance with SAE International (SAE) Aerospace Recommended Practice (ARP) 5485, *Endurance Time Tests for Aircraft Deicing/Anti-Icing Fluids: SAE Type II, III, and IV* (3). Test procedures for holdover time testing of Type I fluids were developed in accordance with SAE ARP5945, *Endurance Time Tests for Aircraft Deicing/Anti-Icing Fluids: SAE Type I* (4).

Because this report serves as the publishing vehicle for the APS endurance time test program, all of the 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 the 2010-11 winter are included in Appendix B. They include:

1. Test Requirements for Natural Precipitation Flat Plate Testing;
2. Determination of Endurance Times of Type I Fluids Under Natural Snow Precipitation at Dorval;
3. Test Requirements for Simulated Freezing Precipitation Flat Plate Testing;
4. Overall Program of Tests at NRC, April 2011; and
5. Overall Program of Tests at NRC, July 2011.

The first two procedures provide the detailed test methodology for natural snow testing. The third procedure provides the detailed test methodology for indoor simulated light freezing rain, freezing fog, freezing drizzle and rain on cold-soaked surface testing.

The fourth and fifth procedures were developed to coordinate holdover time testing and other aircraft ground icing research projects at APS indoor simulated precipitation test sessions in 2011. Holdover time testing and other program element testing were conducted at these sessions to maximize use of the facility and resources. The procedures provide detailed test plans, personnel assignments, fluid requirements and the precipitation schedules.

The endurance time test methodology is described in detail in the Transport Canada report, TP 14144E, *Aircraft Ground De/Anti-Icing Fluid Holdover Time Development Program for the 2002-03 Winter* (1).

2.2 Test Sites

In the winter of 2010-11, data was collected in natural snow at the APS test site at the Pierre Elliott Trudeau Airport in Montreal and in simulated precipitation conditions (freezing drizzle, light freezing rain, freezing fog and rain on cold-soaked surfaces) at the NRC Climatic Engineering Facility (CEF) in Ottawa.

2.3 Fluids Tested

Seven fluids were submitted for endurance time testing in the winter of 2010-11. As per the protocol described in Section 1.3, only the endurance time results of fluids that are expected to be qualified/commercialized are published in this report; the results of any other fluids that undergo testing are provided only to the fluid manufacturer(s).

Of the seven fluids submitted for testing in 2010-11:

- Two fluids underwent a complete set of testing and are expected to be qualified and commercialized for the winter of 2011-12. The results of testing with these fluids are provided in this report (see Appendix C and Appendix D);
- One fluid underwent a complete set of testing but the manufacturer chose not to commercialize the fluid and therefore the results will not be provided in this report; and
- Four fluids were experimental fluids which underwent testing in a limited number of conditions. These fluids will not be commercialized and therefore the results will not be provided in this report.

Additional relevant fluid receipt data for the two commercialized fluids, Cryotech Polar Guard Advance (Type IV) and Octagon EcoFlo 2 (Type I), is provided in Table 2.1. Fluid viscosity and Brix information for the commercialized fluids is given in Table 2.2. Fluid freeze point, lowest operational use temperature (LOUT) and water spray endurance test (WSET) result information is provided in Table 2.3.

2.4 Description of Tests

In total, 420 endurance time tests were conducted during the winter of 2010-11. A summary of the total number of tests conducted is shown by precipitation condition in Table 2.4. Details for each test are included in the detailed reports provided to the manufacturers (see Subsection 2.5).

Table 2.1: Fluid Receipt Data (Commercialized Fluids)

Fluid Manufacturer	Fluid Name	Fluid Type	Fluid Formulation	Date Received	Dilution(s) Received	Batch #
Cryotech	Polar Guard Advance	IV	Propylene Glycol	23-Feb-11	100%, 75%, 50%	1.042.1430
Octagon*	EcoFlo 2	I	Non-Glycol	12-Jul-11	Concentrate	52620-76

* Fluid was submitted by Battelle but commercialized under the Octagon brand name. Manufacturer of this fluid is referred to as Octagon throughout this report.

Table 2.2: Fluid Brix and Viscosity (Commercialized Fluids)

Fluid	Fluid Dilution	Brix Measured	Viscosity Manufacturer Method (mPa.s)		Viscosity AIR 9968 Method (mPa.s)	
			Stated	Measured	Stated	Measured
Polar Guard Advance	100%	35.75°	3,800 [1]	4,400 [1]	4,120 [2]	4,050 [2]
	75%	28.00°	8,840 [1]	11,600 [1]	9,800 [2]	9,750 [2]
	50%	19.75°	80 [2]	80 [2]	80 [2]	80 [2]
EcoFlo 2	Conc.	>50°	n/a	n/a	n/a	n/a

[1] Spindle SC4-34/13R, small sample adapter, 10 mL of fluid, 20°C, 0.3 rpm, for 10 minutes 0 seconds
[2] Spindle LV1 with guard leg, 600 mL beaker, 500 mL of fluid, 20°C, 0.3 rpm, for 10 minutes 0 seconds

Table 2.3: Fluid Freeze Point, LOUT and WSET (Commercialized Fluids)

Fluid	Fluid Dilution	WSET (AMIL)	Freeze Point (Stated)	LOUT (Stated)
Polar Guard Advance	100%	93 mins	-37.6°C	-30.5°C
	75%	n/a	-25.0°C	-18.0°C
	50%	n/a	-20.5°C	-9.0°C
EcoFlo 2	Conc.	4.9 mins (50/50)	n/a	-29°C [1] (65/35 dilution)

[1] High speed ramp. Low speed ramp not conducted.

Table 2.4: Summary of Tests Conducted

Precipitation Condition	Tests Conducted
Freezing Fog	90
Natural Snow	115
Freezing Drizzle	105
Light Freezing Rain	86
Rain on Cold-Soaked Surface	24
Total	**420**

2.5 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 the protocol described in Subsection 1.3, copies of the reports for fluids which were expected to be qualified/commercialized have been included as appendices to this report. The relevant reports can be found in Appendix C (Octagon EcoFlo 2) and Appendix D (Cryotech Polar Guard Advance).

2.6 Composite Surfaces Research

Preliminary correlation testing was conducted with an operational aircraft in the winter of 2010-11 to validate the current Type I composite surface holdover times. This research is documented in the Transport Canada report, TP 15158E, *Aircraft Ground Icing General Research Activities During the 2010-11 Winter* (5). The research showed that composite surfaces generally absorb less heat and cool more quickly than aluminum surfaces. This supports the findings from previous tests on composite surface flat plates.

2.7 Light Snow and Very Light Snow Holdover Times for Type II/IV Fluids

An analysis was completed to evaluate the feasibility of expanding the current Type II/IV fluid HOT tables to include light snow and very light snow holdover times. The analysis concluded that the approach is feasible; however, some of the existing data sets may not have enough data to provide reliable holdover times. Further work is recommended; it is possible light and very light snow holdover times will be added to the Type II/IV HOT guidelines for winter 2012-13. This work is documented in TP 15158E (5).

2.8 Ice Pellet Research

Further research was conducted with ice pellets in the winter of 2010-11. As the research will continue in the winter of 2011-12, it was documented in an interim report, which was provided to Transport Canada and the FAA. A final report will be written upon completion of the research.

No changes were made to the ice pellet allowance time table as a result of the winter 2010-11 research.

2.9 Collection of LOUT Data

At the request of users, Lowest Operational Use Temperature (LOUT) information for all fluids was added to the HOT guidelines in the winter of 2010-11. This information was provided by the fluid manufacturers and collected by APS. Due to the short time available for the initial development of the LOUT table, the information published in the 2010-11 guidelines was incomplete and included some discrepancies. Changes were made to the LOUT table in July 2011 to reflect new data collected from the fluid manufacturers since the last publication.

APS was responsible for collecting the new LOUT data and updating the LOUT table for the winter 2011-12 HOT guidelines accordingly. This work is documented in detail in TP 15158E (5).

2.10 Documentation of Freezing Precipitation Stand Setup and Sprayer Characteristics

During the April 2011 and July 2011 test sessions at the NRC climate chamber, work was completed to document the characteristics of the test stand setup and sprayer system in all 18 simulated freezing precipitation conditions. The data collected included final stand position, area of spray zone, cycle time and time of plate impact (as per the procedure in Appendix B for the April 2011 testing). The final data is included in Appendix E.

This page intentionally left blank.

3. CHANGES TO THE TYPE I HOT GUIDELINES

Changes made to the Type I HOT guidelines for the winter of 2011-12 are documented in this chapter. The Transport Canada and FAA 2011-12 generic Type I HOT guidelines are included in Appendix F.

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 the endurance times of Type I deicing fluids formulated with propylene glycol, ethylene glycol or diethylene glycol be measured. However, they do require that the endurance times of fluids formulated with other glycol bases or with non-glycol bases be measured. This is to ensure the endurance time performance of these fluids are similar to the performance of the Type I fluids used to generate the currently accepted values in the Type I HOT table.

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 propylene glycol, ethylene glycol or diethylene glycol based.

One Type I fluid was submitted for endurance time testing in 2010-11.

3.1.1 Octagon EcoFlo 2

Octagon EcoFlo 2, a non-glycol based fluid, was submitted for endurance time testing in 2010-11. The detailed test results and analysis are included in the test report that was provided to the fluid manufacturer and which is included in Appendix C.

The results of the testing conclude that Octagon EcoFlo 2 performs similarly to Type I fluids tested in past years and therefore can be used with the generic Type I HOT guidelines.

3.2 Changes to HOT Guidelines Format

As a result of feedback from users, the Type I HOT table was divided into two separate tables for the winter of 2011-12. One table contains the holdover times for aluminum surfaces, while the other table contains the holdover times for composite surfaces. Guidance appears at the top of the tables to help users select the appropriate table. The holdover time values in the table did not change; they were simply moved into the appropriate table.

3.3 Type I Generic Holdover Time Values

No changes were made to the Type I generic holdover times for the winter of 2011-12.

4. CHANGES TO THE TYPE II HOT GUIDELINES

Changes made to the Type II HOT guidelines for the winter of 2011-12 are documented in this chapter. The Transport Canada and FAA 2011-12 Type II HOT guidelines are included in Appendix F.

4.1 New Fluids/Data

No new Type II fluids were tested in the winter of 2010-11 and/or added to the HOT guidelines for 2011-12.

Due to a change in the rounding protocol for Type II/IV holdover times, the Type II fluid-specific holdover time data was re-examined in the winter of 2010-11 and updates were made to the winter 2011-12 HOT guidelines.

Previously, the rounding protocol that was used for Type II/IV holdover times was to round holdover times below 10 minutes down to 5 minutes. The new protocol is for holdover times below 10.0 minutes to be rounded down to the nearest 1 minute (for example, 9.8 minutes becomes 9 minutes). The new protocol also specifies that one decimal place be considered when looking at raw holdover times (i.e. 9.8 minutes).

The entire Type II holdover time database was examined. All raw Type II holdover times less than 10.0 minutes were examined to determine the new appropriate rounded value. The changes made to the fluid-specific holdover times also resulted in several changes to the generic holdover times. The changes made as a result of this analysis are shown in Table 4.1.

The new rounding protocol is detailed in SAE ARP5718, *Qualification Process for SAE AMS1428 Type II, III, and IV Fluids* (6).

4.2 Removed Fluids/Data

No fluids or data were removed from the Type II HOT guidelines for the winter of 2011-12.

4.3 Changes to HOT Guidelines Format

One change was made to the format of the Type II HOT guidelines for the winter of 2011-12: the lower limit of the lowest temperature band in the fluid-specific HOT tables was changed from "-25°C or LOUT" to the actual numeric lowest operational use temperature (LOUT) value for the fluid.

Table 4.1: New Rounded Type II Holdover Times

Fluid	Fluid Dilution	Cell			Raw HOT	Previous Rounded HOT	New Rounded HOT
		Precip.	Temp. (°C)	Lower/Upper			
ABAX Ecowing 26	50/50	Freezing Rain	-3	lower	8.1	5	8
Aviation Shaanxi Cleanwing II	75/25	Cold-Soaked Wing	1	lower	7.4	5	7
Clariant Safewing 1951*	50/50	Snow	-3	lower	6.0	5	6
Clariant Safewing 1951*	50/50	Freezing Drizzle	-3	lower	8.4	5	8
Clariant Safewing 1951*	50/50	Freezing Rain	-3	lower	6.5	5	6
Clariant Safewing 1951*	50/50	Freezing Rain	-3	upper	9.5	10	9
Clariant Safewing 1951*	75/25	Cold-Soaked Wing	1	lower	7.8	5	7
Clariant Safewing 2025	50/50	Snow	-3	lower	9.7	5	9
Clariant Safewing 2025	50/50	Freezing Rain	-3	lower	7.5	5	7
Clariant Safewing 2025	75/25	Cold-Soaked Wing	1	lower	8.6	5	8
Clariant Safewing Flight	75/25	Cold-Soaked Wing	1	lower	6.0	5	6
Kilfrost ABC 2000	50/50	Freezing Rain	-3	lower	8.7	5	8
Kilfrost ABC-K Plus	50/50	Snow	-3	lower	7.5	5	7
Kilfrost ABC-K Plus	75/25	Freezing Rain	-10	lower	9.0	5	9
Newave Aerochemical FCY-2	50/50	Freezing Rain	-3	lower	7.7	5	7
Newave Aerochemical FCY-2	75/25	Freezing Rain	-10	lower	8.1	5	8
Newave Aerochemical FCY-2	Neat	Cold-Soaked Wing	1	lower	8.3	5	8
Octagon E Max II	50/50	Freezing Rain	-3	lower	9.5	10	9
Type II Generic	50/50	Freezing Drizzle	-3	lower	8.4	5	8
Type II Generic	50/50	Freezing Rain	-3	upper	9.5	10	9
Type II Generic	75/25	Freezing Rain	-10	lower	8.1	5	8
Type II Generic	Neat	Cold-Soaked Wing	1	lower	8.3	5	8

* Clariant Safewing 1951 does not have a fluid-specific table; however, its holdover times are used in the creation of the Type II generic holdover time values and therefore must be included in this analysis.

4.4 Type II Generic Holdover Time Values

The generic HOT guidelines for Type II fluid were developed prior to 1996-97 based on the results of endurance time tests with "grandfathered" fluids, such as Kilfrost ABC-3. Since 1999-2000, fluid-specific holdover times have been developed for each new Type II fluid tested, and the generic Type II holdover times have been generated each year by taking the shortest holdover times of all fluids on the list of qualified Type II fluids (given as Table 5-2 in the Transport Canada HOT Guidelines) and the "grandfathered" fluid data. The "grandfathered" fluid data remains in the analysis to account for the performance of the "grandfathered" fluids that remain on the list of qualified fluids; these fluids do not have fluid-specific holdover time data available. Since all Type IV fluids also qualify as Type II fluids, Type IV fluids are also included in the Type II generic analysis.

It should be noted that the list of qualified Type II fluids also includes fluids whose qualifications have recently expired (i.e. within the previous four years). These "recently expired" fluids are also included in the Type II generic analysis. When a fluid is removed from the list of qualified Type II fluids (four years after its qualification has expired) it is also removed from the Type II generic analysis.

It should also be noted that a fluid-specific table is no longer produced for Clariant Safewing MP II 1951, but the fluid is still available for use with the generic HOT guidelines and therefore is still used in the calculation of generic Type II holdover times.

4.4.1 Use of Generic Holdover Times in Very Cold Snow

Following the winter of 2003-04, a decision was made that fluid-specific holdover times would not be provided for Type II fluids in snow at temperatures below -14°C. This was due to the limited data that exits for most fluids at these temperatures. Instead, all Type II fluids are given pre-established "generic" holdover times in very cold snow. These holdover times were determined based on historical data and analysis.

4.4.2 Impact of New and Removed Fluids/Data

Although no new fluids were added or old fluids removed this year, the updates made to the rounded Type II holdover times did have an impact on the Type II generic holdover times. Four changes were made in total: three 3-minute increases and one 1-minute decrease. The changes are detailed in Table 4.1.

4.4.3 Fluids Responsible for Type II Generic Holdover Time Values

The fluids responsible for the values in the generic Type II HOT guidelines in 2011-12 are shown in Table 4.2. "Grandfather" is indicated where "grandfathered" fluids are responsible for times in the cells. "Type IV" is indicated where Type IV fluids are responsible for times in the cells. 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 4.2: Fluids Responsible for Type II Generic Holdover Time Values

OAT °C	OAT °F	Type II Fluid Concentration Neat Fluid/Water (vol % / vol %)	FREEZING FOG	SNOW	FREEZING DRIZZLE	LIGHT FREEZING RAIN	RAIN ON COLD SOAKED WING
			Approximate Holdover Times Under Various Weather Conditions (hours:minutes)				
-3 and above	27 and above	100/0	Grandfather **(B)**	Grandfather **(B)** C-1951 **(B)**	Grandfather **(L)** C-1951 **(U)**	Grandfather **(B)** C-1951 **(U)**	N-FCY-2 **(L)** Grandfather **(U)**
		75/25	Grandfather **(B)**	Grandfather **(B)** C-1951 **(L)**	Grandfather **(B)** C-1951 **(U)** C-2025 **(U)** N-FCY-2 **(U)**	Grandfather **(B)** C-1951 **(U)** C-2025 **(U)** N-FCY-2 **(U)**	Grandfather **(B)** N-FCY-2 **(B)**
		50/50	Grandfather **(L)** Type IV **(L)** C-1951 **(U)**	Grandfather **(B)** C-1951 **(U)** C-2025 **(U)** ABC-K+ **(U)** Type IV **(U)**	C-1951 **(B)** C-2025 **(U)**	Grandfather **(L)** C-1951 **(U)**	
below -3 to -14	below 27 to 7	100/0	Type IV **(L)** ABC-K+ **(U)**	N-FCY-2 **(B)** Grandfather **(L)**	N-FCY-2 **(B)** Type IV **(L)**	Grandfather **(L)** K2000 **(L)** Type IV **(L)** N-FCY-2 **(U)**	
		75/25	Type IV **(B)** Grandfather **(L)** ABC-K+ **(L)** C-Flight **(L)**	N-FCY-2 **(B)**	N-FCY-2 **(B)** Type IV **(L)**	N-FCY-2 **(B)**	
below -14 to -25 or LOUT	below 7 to -13 or LOUT	100/0	Type IV **(L)** E II **(U)** N-FCY-2 **(U)**	Grandfather **(B)**			

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

M:\Groups\PM2169.003\Reports\HOT\Working Documents\Fluids Responsible for Generic Table Values At: Type II

4.4.4 Evolution of Type II Generic Holdover Time Values

The history of Type II fluid testing and the evolution of the fluid-specific and generic Type II holdover time values are illustrated through a series of tables presented in Tables 4.2 to 4.26. Each table represents one cell in the HOT guidelines and the title of the table links the table to the appropriate cell. Fluids that are no longer used in the generic analysis (see Subsection 4.2) are not included.

The first row in each table contains the generic values from testing in 1998-99, also known as the "grandfathered" fluid data. Each subsequent set of two rows represents a winter test season and the subsequent winter's HOT table values. The final line contains the generic and fluid-specific holdover time values for use in 2011-12 winter operations.

Underlined values indicate the fluid or fluids responsible for the generic holdover time. If the value in the first row is underlined, it indicates that the generic value is based on the "grandfathered" fluid data set.

Strikethrough values indicate endurance time test results that are not valid; this is typically a result of testing in multiple years (details are usually provided in the HOT report written in the most recent year the fluid underwent testing).

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

- Clariant Safewing MP II 1951 (C-1951);
- ABAX Ecowing 26 (A-E26);
- Kilfrost ABC-2000 (K2000);
- Octagon E Max II (E II);
- Clariant Safewing MP II 2025 ECO (C-2025);
- Clariant Safewing MP II Flight (C-Flight);
- Newave Aerochemical FCY-2 (N-FCY-2);
- Kilfrost ABC-K Plus (ABC-K+); and
- Aviation Shaanxi Hi-tech Cleanwing II (AS CII).

Table 4.3: Type II Neat Fluid, Snow, -3ºC and Above

		GENERIC	C-1951	A-E26	K2000	E II	C-2025	C-Flight	N-FCY-2	ABC-K+	AS CII
HISTORICAL	1998-99 HOT Table Values	0:20-0:45									
	1998-99 ET Test Results										
	1999-00 HOT Table Values	0:20-0:45									
	1999-00 ET Test Results		0:20-0:45								
	2000-01 HOT Table Values	0:20-0:45	0:20-0:45								
	2000-01 ET Test Results			0:40-1:00							
	2001-02 HOT Table Values	0:20-0:45	0:20-0:45	0:40-1:00							
	2001-02 ET Test Results				0:30-1:00	0:40-1:20					
	2002-03 HOT Table Values	0:20-0:45		0:40-1:00	0:30-1:00	0:40-1:20					
	2002-03 ET Test Results						0:40-1:10				
	2003-04 HOT Table Values	0:20-0:45		0:40-1:00	0:30-1:00	0:40-1:20	0:40-1:10				
	2003-04 ET Test Results										
	2004-05 HOT Table Values	0:20-0:45		0:40-1:00	0:30-1:00	0:40-1:20	0:40-1:10				
	2004-05 ET Test Results										
	2005-06 HOT Table Values	0:20-0:45		0:40-1:00	0:30-1:00	0:40-1:20	0:40-1:10				
	2005-06 ET Test Results							1:00-1:35			
	2006-07 HOT Table Values	0:20-0:45		0:40-1:00	0:30-1:00	0:40-1:20	0:40-1:10	1:00-1:35			
	2006-07 ET Test Results								0:30-0:55		
	2007-08 HOT Table Values	0:20-0:45		0:40-1:00	0:30-1:00	0:40-1:20	0:40-1:10	1:00-1:35	0:30-0:55		
	2007-08 ET Test Results									1:00-1:40	
	2008-09 HOT Table Values	0:20-0:45		0:40-1:00	0:30-1:00	0:40-1:20	0:40-1:10	1:00-1:35	0:30-0:55	1:00-1:40	
	2008-09 ET Test Results										0:30-0:55
	2009-10 HOT Table Values	0:20-0:45		0:40-1:00	0:30-1:00	0:40-1:20	0:40-1:10	1:00-1:35	0:30-0:55	1:00-1:40	0:30-0:55
	2009-10 ET Test Results										
	2010-11 HOT Table Values	0:20-0:45		0:40-1:00	0:30-1:00	0:40-1:20	0:40-1:10	1:00-1:35	0:30-0:55	1:00-1:40	0:30-0:55
CURRENT	2010-11 ET Test Results										
	2011-12 HOT Table Values	0:20-0:45		0:40-1:00	0:30-1:00	0:40-1:20	0:40-1:10	1:00-1:35	0:30-0:55	1:00-1:40	0:30-0:55

Table 4.4: Type II 75/25 Fluid, Snow, -3°C and Above

		GENERIC	C-1951	A-E26	K2000	E II	C-2025	C-Flight	N-FCY-2	ABC-K+	AS CII
HISTORICAL	1998-99 HOT Table Values	0:15-0:30									
	1998-99 ET Test Results										
	1999-00 HOT Table Values	0:15-0:30									
	1999-00 ET Test Results		0:15-0:35								
	2000-01 HOT Table Values	0:15-0:30	0:15-0:35								
	2000-01 ET Test Results			0:25-0:45							
	2001-02 HOT Table Values	0:15-0:30	0:15-0:35	0:25-0:45							
	2001-02 ET Test Results				0:30-1:05	0:25-0:55					
	2002-03 HOT Table Values	0:15-0:30		0:25-0:45	0:30-1:05	0:25-0:55					
	2002-03 ET Test Results						0:25-0:45				
	2003-04 HOT Table Values	0:15-0:30		0:25-0:45	0:30-1:05	0:25-0:55	0:25-0:45				
	2003-04 ET Test Results										
	2004-05 HOT Table Values	0:15-0:30		0:25-0:45	0:30-1:05	0:25-0:55	0:25-0:45				
	2004-05 ET Test Results										
	2005-06 HOT Table Values	0:15-0:30		0:25-0:45	0:30-1:05	0:25-0:55	0:25-0:45				
	2005-06 ET Test Results							0:40-1:20			
	2006-07 HOT Table Values	0:15-0:30		0:25-0:45	0:30-1:05	0:25-0:55	0:25-0:45	0:40-1:20			
	2006-07 ET Test Results								0:20-0:40		
	2007-08 HOT Table Values	0:15-0:30		0:25-0:45	0:30-1:05	0:25-0:55	0:25-0:45	0:40-1:20	0:20-0:40		
	2007-08 ET Test Results									0:35-1:10	
	2008-09 HOT Table Values	0:15-0:30		0:25-0:45	0:30-1:05	0:25-0:55	0:25-0:45	0:40-1:20	0:20-0:40	0:35-1:10	
	2008-09 ET Test Results										0:25-0:45
	2009-10 HOT Table Values	0:15-0:30		0:25-0:45	0:30-1:05	0:25-0:55	0:25-0:45	0:40-1:20	0:20-0:40	0:35-1:10	0:25-0:45
	2009-10 ET Test Results							~~1:00-2:00~~			
	2010-11 HOT Table Values	0:15-0:30		0:25-0:45	0:30-1:05	0:25-0:55	0:25-0:45	0:40-1:20	0:20-0:40	0:35-1:10	0:25-0:45
CURRENT	2010-11 ET Test Results										
	2011-12 HOT Table Values	0:15-0:30		0:25-0:45	0:30-1:05	0:25-0:55	0:25-0:45	0:40-1:20	0:20-0:40	0:35-1:10	0:25-0:45

Table 4.5: Type II 50/50 Fluid, Snow, -3°C and Above

		GENERIC	C-1951	A-E26	K2000	E II	C-2025	C-Flight	N-FCY-2	ABC-K+	AS CII
HISTORICAL	1998-99 HOT Table Values	0:05-0:15									
	1998-99 ET Test Results										
	1999-00 HOT Table Values	0:05-0:15									
	1999-00 ET Test Results		0:06-0:15								
	2000-01 HOT Table Values	0:05-0:15	0:05-0:15								
	2000-01 ET Test Results			0:10-0:20							
	2001-02 HOT Table Values	0:05-0:15	0:05-0:15	0:10-0:20							
	2001-02 ET Test Results				0:15-0:30	0:10-0:25					
	2002-03 HOT Table Values	0:05-0:15		0:10-0:20	0:15-0:30	0:10-0:25					
	2002-03 ET Test Results						0:09-0:15				
	2003-04 HOT Table Values	0:05-0:15		0:10-0:20	0:15-0:30	0:10-0:25	0:05-0:15				
	2003-04 ET Test Results										
	2004-05 HOT Table Values	0:05-0:15		0:10-0:20	0:15-0:30	0:10-0:25	0:05-0:15				
	2004-05 ET Test Results										
	2005-06 HOT Table Values	0:05-0:15		0:10-0:20	0:15-0:30	0:10-0:25	0:05-0:15				
	2005-06 ET Test Results							0:10-0:25			
	2006-07 HOT Table Values	0:05-0:15		0:10-0:20	0:15-0:30	0:10-0:25	0:05-0:15	0:10-0:25			
	2006-07 ET Test Results								0:15-0:25		
	2007-08 HOT Table Values	0:05-0:15		0:10-0:20	0:15-0:30	0:10-0:25	0:05-0:15	0:10-0:25	0:15-0:25		
	2007-08 ET Test Results									0:07-0:15	
	2008-09 HOT Table Values	0:05-0:15		0:10-0:20	0:15-0:30	0:10-0:25	0:05-0:15	0:10-0:25	0:15-0:25	0:05-0:15	
	2008-09 ET Test Results										0:15-0:30
	2009-10 HOT Table Values	0:05-0:15		0:10-0:20	0:15-0:30	0:10-0:25	0:05-0:15	0:10-0:25	0:15-0:25	0:05-0:15	0:15-0:30
	2009-10 ET Test Results										
	2010-11 HOT Table Values	0:05-0:15		0:10-0:20	0:15-0:30	0:10-0:25	0:05-0:15	0:10-0:25	0:15-0:25	0:05-0:15	0:15-0:30
CURRENT	2010-11 ET Test Results										
	2011-12 HOT Table Values	0:05-0:15		0:10-0:20	0:15-0:30	0:10-0:25	0:09-0:15	0:10-0:25	0:15-0:25	0:07-0:15	0:15-0:30

Table 4.6: Type II Neat Fluid, Snow, Below -3ºC to -14ºC

		GENERIC	C-1951	A-E26	K2000	E II	C-2025	C-Flight	N-FCY-2	ABC-K+	AS CII
HISTORICAL	1998-99 HOT Table Values	0:15-0:40									
	1998-99 ET Test Results										
	1999-00 HOT Table Values	0:15-0:35									
	1999-00 ET Test Results		0:20-0:40								
	2000-01 HOT Table Values	0:15-0:35	0:20-0:40								
	2000-01 ET Test Results			0:35-0:55							
	2001-02 HOT Table Values	0:15-0:35	0:20-0:40	0:35-0:55							
	2001-02 ET Test Results				0:25-0:45	0:35-1:10					
	2002-03 HOT Table Values	0:15-0:35		0:35-0:55	0:25-0:45	0:35-1:10					
	2002-03 ET Test Results						0:35-1:00				
	2003-04 HOT Table Values	0:15-0:35		0:35-0:55	0:25-0:45	0:35-1:10	0:35-1:00				
	2003-04 ET Test Results										
	2004-05 HOT Table Values	0:15-0:35		0:35-0:55	0:25-0:45	0:35-1:10	0:35-1:00				
	2004-05 ET Test Results										
	2005-06 HOT Table Values	0:15-0:35		0:35-0:55	0:25-0:45	0:35-1:10	0:35-1:00				
	2005-06 ET Test Results							0:40-1:05			
	2006-07 HOT Table Values	0:15-0:35		0:35-0:55	0:25-0:45	0:35-1:10	0:35-1:00	0:40-1:05			
	2006-07 ET Test Results								0:15-0:30		
	2007-08 HOT Table Values	0:15-0:30		0:35-0:55	0:25-0:45	0:35-1:10	0:35-1:00	0:40-1:05	0:15-0:30		
	2007-08 ET Test Results									0:50-1:25	
	2008-09 HOT Table Values	0:15-0:30		0:35-0:55	0:25-0:45	0:35-1:10	0:35-1:00	0:40-1:05	0:15-0:30	0:50-1:25	
	2008-09 ET Test Results										0:30-0:55
	2009-10 HOT Table Values	0:15-0:30		0:35-0:55	0:25-0:45	0:35-1:10	0:35-1:00	0:40-1:05	0:15-0:30	0:50-1:25	0:30-0:55
	2009-10 ET Test Results										
	2010-11 HOT Table Values	0:15-0:30		0:35-0:55	0:25-0:45	0:35-1:10	0:35-1:00	0:40-1:05	0:15-0:30	0:50-1:25	0:30-0:55
CURRENT	2010-11 ET Test Results										
	2011-12 HOT Table Values	0:15-0:30		0:35-0:55	0:25-0:45	0:35-1:10	0:35-1:00	0:40-1:05	0:15-0:30	0:50-1:25	0:30-0:55

Table 4.7: Type II 75/25 Fluid, Snow, Below -3ºC to -14ºC

		GENERIC	C-1951	A-E26	K2000	E II	C-2025	C-Flight	N-FCY-2	ABC-K+	AS CII
HISTORICAL	1998-99 HOT Table Values	0:15-0:30									
HISTORICAL	1998-99 ET Test Results										
HISTORICAL	1999-00 HOT Table Values	0:15-0:25									
HISTORICAL	1999-00 ET Test Results		0:15-0:25								
HISTORICAL	2000-01 HOT Table Values	0:15-0:25	0:15-0:25								
HISTORICAL	2000-01 ET Test Results			0:25-0:40							
HISTORICAL	2001-02 HOT Table Values	0:15-0:25	0:15-0:25	0:25-0:40							
HISTORICAL	2001-02 ET Test Results				0:25-0:50	0:25-0:50					
HISTORICAL	2002-03 HOT Table Values	0:15-0:25		0:25-0:40	0:25-0:50	0:25-0:50					
HISTORICAL	2002-03 ET Test Results						0:25-0:45				
HISTORICAL	2003-04 HOT Table Values	0:15-0:25		0:25-0:40	0:25-0:50	0:25-0:50	0:25-0:45				
HISTORICAL	2003-04 ET Test Results										
HISTORICAL	2004-05 HOT Table Values	0:15-0:25		0:25-0:40	0:25-0:50	0:25-0:50	0:25-0:45				
HISTORICAL	2004-05 ET Test Results										
HISTORICAL	2005-06 HOT Table Values	0:15-0:25		0:25-0:40	0:25-0:50	0:25-0:50	0:25-0:45				
HISTORICAL	2005-06 ET Test Results							0:20-0:40			
HISTORICAL	2006-07 HOT Table Values	0:15-0:25		0:25-0:40	0:25-0:50	0:25-0:50	0:25-0:45	0:20-0:40			
HISTORICAL	2006-07 ET Test Results								0:10-0:20		
HISTORICAL	2007-08 HOT Table Values	0:10-0:20		0:25-0:40	0:25-0:50	0:25-0:50	0:25-0:45	0:20-0:40	0:10-0:20		
HISTORICAL	2007-08 ET Test Results									0:35-1:05	
HISTORICAL	2008-09 HOT Table Values	0:10-0:20		0:25-0:40	0:25-0:50	0:25-0:50	0:25-0:45	0:20-0:40	0:10-0:20	0:35-1:05	
HISTORICAL	2008-09 ET Test Results										0:25-0:45
HISTORICAL	2009-10 HOT Table Values	0:10-0:20		0:25-0:40	0:25-0:50	0:25-0:50	0:25-0:45	0:20-0:40	0:10-0:20	0:35-1:05	0:25-0:45
HISTORICAL	2009-10 ET Test Results							~~1:00-2:00~~			
HISTORICAL	2010-11 HOT Table Values	0:10-0:20		0:25-0:40	0:25-0:50	0:25-0:50	0:25-0:45	0:20-0:40	0:10-0:20	0:35-1:05	0:25-0:45
CURRENT	2010-11 ET Test Results										
CURRENT	2011-12 HOT Table Values	0:10-0:20		0:25-0:40	0:25-0:50	0:25-0:50	0:25-0:45	0:20-0:40	0:10-0:20	0:35-1:05	0:25-0:45

Table 4.8: Type II Neat Fluid, Snow, Below -14ºC to -25ºC

		GENERIC	C-1951	A-E26	K2000	E II	C-2025	C-Flight	N-FCY-2	ABC-K+	AS CII
HISTORICAL	1998-99 HOT Table Values	0:15-0:30									
	1998-99 ET Test Results										
	1999-00 HOT Table Values	0:15-0:30									
	1999-00 ET Test Results		0:20-0:35								
	2000-01 HOT Table Values	0:15-0:30	0:20-0:35								
	2000-01 ET Test Results			0:30-0:50							
	2001-02 HOT Table Values	0:15-0:30	0:20-0:35	0:30-0:50							
	2001-02 ET Test Results				0:20-0:40	0:35-1:05					
	2002-03 HOT Table Values	0:15-0:30		0:30-0:50	0:15-0:30	0:15-0:30					
	2002-03 ET Test Results						0:30-0:55				
	2003-04 HOT Table Values	0:15-0:30		0:30-0:50	0:15-0:30	0:15-0:30	0:15-0:30				
	2003-04 ET Test Results										
	2004-05 HOT Table Values	0:15-0:30		0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*				
	2004-05 ET Test Results										
	2005-06 HOT Table Values	0:15-0:30		0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*				
	2005-06 ET Test Results							0:35-0:55			
	2006-07 HOT Table Values	0:15-0:30		0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*			
	2006-07 ET Test Results								0:10-0:25		
	2007-08 HOT Table Values	0:15-0:30		0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*		
	2007-08 ET Test Results									0:05-0:15	
	2008-09 HOT Table Values	0:15-0:30		0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*	
	2008-09 ET Test Results										0:15-0:30
	2009-10 HOT Table Values	0:15-0:30		0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*
	2009-10 ET Test Results										
	2010-11 HOT Table Values	0:15-0:30		0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*
CURRENT	2010-11 ET Test Results										
	2011-12 HOT Table Values	0:15-0:30		0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*

*Historic generic HOT values were used for this cell

Table 4.9: Type II Neat Fluid, Freezing Drizzle, -3ºC and Above

		GENERIC	C-1951	A-E26	K2000	E II	C-2025	C-Flight	N-FCY-2	ABC-K+	AS CII
HISTORICAL	1998-99 HOT Table Values	0:30-1:00									
	1998-99 ET Test Results										
	1999-00 HOT Table Values	0:30-1:00									
	1999-00 ET Test Results		0:35-0:55								
	2000-01 HOT Table Values	0:30-0:55	0:35-0:55								
	2000-01 ET Test Results			0:50-1:35							
	2001-02 HOT Table Values	0:30-0:55	0:35-0:55	0:50-1:35							
	2001-02 ET Test Results				0:55-1:35	0:45-1:35					
	2002-03 HOT Table Values	0:30-0:55		0:50-1:35	0:55-1:35	0:45-1:35					
	2002-03 ET Test Results						0:40-1:00				
	2003-04 HOT Table Values	0:30-0:55		0:50-1:35	0:55-1:35	0:45-1:35	0:40-1:00				
	2003-04 ET Test Results										
	2004-05 HOT Table Values	0:30-0:55		0:50-1:35	0:55-1:35	0:45-1:35	0:40-1:00				
	2004-05 ET Test Results										
	2005-06 HOT Table Values	0:30-0:55		0:50-1:35	0:55-1:35	0:45-1:35	0:40-1:00				
	2005-06 ET Test Results							1:20-2:00			
	2006-07 HOT Table Values	0:30-0:55		0:50-1:35	0:55-1:35	0:45-1:35	0:40-1:00	1:20-2:00			
	2006-07 ET Test Results								0:35-1:05		
	2007-08 HOT Table Values	0:30-0:55		0:50-1:35	0:55-1:35	0:45-1:35	0:40-1:00	1:20-2:00	0:35-1:05		
	2007-08 ET Test Results									1:50-2:00	
	2008-09 HOT Table Values	0:30-0:55		0:50-1:35	0:55-1:35	0:45-1:35	0:40-1:00	1:20-2:00	0:35-1:05	1:50-2:00	
	2008-09 ET Test Results										0:35-1:05
	2009-10 HOT Table Values	0:30-0:55		0:50-1:35	0:55-1:35	0:45-1:35	0:40-1:00	1:20-2:00	0:35-1:05	1:50-2:00	0:35-1:05
	2009-10 ET Test Results										
	2010-11 HOT Table Values	0:30-0:55		0:50-1:35	0:55-1:35	0:45-1:35	0:40-1:00	1:20-2:00	0:35-1:05	1:50-2:00	0:35-1:05
CURRENT	2010-11 ET Test Results										
	2011-12 HOT Table Values	0:30-0:55		0:50-1:35	0:55-1:35	0:45-1:35	0:40-1:00	1:20-2:00	0:35-1:05	1:50-2:00	0:35-1:05

Table 4.10: Type II 75/25 Fluid, Freezing Drizzle, -3°C and Above

		GENERIC	C-1951	A-E26	K2000	E II	C-2025	C-Flight	N-FCY-2	ABC-K+	AS CII
HISTORICAL	1998-99 HOT Table Values	0:20-0:45									
HISTORICAL	1998-99 ET Test Results										
HISTORICAL	1999-00 HOT Table Values	0:20-0:45									
HISTORICAL	1999-00 ET Test Results		0:25-0:45								
HISTORICAL	2000-01 HOT Table Values	0:20-0:45	0:25-0:45								
HISTORICAL	2000-01 ET Test Results			0:45-1:05							
HISTORICAL	2001-02 HOT Table Values	0:20-0:45	0:25-0:45	0:45-1:05							
HISTORICAL	2001-02 ET Test Results				0:45-1:15	0:40-1:10					
HISTORICAL	2002-03 HOT Table Values	0:20-0:45		0:45-1:05	0:45-1:15	0:40-1:10					
HISTORICAL	2002-03 ET Test Results						0:25-0:45				
HISTORICAL	2003-04 HOT Table Values	0:20-0:45		0:45-1:05	0:45-1:15	0:40-1:10	0:25-0:45				
HISTORICAL	2003-04 ET Test Results										
HISTORICAL	2004-05 HOT Table Values	0:20-0:45		0:45-1:05	0:45-1:15	0:40-1:10	0:25-0:45				
HISTORICAL	2004-05 ET Test Results										
HISTORICAL	2005-06 HOT Table Values	0:20-0:45		0:45-1:05	0:45-1:15	0:40-1:10	0:25-0:45				
HISTORICAL	2005-06 ET Test Results							~~1:15-2:00~~			
HISTORICAL	2006-07 HOT Table Values	0:20-0:45		0:45-1:05	0:45-1:15	0:40-1:10	0:25-0:45	1:15-2:00			
HISTORICAL	2006-07 ET Test Results								0:25-0:45		
HISTORICAL	2007-08 HOT Table Values	0:20-0:45		0:45-1:05	0:45-1:15	0:40-1:10	0:25-0:45	1:15-2:00	0:25-0:45		
HISTORICAL	2007-08 ET Test Results									1:25-2:00	
HISTORICAL	2008-09 HOT Table Values	0:20-0:45		0:45-1:05	0:45-1:15	0:40-1:10	0:25-0:45	1:15-2:00	0:25-0:45	1:25-2:00	
HISTORICAL	2008-09 ET Test Results										0:35-1:00
HISTORICAL	2009-10 HOT Table Values	0:20-0:45		0:45-1:05	0:45-1:15	0:40-1:10	0:25-0:45	1:15-2:00	0:25-0:45	1:25-2:00	0:35-1:00
HISTORICAL	2009-10 ET Test Results							1:10-1:30			
HISTORICAL	2010-11 HOT Table Values	0:20-0:45		0:45-1:05	0:45-1:15	0:40-1:10	0:25-0:45	1:10-1:30	0:25-0:45	1:25-2:00	0:35-1:00
CURRENT	2010-11 ET Test Results										
CURRENT	2011-12 HOT Table Values	0:20-0:45		0:45-1:05	0:45-1:15	0:40-1:10	0:25-0:45	1:10-1:30	0:25-0:45	1:25-2:00	0:35-1:00

Table 4.11: Type II 50/50 Fluid, Freezing Drizzle, -3°C and Above

		GENERIC	C-1951	A-E26	K2000	E II	C-2025	C-Flight	N-FCY-2	ABC-K+	AS CII
HISTORICAL	1998-99 HOT Table Values	0:10-0:20									
	1998-99 ET Test Results										
	1999-00 HOT Table Values	0:05-0:20									
	1999-00 ET Test Results		0:08-0:15								
	2000-01 HOT Table Values	0:05-0:15	0:05-0:15								
	2000-01 ET Test Results			0:15-0:25							
	2001-02 HOT Table Values	0:05-0:15	0:05-0:15	0:15-0:25							
	2001-02 ET Test Results				0:15-0:25	0:15-0:30					
	2002-03 HOT Table Values	0:05-0:15		0:15-0:25	0:15-0:25	0:15-0:30					
	2002-03 ET Test Results						0:10-0:15				
	2003-04 HOT Table Values	0:05-0:15		0:15-0:25	0:15-0:25	0:15-0:30	0:10-0:15				
	2003-04 ET Test Results										
	2004-05 HOT Table Values	0:05-0:15		0:15-0:25	0:15-0:25	0:15-0:30	0:10-0:15				
	2004-05 ET Test Results										
	2005-06 HOT Table Values	0:05-0:15		0:15-0:25	0:15-0:25	0:15-0:30	0:10-0:15				
	2005-06 ET Test Results							0:20-0:30			
	2006-07 HOT Table Values	0:05-0:15		0:15-0:25	0:15-0:25	0:15-0:30	0:10-0:15	0:20-0:30			
	2006-07 ET Test Results								0:10-0:20		
	2007-08 HOT Table Values	0:05-0:15		0:15-0:25	0:15-0:25	0:15-0:30	0:10-0:15	0:20-0:30	0:10-0:20		
	2007-08 ET Test Results									0:20-0:30	
	2008-09 HOT Table Values	0:05-0:15		0:15-0:25	0:15-0:25	0:15-0:30	0:10-0:15	0:20-0:30	0:10-0:20	0:20-0:30	
	2008-09 ET Test Results										0:20-0:40
	2009-10 HOT Table Values	0:05-0:15		0:15-0:25	0:15-0:25	0:15-0:30	0:10-0:15	0:20-0:30	0:10-0:20	0:20-0:30	0:20-0:40
	2009-10 ET Test Results										
	2010-11 HOT Table Values	0:05-0:15		0:15-0:25	0:15-0:25	0:15-0:30	0:10-0:15	0:20-0:30	0:10-0:20	0:20-0:30	0:20-0:40
CURRENT	2010-11 ET Test Results										
	2011-12 HOT Table Values	0:08-0:15		0:15-0:25	0:15-0:25	0:15-0:30	0:10-0:15	0:20-0:30	0:10-0:20	0:20-0:30	0:20-0:40

Table 4.12: Type II Neat Fluid, Freezing Drizzle, Below -3ºC to -10ºC

		GENERIC	C-1951	A-E26	K2000	E II	C-2025	C-Flight	N-FCY-2	ABC-K+	AS CII
HISTORICAL	1998-99 HOT Table Values	0:30-1:00									
HISTORICAL	1998-99 ET Test Results										
HISTORICAL	1999-00 HOT Table Values	0:15-0:45									
HISTORICAL	1999-00 ET Test Results		0:25-0:50								
HISTORICAL	2000-01 HOT Table Values	0:15-0:45	0:25-0:50								
HISTORICAL	2000-01 ET Test Results			0:30-1:10							
HISTORICAL	2001-02 HOT Table Values	0:15-0:45	0:25-0:50	0:30-1:10							
HISTORICAL	2001-02 ET Test Results				0:25-0:50	0:35-1:00					
HISTORICAL	2002-03 HOT Table Values	0:15-0:45		0:30-1:10	0:25-0:50	0:35-1:00					
HISTORICAL	2002-03 ET Test Results						0:35-1:05				
HISTORICAL	2003-04 HOT Table Values	0:15-0:45		0:30-1:10	0:25-0:50	0:35-1:00	0:35-1:05				
HISTORICAL	2003-04 ET Test Results										
HISTORICAL	2004-05 HOT Table Values	0:15-0:45		0:30-1:10	0:25-0:50	0:35-1:00	0:35-1:05				
HISTORICAL	2004-05 ET Test Results										
HISTORICAL	2005-06 HOT Table Values	0:15-0:45		0:30-1:10	0:25-0:50	0:35-1:00	0:35-1:05				
HISTORICAL	2005-06 ET Test Results							0:35-1:30			
HISTORICAL	2006-07 HOT Table Values	0:15-0:45		0:30-1:10	0:25-0:50	0:35-1:00	0:35-1:05	0:35-1:30			
HISTORICAL	2006-07 ET Test Results								0:20-0:45		
HISTORICAL	2007-08 HOT Table Values	0:15-0:45		0:30-1:10	0:25-0:50	0:35-1:00	0:35-1:05	0:35-1:30	0:20-0:45		
HISTORICAL	2007-08 ET Test Results									0:25-1:00	
HISTORICAL	2008-09 HOT Table Values	0:15-0:45		0:30-1:10	0:25-0:50	0:35-1:00	0:35-1:05	0:35-1:30	0:20-0:45	0:25-1:00	
HISTORICAL	2008-09 ET Test Results										0:30-0:55
HISTORICAL	2009-10 HOT Table Values	0:20-0:45		0:30-1:10	0:25-0:50	0:35-1:00	0:35-1:05	0:35-1:30	0:20-0:45	0:25-1:00	0:30-0:55
HISTORICAL	2009-10 ET Test Results										
HISTORICAL	2010-11 HOT Table Values	0:20-0:45		0:30-1:10	0:25-0:50	0:35-1:00	0:35-1:05	0:35-1:30	0:20-0:45	0:25-1:00	0:30-0:55
CURRENT	2010-11 ET Test Results										
CURRENT	2011-12 HOT Table Values	0:20-0:45		0:30-1:10	0:25-0:50	0:35-1:00	0:35-1:05	0:35-1:30	0:20-0:45	0:25-1:00	0:30-0:55

Table 4.13: Type II 75/25 Fluid, Freezing Drizzle, Below -3ºC to -10ºC

		GENERIC	C-1951	A-E26	K2000	E II	C-2025	C-Flight	N-FCY-2	ABC-K+	AS CII
HISTORICAL	1998-99 HOT Table Values	0:20-0:45									
	1998-99 ET Test Results										
	1999-00 HOT Table Values	0:15-0:30									
	1999-00 ET Test Results		0:20-0:35								
	2000-01 HOT Table Values	0:15-0:30	0:20-0:35								
	2000-01 ET Test Results			0:20-0:50							
	2001-02 HOT Table Values	0:15-0:30	0:20-0:35	0:20-0:50							
	2001-02 ET Test Results				0:25-0:55	0:35-1:10					
	2002-03 HOT Table Values	0:15-0:30		0:20-0:50	0:25-0:55	0:35-1:10					
	2002-03 ET Test Results						0:30-0:40				
	2003-04 HOT Table Values	0:15-0:30		0:20-0:50	0:25-0:55	0:35-1:05	0:30-0:40				
	2003-04 ET Test Results										
	2004-05 HOT Table Values	0:15-0:30		0:20-0:50	0:25-0:55	0:35-1:05	0:30-0:40				
	2004-05 ET Test Results										
	2005-06 HOT Table Values	0:15-0:30		0:20-0:50	0:25-0:55	0:35-1:05	0:30-0:40				
	2005-06 ET Test Results							0:25-1:10			
	2006-07 HOT Table Values	0:15-0:30		0:20-0:50	0:25-0:55	0:35-1:05	0:30-0:40	0:25-1:10			
	2006-07 ET Test Results								0:15-0:30		
	2007-08 HOT Table Values	0:15-0:30		0:20-0:50	0:25-0:55	0:35-1:05	0:30-0:40	0:25-1:10	0:15-0:30		
	2007-08 ET Test Results									0:20-0:55	
	2008-09 HOT Table Values	0:15-0:30		0:20-0:50	0:25-0:55	0:35-1:05	0:30-0:40	0:25-1:10	0:15-0:30	0:20-0:55	
	2008-09 ET Test Results										0:35-0:40
	2009-10 HOT Table Values	0:15-0:30		0:20-0:50	0:25-0:55	0:35-1:05	0:30-0:40	0:25-1:10	0:15-0:30	0:20-0:55	0:35-0:40
	2009-10 ET Test Results							~~0:25-1:15~~			
	2010-11 HOT Table Values	0:15-0:30		0:20-0:50	0:25-0:55	0:35-1:05	0:30-0:40	0:25-1:10	0:15-0:30	0:20-0:55	0:35-0:40
CURRENT	2010-11 ET Test Results										
	2011-12 HOT Table Values	0:15-0:30		0:20-0:50	0:25-0:55	0:35-1:05	0:30-0:40	0:25-1:10	0:15-0:30	0:20-0:55	0:35-0:40

Table 4.14: Type II Neat Fluid, Light Freezing Rain, -3°C and Above

		GENERIC	C-1951	A-E26	K2000	E II	C-2025	C-Flight	N-FCY-2	ABC-K+	AS CII
HISTORICAL	1998-99 HOT Table Values	0:15-0:30									
HISTORICAL	1998-99 ET Test Results										
HISTORICAL	1999-00 HOT Table Values	0:15-0:30									
HISTORICAL	1999-00 ET Test Results		0:20-0:30								
HISTORICAL	2000-01 HOT Table Values	0:15-0:30	0:20-0:30								
HISTORICAL	2000-01 ET Test Results			0:40-0:50							
HISTORICAL	2001-02 HOT Table Values	0:15-0:30	0:20-0:30	0:40-0:50							
HISTORICAL	2001-02 ET Test Results				0:40-0:50	0:30-0:40					
HISTORICAL	2002-03 HOT Table Values	0:15-0:30		0:40-0:50	0:40-0:50	0:30-0:40					
HISTORICAL	2002-03 ET Test Results						0:25-0:35				
HISTORICAL	2003-04 HOT Table Values	0:15-0:30		0:40-0:50	0:40-0:50	0:30-0:40	0:25-0:35				
HISTORICAL	2003-04 ET Test Results										
HISTORICAL	2004-05 HOT Table Values	0:15-0:30		0:40-0:50	0:40-0:50	0:30-0:40	0:25-0:35				
HISTORICAL	2004-05 ET Test Results										
HISTORICAL	2005-06 HOT Table Values	0:15-0:30		0:40-0:50	0:40-0:50	0:30-0:40	0:25-0:35				
HISTORICAL	2005-06 ET Test Results							0:45-1:25			
HISTORICAL	2006-07 HOT Table Values	0:15-0:30		0:40-0:50	0:40-0:50	0:30-0:40	0:25-0:35	0:45-1:25			
HISTORICAL	2006-07 ET Test Results								0:25-0:35		
HISTORICAL	2007-08 HOT Table Values	0:15-0:30		0:40-0:50	0:40-0:50	0:30-0:40	0:25-0:35	0:45-1:25	0:25-0:35		
HISTORICAL	2007-08 ET Test Results									1:00-1:25	
HISTORICAL	2008-09 HOT Table Values	0:15-0:30		0:40-0:50	0:40-0:50	0:30-0:40	0:25-0:35	0:45-1:25	0:25-0:35	1:00-1:25	
HISTORICAL	2008-09 ET Test Results										0:25-0:35
HISTORICAL	2009-10 HOT Table Values	0:15-0:30		0:40-0:50	0:40-0:50	0:30-0:40	0:25-0:35	0:45-1:25	0:25-0:35	1:00-1:25	0:25-0:35
HISTORICAL	2009-10 ET Test Results										
HISTORICAL	2010-11 HOT Table Values	0:15-0:30		0:40-0:50	0:40-0:50	0:30-0:40	0:25-0:35	0:45-1:25	0:25-0:35	1:00-1:25	0:25-0:35
CURRENT	2010-11 ET Test Results										
CURRENT	2011-12 HOT Table Values	0:15-0:30		0:40-0:50	0:40-0:50	0:30-0:40	0:25-0:35	0:45-1:25	0:25-0:35	1:00-1:25	0:25-0:35

Table 4.15: Type II 75/25 Fluid, Light Freezing Rain, -3°C and Above

		GENERIC	C-1951	A-E26	K2000	E II	C-2025	C-Flight	N-FCY-2	ABC-K+	AS CII
HISTORICAL	1998-99 HOT Table Values	0:10-0:25									
HISTORICAL	1998-99 ET Test Results										
HISTORICAL	1999-00 HOT Table Values	0:10-0:25									
HISTORICAL	1999-00 ET Test Results		0:15-0:25								
HISTORICAL	2000-01 HOT Table Values	0:10-0:25	0:15-0:25								
HISTORICAL	2000-01 ET Test Results			0:25-0:35							
HISTORICAL	2001-02 HOT Table Values	0:10-0:25	0:15-0:25	0:25-0:35							
HISTORICAL	2001-02 ET Test Results				0:40-0:50	0:20-0:30					
HISTORICAL	2002-03 HOT Table Values	0:10-0:25		0:25-0:35	0:40-0:50	0:20-0:30					
HISTORICAL	2002-03 ET Test Results						0:20-0:25				
HISTORICAL	2003-04 HOT Table Values	0:10-0:25		0:25-0:35	0:40-0:50	0:20-0:30	0:20-0:25				
HISTORICAL	2003-04 ET Test Results										
HISTORICAL	2004-05 HOT Table Values	0:10-0:25		0:25-0:35	0:40-0:50	0:20-0:30	0:20-0:25				
HISTORICAL	2004-05 ET Test Results										
HISTORICAL	2005-06 HOT Table Values	0:10-0:25		0:25-0:35	0:40-0:50	0:20-0:30	0:20-0:25				
HISTORICAL	2005-06 ET Test Results							~~0:30-0:55~~			
HISTORICAL	2006-07 HOT Table Values	0:10-0:25		0:25-0:35	0:40-0:50	0:20-0:30	0:20-0:25	0:30-0:55			
HISTORICAL	2006-07 ET Test Results								0:15-0:25		
HISTORICAL	2007-08 HOT Table Values	0:10-0:25		0:25-0:35	0:40-0:50	0:20-0:30	0:20-0:25	0:30-0:55	0:15-0:25		
HISTORICAL	2007-08 ET Test Results									0:50-1:10	
HISTORICAL	2008-09 HOT Table Values	0:10-0:25		0:25-0:35	0:40-0:50	0:20-0:30	0:20-0:25	0:30-0:55	0:15-0:25	0:50-1:10	
HISTORICAL	2008-09 ET Test Results										0:20-0:30
HISTORICAL	2009-10 HOT Table Values	0:10-0:25		0:25-0:35	0:40-0:50	0:20-0:30	0:20-0:25	0:30-0:55	0:15-0:25	0:50-1:10	0:20-0:30
HISTORICAL	2009-10 ET Test Results							0:30-0:55			
HISTORICAL	2010-11 HOT Table Values	0:10-0:25		0:25-0:35	0:40-0:50	0:20-0:30	0:20-0:25	0:30-0:55	0:15-0:25	0:50-1:10	0:20-0:30
CURRENT	2010-11 ET Test Results										
CURRENT	2011-12 HOT Table Values	0:10-0:25		0:25-0:35	0:40-0:50	0:20-0:30	0:20-0:25	0:30-0:55	0:15-0:25	0:50-1:10	0:20-0:30

Table 4.16: Type II 50/50 Fluid, Light Freezing Rain, -3°C and Above

		GENERIC	C-1951	A-E26	K2000	E II	C-2025	C-Flight	N-FCY-2	ABC-K+	AS CII
HISTORICAL	1998-99 HOT Table Values	0:05-0:10									
HISTORICAL	1998-99 ET Test Results										
HISTORICAL	1999-00 HOT Table Values	0:05-0:10									
HISTORICAL	1999-00 ET Test Results		0:06-0:09								
HISTORICAL	2000-01 HOT Table Values	0:05-0:10	0:05-0:10								
HISTORICAL	2000-01 ET Test Results			0:08-0:10							
HISTORICAL	2001-02 HOT Table Values	0:05-0:10	0:05-0:10	0:05-0:10							
HISTORICAL	2001-02 ET Test Results				0:08-0:15	0:09-0:15					
HISTORICAL	2002-03 HOT Table Values	0:05-0:10		0:05-0:10	0:05-0:15	0:10-0:15					
HISTORICAL	2002-03 ET Test Results						0:07-0:10				
HISTORICAL	2003-04 HOT Table Values	0:05-0:10		0:05-0:10	0:05-0:15	0:10-0:15	0:05-0:10				
HISTORICAL	2003-04 ET Test Results										
HISTORICAL	2004-05 HOT Table Values	0:05-0:10		0:05-0:10	0:05-0:15	0:10-0:15	0:05-0:10				
HISTORICAL	2004-05 ET Test Results										
HISTORICAL	2005-06 HOT Table Values	0:05-0:10		0:05-0:10	0:05-0:15	0:10-0:15	0:05-0:10				
HISTORICAL	2005-06 ET Test Results							0:10-0:15			
HISTORICAL	2006-07 HOT Table Values	0:05-0:10		0:05-0:10	0:05-0:15	0:10-0:15	0:05-0:10	0:10-0:15			
HISTORICAL	2006-07 ET Test Results								0:07-0:10		
HISTORICAL	2007-08 HOT Table Values	0:05-0:10		0:05-0:10	0:05-0:15	0:10-0:15	0:05-0:10	0:10-0:15	0:05-0:10		
HISTORICAL	2007-08 ET Test Results									0:10-0:15	
HISTORICAL	2008-09 HOT Table Values	0:05-0:10		0:05-0:10	0:05-0:15	0:10-0:15	0:05-0:10	0:10-0:15	0:05-0:10	0:10-0:15	
HISTORICAL	2008-09 ET Test Results										0:10-0:20
HISTORICAL	2009-10 HOT Table Values	0:05-0:10		0:05-0:10	0:05-0:15	0:10-0:15	0:05-0:10	0:10-0:15	0:05-0:10	0:10-0:15	0:10-0:20
HISTORICAL	2009-10 ET Test Results										
HISTORICAL	2010-11 HOT Table Values	0:05-0:10		0:05-0:10	0:05-0:15	0:10-0:15	0:05-0:10	0:10-0:15	0:05-0:10	0:10-0:15	0:10-0:20
CURRENT	2010-11 ET Test Results										
CURRENT	2011-12 HOT Table Values	0:05-0:09		0:08-0:10	0:08-0:15	0:09-0:15	0:07-0:10	0:10-0:15	0:07-0:10	0:10-0:15	0:10-0:20

Table 4.17: Type II Neat Fluid, Light Freezing Rain, Below -3°C to -10°C

		GENERIC	C-1951	A-E26	K2000	E II	C-2025	C-Flight	N-FCY-2	ABC-K+	AS CII
HISTORICAL	1998-99 HOT Table Values	0:10-0:30									
	1998-99 ET Test Results										
	1999-00 HOT Table Values	0:10-0:30									
	1999-00 ET Test Results		0:15-0:30								
	2000-01 HOT Table Values	0:10-0:30	0:15-0:30								
	2000-01 ET Test Results			0:15-0:35							
	2001-02 HOT Table Values	0:10-0:25*	0:15-0:30	0:15-0:35							
	2001-02 ET Test Results				0:10-0:30	0:20-0:30					
	2002-03 HOT Table Values	0:10-0:25*		0:15-0:35	0:10-0:30	0:20-0:30					
	2002-03 ET Test Results						0:20-0:35				
	2003-04 HOT Table Values	0:10-0:25*		0:15-0:35	0:10-0:30	0:20-0:30	0:20-0:35				
	2003-04 ET Test Results										
	2004-05 HOT Table Values	0:10-0:25*		0:15-0:35	0:10-0:30	0:20-0:30	0:20-0:35				
	2004-05 ET Test Results										
	2005-06 HOT Table Values	0:10-0:25*		0:15-0:35	0:10-0:30	0:20-0:30	0:20-0:35				
	2005-06 ET Test Results							0:25-0:45			
	2006-07 HOT Table Values	0:10-0:25*		0:15-0:35	0:10-0:30	0:20-0:30	0:20-0:35	0:25-0:45			
	2006-07 ET Test Results								0:15-0:20		
	2007-08 HOT Table Values	0:10-0:20		0:15-0:35	0:10-0:30	0:20-0:30	0:20-0:35	0:25-0:45	0:15-0:20		
	2007-08 ET Test Results									0:15-0:35	
	2008-09 HOT Table Values	0:10-0:20		0:15-0:35	0:10-0:30	0:20-0:30	0:20-0:35	0:25-0:45	0:15-0:20	0:15-0:35	
	2008-09 ET Test Results										0:20-0:25
	2009-10 HOT Table Values	0:10-0:20		0:15-0:35	0:10-0:30	0:20-0:30	0:20-0:35	0:25-0:45	0:15-0:20	0:15-0:35	0:20-0:25
	2009-10 ET Test Results										
	2010-11 HOT Table Values	0:10-0:20		0:15-0:35	0:10-0:30	0:20-0:30	0:20-0:35	0:25-0:45	0:15-0:20	0:15-0:35	0:20-0:25
CURRENT	2010-11 ET Test Results										
	2011-12 HOT Table Values	0:10-0:20		0:15-0:35	0:10-0:30	0:20-0:30	0:20-0:35	0:25-0:45	0:15-0:20	0:15-0:35	0:20-0:25

* Value in Type II generic table can not be more than value in Type IV generic table; values were reduced for this reason

Table 4.18: Type II 75/25 Fluid, Light Freezing Rain, Below -3°C to -10°C

		GENERIC	C-1951	A-E26	K2000	E II	C-2025	C-Flight	N-FCY-2	ABC-K+	AS CII
HISTORICAL	1998-99 HOT Table Values	0:10-0:25									
HISTORICAL	1998-99 ET Test Results										
HISTORICAL	1999-00 HOT Table Values	0:10-0:20									
HISTORICAL	1999-00 ET Test Results		0:15-0:20								
HISTORICAL	2000-01 HOT Table Values	0:10-0:20	0:15-0:20								
HISTORICAL	2000-01 ET Test Results			0:15-0:25							
HISTORICAL	2001-02 HOT Table Values	0:10-0:20	0:15-0:20	0:15-0:25							
HISTORICAL	2001-02 ET Test Results				0:15-0:30	0:15-0:30					
HISTORICAL	2002-03 HOT Table Values	0:10-0:20		0:15-0:25	0:15-0:30	0:15-0:30					
HISTORICAL	2002-03 ET Test Results						0:15-0:25				
HISTORICAL	2003-04 HOT Table Values	0:10-0:20		0:15-0:25	0:15-0:30	0:15-0:30	0:15-0:25				
HISTORICAL	2003-04 ET Test Results										
HISTORICAL	2004-05 HOT Table Values	0:10-0:20		0:15-0:25	0:15-0:30	0:15-0:30	0:15-0:25				
HISTORICAL	2004-05 ET Test Results										
HISTORICAL	2005-06 HOT Table Values	0:10-0:20		0:15-0:25	0:15-0:30	0:15-0:30	0:15-0:25				
HISTORICAL	2005-06 ET Test Results							~~0:30-0:40~~			
HISTORICAL	2006-07 HOT Table Values	0:10-0:20		0:15-0:25	0:15-0:30	0:15-0:30	0:15-0:25	0:30-0:40			
HISTORICAL	2006-07 ET Test Results								0:08-0:15		
HISTORICAL	2007-08 HOT Table Values	0:05-0:15		0:15-0:25	0:15-0:30	0:15-0:30	0:15-0:25	0:30-0:40	0:05-0:15		
HISTORICAL	2007-08 ET Test Results									0:09-0:30	
HISTORICAL	2008-09 HOT Table Values	0:05-0:15		0:15-0:25	0:15-0:30	0:15-0:30	0:15-0:25	0:30-0:40	0:05-0:15	0:05-0:30	
HISTORICAL	2008-09 ET Test Results										0:20-0:25
HISTORICAL	2009-10 HOT Table Values	0:05-0:15		0:15-0:25	0:15-0:30	0:15-0:30	0:15-0:25	0:30-0:40	0:05-0:15	0:05-0:30	0:20-0:25
HISTORICAL	2009-10 ET Test Results							0:20-0:35			
HISTORICAL	2010-11 HOT Table Values	0:05-0:15		0:15-0:25	0:15-0:30	0:15-0:30	0:15-0:25	0:20-0:35	0:05-0:15	0:05-0:30	0:20-0:25
CURRENT	2010-11 ET Test Results										
CURRENT	2011-12 HOT Table Values	0:08-0:15		0:15-0:25	0:15-0:30	0:15-0:30	0:15-0:25	0:20-0:35	0:08-0:15	0:09-0:30	0:20-0:25

Table 4.19: Type II Neat Fluid, Freezing Fog, -3°C and Above

		GENERIC	C-1951	A-E26	K2000	E II	C-2025	C-Flight	N-FCY-2	ABC-K+	AS CII
HISTORICAL	1998-99 HOT Table Values	0:35-1:30									
	1998-99 ET Test Results										
	1999-00 HOT Table Values	0:35-1:30									
	1999-00 ET Test Results		0:55-1:40								
	2000-01 HOT Table Values	0:35-1:30	0:55-1:40								
	2000-01 ET Test Results			1:25-2:35							
	2001-02 HOT Table Values	0:35-1:30	0:55-1:40	1:25-2:35							
	2001-02 ET Test Results				1:30-3:05	2:05-3:45					
	2002-03 HOT Table Values	0:35-1:30		1:25-2:35	1:30-3:05	2:05-3:45					
	2002-03 ET Test Results						1:30-2:05				
	2003-04 HOT Table Values	0:35-1:30		1:25-2:35	1:30-3:05	2:05-3:45	1:30-2:05				
	2003-04 ET Test Results										
	2004-05 HOT Table Values	0:35-1:30		1:25-2:35	1:30-3:05	2:05-3:45	1:30-2:05				
	2004-05 ET Test Results										
	2005-06 HOT Table Values	0:35-1:30		1:25-2:35	1:30-3:05	2:05-3:45	1:30-2:05				
	2005-06 ET Test Results							3:30-4:00			
	2006-07 HOT Table Values	0:35-1:30		1:25-2:35	1:30-3:05	2:05-3:45	1:30-2:05	3:30-4:00			
	2006-07 ET Test Results								1:15-2:25		
	2007-08 HOT Table Values	0:35-1:30		1:25-2:35	1:30-3:05	2:05-3:45	1:30-2:05	3:30-4:00	1:15-2:25		
	2007-08 ET Test Results									2:15-3:45	
	2008-09 HOT Table Values	0:35-1:30		1:25-2:35	1:30-3:05	2:05-3:45	1:30-2:05	3:30-4:00	1:15-2:25	2:15-3:45	
	2008-09 ET Test Results										0:55-1:50
	2009-10 HOT Table Values	0:35-1:30		1:25-2:35	1:30-3:05	2:05-3:45	1:30-2:05	3:30-4:00	1:15-2:25	2:15-3:45	0:55-1:50
	2009-10 ET Test Results										
	2010-11 HOT Table Values	0:35-1:30		1:25-2:35	1:30-3:05	2:05-3:45	1:30-2:05	3:30-4:00	1:15-2:25	2:15-3:45	0:55-1:50
CURRENT	2010-11 ET Test Results										
	2011-12 HOT Table Values	0:35-1:30		1:25-2:35	1:30-3:05	2:05-3:45	1:30-2:05	3:30-4:00	1:15-2:25	2:15-3:45	0:55-1:50

Table 4.20: Type II 75/25 Fluid, Freezing Fog, -3°C and Above

		GENERIC	C-1951	A-E26	K2000	E II	C-2025	C-Flight	N-FCY-2	ABC-K+	AS CII
HISTORICAL	1998-99 HOT Table Values	0:25-1:00									
	1998-99 ET Test Results										
	1999-00 HOT Table Values	0:25-1:00									
	1999-00 ET Test Results		0:45-1:15								
	2000-01 HOT Table Values	0:25-1:00	0:45-1:15								
	2000-01 ET Test Results			1:05-1:55							
	2001-02 HOT Table Values	0:25-1:00	0:45-1:15	1:05-1:55							
	2001-02 ET Test Results				1:40-3:30	1:25-2:50					
	2002-03 HOT Table Values	0:25-1:00		1:05-1:55	1:40-3:30	1:25-2:50					
	2002-03 ET Test Results						0:55-1:45				
	2003-04 HOT Table Values	0:25-1:00		1:05-1:55	1:40-3:30	1:25-2:50	0:55-1:45				
	2003-04 ET Test Results										
	2004-05 HOT Table Values	0:25-1:00		1:05-1:55	1:40-3:30	1:25-2:50	0:55-1:45				
	2004-05 ET Test Results										
	2005-06 HOT Table Values	0:25-1:00		1:05-1:55	1:40-3:30	1:25-2:50	0:55-1:45				
	2005-06 ET Test Results							~~2:30-4:00~~			
	2006-07 HOT Table Values	0:25-1:00		1:05-1:55	1:40-3:30	1:25-2:50	0:55-1:45	2:30-4:00			
	2006-07 ET Test Results								0:50-1:30		
	2007-08 HOT Table Values	0:25-1:00		1:05-1:55	1:40-3:30	1:25-2:50	0:55-1:45	2:30-4:00	0:50-1:30		
	2007-08 ET Test Results									1:40-2:30	
	2008-09 HOT Table Values	0:25-1:00		1:05-1:55	1:40-3:30	1:25-2:50	0:55-1:45	2:30-4:00	0:50-1:30	1:40-2:30	
	2008-09 ET Test Results										0:50-1:20
	2009-10 HOT Table Values	0:25-1:00		1:05-1:55	1:40-3:30	1:25-2:50	0:55-1:45	2:30-4:00	0:50-1:30	1:40-2:30	0:50-1:20
	2009-10 ET Test Results							1:50-2:45			
	2010-11 HOT Table Values	0:25-1:00		1:05-1:55	1:40-3:30	1:25-2:50	0:55-1:45	1:50-2:45	0:50-1:30	1:40-2:30	0:50-1:20
CURRENT	2010-11 ET Test Results										
	2011-12 HOT Table Values	0:25-1:00		1:05-1:55	1:40-3:30	1:25-2:50	0:55-1:45	1:50-2:45	0:50-1:30	1:40-2:30	0:50-1:20

Table 4.21: Type II 50/50 Fluid, Freezing Fog, -3ºC and Above

		GENERIC	C-1951	A-E26	K2000	E II	C-2025	C-Flight	N-FCY-2	ABC-K+	AS CII
HISTORICAL	1998-99 HOT Table Values	0:15-0:45									
HISTORICAL	1998-99 ET Test Results										
HISTORICAL	1999-00 HOT Table Values	0:15-0:35									
HISTORICAL	1999-00 ET Test Results		0:20-0:30								
HISTORICAL	2000-01 HOT Table Values	0:15-0:30	0:20-0:30								
HISTORICAL	2000-01 ET Test Results			0:30-0:45							
HISTORICAL	2001-02 HOT Table Values	0:15-0:30	0:20-0:30	0:30-0:45							
HISTORICAL	2001-02 ET Test Results				1:00-2:10	0:30-0:55					
HISTORICAL	2002-03 HOT Table Values	0:15-0:30		0:30-0:45	1:00-2:10	0:30-0:55					
HISTORICAL	2002-03 ET Test Results						0:20-0:35				
HISTORICAL	2003-04 HOT Table Values	0:15-0:30		0:30-0:45	1:00-2:10	0:30-0:55	0:20-0:35				
HISTORICAL	2003-04 ET Test Results										
HISTORICAL	2004-05 HOT Table Values	0:15-0:30		0:30-0:45	1:00-2:10	0:30-0:55	0:20-0:35				
HISTORICAL	2004-05 ET Test Results										
HISTORICAL	2005-06 HOT Table Values	0:15-0:30		0:30-0:45	1:00-2:10	0:30-0:55	0:20-0:35				
HISTORICAL	2005-06 ET Test Results							0:55-1:45			
HISTORICAL	2006-07 HOT Table Values	0:15-0:30		0:30-0:45	1:00-2:10	0:30-0:55	0:20-0:35	0:55-1:45			
HISTORICAL	2006-07 ET Test Results								0:25-0:35		
HISTORICAL	2007-08 HOT Table Values	0:15-0:30		0:30-0:45	1:00-2:10	0:30-0:55	0:20-0:35	0:55-1:45	0:25-0:35		
HISTORICAL	2007-08 ET Test Results									0:35-1:05	
HISTORICAL	2008-09 HOT Table Values	0:15-0:30		0:30-0:45	1:00-2:10	0:30-0:55	0:20-0:35	0:55-1:45	0:25-0:35	0:35-1:05	
HISTORICAL	2008-09 ET Test Results										0:35-1:00
HISTORICAL	2009-10 HOT Table Values	0:15-0:30		0:30-0:45	1:00-2:10	0:30-0:55	0:20-0:35	0:55-1:45	0:25-0:35	0:35-1:05	0:35-1:00
HISTORICAL	2009-10 ET Test Results										
HISTORICAL	2010-11 HOT Table Values	0:15-0:30		0:30-0:45	1:00-2:10	0:30-0:55	0:20-0:35	0:55-1:45	0:25-0:35	0:35-1:05	0:35-1:00
CURRENT	2010-11 ET Test Results										
CURRENT	2011-12 HOT Table Values	0:15-0:30		0:30-0:45	1:00-2:10	0:30-0:55	0:20-0:35	0:55-1:45	0:25-0:35	0:35-1:05	0:35-1:00

Table 4.22: Type II Neat Fluid, Freezing Fog, Below -3°C to -14°C

		GENERIC	C-1951	A-E26	K2000	E II	C-2025	C-Flight	N-FCY-2	ABC-K+	AS CII
HISTORICAL	1998-99 HOT Table Values	0:35-1:30									
	1998-99 ET Test Results										
	1999-00 HOT Table Values	0:30-1:05									
	1999-00 ET Test Results		0:45-1:25								
	2000-01 HOT Table Values	0:20*-1:05	0:45-1:25								
	2000-01 ET Test Results			0:45-2:15							
	2001-02 HOT Table Values	0:20*-1:05	0:45-1:25	0:45-2:15							
	2001-02 ET Test Results				0:35-1:25	0:50-1:45					
	2002-03 HOT Table Values	0:20*-1:05		0:45-2:15	0:35-1:25	0:50-1:45					
	2002-03 ET Test Results						0:45-1:50				
	2003-04 HOT Table Values	0:20*-1:05		0:45-2:15	0:35-1:25	0:50-1:45	0:45-1:50				
	2003-04 ET Test Results										
	2004-05 HOT Table Values	0:20*-1:05		0:45-2:15	0:35-1:25	0:50-1:45	0:45-1:50				
	2004-05 ET Test Results										
	2005-06 HOT Table Values	0:20*-1:05		0:45-2:15	0:35-1:25	0:50-1:45	0:45-1:50				
	2005-06 ET Test Results							0:55-1:45			
	2006-07 HOT Table Values	0:20*-1:05		0:45-2:15	0:35-1:25	0:50-1:45	0:45-1:50	0:55-1:45			
	2006-07 ET Test Results								0:45-1:30		
	2007-08 HOT Table Values	0:20*-1:05		0:45-2:15	0:35-1:25	0:50-1:45	0:45-1:50	0:55-1:45	0:45-1:30		
	2007-08 ET Test Results									0:30-1:05	
	2008-09 HOT Table Values	0:20*-1:05		0:45-2:15	0:35-1:25	0:50-1:45	0:45-1:50	0:55-1:45	0:45-1:30	0:30-1:05	
	2008-09 ET Test Results										0:45-1:50
	2009-10 HOT Table Values	0:20*-1:05		0:45-2:15	0:35-1:25	0:50-1:45	0:45-1:50	0:55-1:45	0:45-1:30	0:30-1:05	0:45-1:50
	2009-10 ET Test Results										
	2010-11 HOT Table Values	0:20*-1:05		0:45-2:15	0:35-1:25	0:50-1:45	0:45-1:50	0:55-1:45	0:45-1:30	0:30-1:05	0:45-1:50
CURRENT	2010-11 ET Test Results										
	2011-12 HOT Table Values	0:20*-1:05		0:45-2:15	0:35-1:25	0:50-1:45	0:45-1:50	0:55-1:45	0:45-1:30	0:30-1:05	0:45-1:50

* Value in Type II generic table can not be more than value in Type IV generic table; values were reduced for this reason

Table 4.23: Type II 75/25 Fluid, Freezing Fog, Below -3°C to -14°C

		GENERIC	C-1951	A-E26	K2000	E II	C-2025	C-Flight	N-FCY-2	ABC-K+	AS CII
HISTORICAL	1998-99 HOT Table Values	0:25-1:00									
	1998-99 ET Test Results										
	1999-00 HOT Table Values	0:20-0:55									
	1999-00 ET Test Results		0:35-1:00								
	2000-01 HOT Table Values	0:20-0:55	0:35-1:00								
	2000-01 ET Test Results			0:35-1:15							
	2001-02 HOT Table Values	0:20-0:55	0:35-1:00	0:35-1:15							
	2001-02 ET Test Results				0:35-1:15	0:30-1:20					
	2002-03 HOT Table Values	0:20-0:55		0:35-1:15	0:35-1:15	0:30-1:20					
	2002-03 ET Test Results						0:40-1:20				
	2003-04 HOT Table Values	0:20-0:55		0:35-1:15	0:35-1:15	0:30-1:20	0:40-1:20				
	2003-04 ET Test Results										
	2004-05 HOT Table Values	0:20-0:55		0:35-1:15	0:35-1:15	0:30-1:20	0:40-1:20				
	2004-05 ET Test Results										
	2005-06 HOT Table Values	0:20-0:55		0:35-1:15	0:35-1:15	0:30-1:20	0:40-1:20				
	2005-06 ET Test Results							~~0:40-1:10~~			
	2006-07 HOT Table Values	0:20-0:55		0:35-1:15	0:35-1:15	0:30-1:20	0:40-1:20	0:40-1:10			
	2006-07 ET Test Results								0:30-1:05		
	2007-08 HOT Table Values	0:20-0:55		0:35-1:15	0:35-1:15	0:30-1:20	0:40-1:20	0:40-1:10	0:30-1:05		
	2007-08 ET Test Results									0:25-1:25	
	2008-09 HOT Table Values	0:20-0:55		0:35-1:15	0:35-1:15	0:30-1:20	0:40-1:20	0:40-1:10	0:30-1:05	0:25-1:25	
	2008-09 ET Test Results										0:40-1:45
	2009-10 HOT Table Values	0:25-0:50*		0:35-1:15	0:35-1:15	0:30-1:20	0:40-1:20	0:40-1:10	0:30-1:05	0:25-1:25	0:40-1:45
	2009-10 ET Test Results							0:25-1:05			
	2010-11 HOT Table Values	0:25-0:50*		0:35-1:15	0:35-1:15	0:30-1:20	0:40-1:20	0:25-1:05	0:30-1:05	0:25-1:25	0:40-1:45
CURRENT	2010-11 ET Test Results										
	2011-12 HOT Table Values	0:25-0:50*		0:35-1:15	0:35-1:15	0:30-1:20	0:40-1:20	0:25-1:05	0:30-1:05	0:25-1:25	0:40-1:45

* Value in Type II generic table can not be more than value in Type IV generic table; values were reduced for this reason

Table 4.24: Type II Neat Fluid, Freezing Fog, Below -14ºC to -25ºC

		GENERIC	C-1951	A-E26	K2000	E II	C-2025	C-Flight	N-FCY-2	ABC-K+	AS CII
HISTORICAL	1998-99 HOT Table Values	0:20-1:30									
	1998-99 ET Test Results										
	1999-00 HOT Table Values	0:15-0:20									
	1999-00 ET Test Results		0:20-0:40								
	2000-01 HOT Table Values	0:15-0:20	0:20-0:40								
	2000-01 ET Test Results			0:25-0:45							
	2001-02 HOT Table Values	0:15-0:20	0:20-0:40	0:25-0:45							
	2001-02 ET Test Results				0:20-0:45	0:20-0:35					
	2002-03 HOT Table Values	0:15-0:20		0:25-0:45	0:20-0:45	0:20-0:35					
	2002-03 ET Test Results						0:25-0:45				
	2003-04 HOT Table Values	0:15-0:20		0:25-0:45	0:20-0:45	0:20-0:35	0:25-0:45				
	2003-04 ET Test Results										
	2004-05 HOT Table Values	0:15-0:20		0:25-0:45	0:20-0:45	0:20-0:35	0:25-0:45				
	2004-05 ET Test Results										
	2005-06 HOT Table Values	0:15-0:20		0:25-0:45	0:20-0:45	0:20-0:35	0:25-0:45				
	2005-06 ET Test Results							0:30-0:50			
	2006-07 HOT Table Values	0:15-0:20		0:25-0:45	0:20-0:45	0:20-0:35	0:25-0:45	0:30-0:50			
	2006-07 ET Test Results								0:25-0:35		
	2007-08 HOT Table Values	0:15-0:20		0:25-0:45	0:20-0:45	0:20-0:35	0:25-0:45	0:30-0:50	0:25-0:35		
	2007-08 ET Test Results									0:30-0:55	
	2008-09 HOT Table Values	0:15-0:20		0:25-0:45	0:20-0:45	0:20-0:35	0:25-0:45	0:30-0:50	0:25-0:35	0:30-0:55	
	2008-09 ET Test Results										0:20-0:50
	2009-10 HOT Table Values	0:15*-0:35		0:25-0:45	0:20-0:45	0:20-0:35	0:25-0:45	0:30-0:50	0:25-0:35	0:30-0:55	0:20-0:50
	2009-10 ET Test Results										
	2010-11 HOT Table Values	0:15*-0:35		0:25-0:45	0:20-0:45	0:20-0:35	0:25-0:45	0:30-0:50	0:25-0:35	0:30-0:55	0:20-0:50
CURRENT	2010-11 ET Test Results										
	2011-12 HOT Table Values	0:15*-0:35		0:25-0:45	0:20-0:45	0:20-0:35	0:25-0:45	0:30-0:50	0:25-0:35	0:30-0:55	0:20-0:50

* Value in Type II generic table can not be more than value in Type IV generic table; values were reduced for this reason

Table 4.25: Type II Neat Fluid, Rain on Cold-Soaked Wing, Above 0°C

		GENERIC	C-1951	A-E26	K2000	E II	C-2025	C-Flight	N-FCY-2	ABC-K+	AS CII
HISTORICAL	1998-99 HOT Table Values	0:10-0:40									
	1998-99 ET Test Results										
	1999-00 HOT Table Values	0:05-0:40									
	1999-00 ET Test Results		0:10-0:50								
	2000-01 HOT Table Values	0:05-0:40	0:10-0:50								
	2000-01 ET Test Results			0:20-1:25							
	2001-02 HOT Table Values	0:05-0:40	0:10-0:50	0:20-1:25							
	2001-02 ET Test Results				0:15-1:10	0:15-1:30					
	2002-03 HOT Table Values	0:05-0:40		0:20-1:25	0:15-1:10	0:15-1:30					
	2002-03 ET Test Results						0:10-1:15				
	2003-04 HOT Table Values	0:05-0:40		0:20-1:25	0:15-1:10	0:15-1:30	0:10-1:15				
	2003-04 ET Test Results										
	2004-05 HOT Table Values	0:05-0:40		0:20-1:25	0:15-1:10	0:15-1:30	0:10-1:15				
	2004-05 ET Test Results										
	2005-06 HOT Table Values	0:05-0:40		0:20-1:25	0:15-1:10	0:15-1:30	0:10-1:15				
	2005-06 ET Test Results							0:10-1:30			
	2006-07 HOT Table Values	0:05-0:40		0:20-1:25	0:15-1:10	0:15-1:30	0:10-1:15	0:10-1:30			
	2006-07 ET Test Results								0:08-0:45		
	2007-08 HOT Table Values	0:05-0:40		0:20-1:25	0:15-1:10	0:15-1:30	0:10-1:15	0:10-1:30	0:05-0:45		
	2007-08 ET Test Results									0:20-2:00	
	2008-09 HOT Table Values	0:05-0:40		0:20-1:25	0:15-1:10	0:15-1:30	0:10-1:15	0:10-1:30	0:05-0:45	0:20-2:00	
	2008-09 ET Test Results										0:10-0:55
	2009-10 HOT Table Values	0:05-0:40		0:20-1:25	0:15-1:10	0:15-1:30	0:10-1:15	0:10-1:30	0:05-0:45	0:20-2:00	0:10-0:55
	2009-10 ET Test Results										
	2010-11 HOT Table Values	0:05-0:40		0:20-1:25	0:15-1:10	0:15-1:30	0:10-1:15	0:10-1:30	0:05-0:45	0:20-2:00	0:10-0:55
CURRENT	2010-11 ET Test Results										
	2011-12 HOT Table Values	0:08-0:40		0:20-1:25	0:15-1:10	0:15-1:30	0:10-1:15	0:10-1:30	0:08-0:45	0:20-2:00	0:10-0:55

Table 4.26: Type II 75/25 Fluid, Rain on Cold-Soaked Wing, Above 0°C

		GENERIC	C-1951	A-E26	K2000	E II	C-2025	C-Flight	N-FCY-2	ABC-K+	AS CII
HISTORICAL	1998-99 HOT Table Values	0:05-0:25									
HISTORICAL	1998-99 ET Test Results										
HISTORICAL	1999-00 HOT Table Values	0:05-0:25									
HISTORICAL	1999-00 ET Test Results		0:07-0:40								
HISTORICAL	2000-01 HOT Table Values	0:05-0:25	0:05-0:40								
HISTORICAL	2000-01 ET Test Results			0:10-1:00							
HISTORICAL	2001-02 HOT Table Values	0:05-0:25	0:05-0:40	0:10-1:00							
HISTORICAL	2001-02 ET Test Results				0:15-1:40	0:10-1:05					
HISTORICAL	2002-03 HOT Table Values	0:05-0:25		0:10-1:00	0:15-1:40	0:10-1:05					
HISTORICAL	2002-03 ET Test Results						0:08-0:50				
HISTORICAL	2003-04 HOT Table Values	0:05-0:25		0:10-1:00	0:15-1:40	0:10-1:05	0:05-0:50				
HISTORICAL	2003-04 ET Test Results										
HISTORICAL	2004-05 HOT Table Values	0:05-0:25		0:10-1:00	0:15-1:40	0:10-1:05	0:05-0:50				
HISTORICAL	2004-05 ET Test Results										
HISTORICAL	2005-06 HOT Table Values	0:05-0:25		0:10-1:00	0:15-1:40	0:10-1:05	0:05-0:50				
HISTORICAL	2005-06 ET Test Results							~~0:07-1:20~~			
HISTORICAL	2006-07 HOT Table Values	0:05-0:25		0:10-1:00	0:15-1:40	0:10-1:05	0:05-0:50	0:05-1:20			
HISTORICAL	2006-07 ET Test Results								0:05-0:25		
HISTORICAL	2007-08 HOT Table Values	0:05-0:25		0:10-1:00	0:15-1:40	0:10-1:05	0:05-0:50	0:05-1:20	0:05-0:25		
HISTORICAL	2007-08 ET Test Results									0:15-2:00	
HISTORICAL	2008-09 HOT Table Values	0:05-0:25		0:10-1:00	0:15-1:40	0:10-1:05	0:05-0:50	0:05-1:20	0:05-0:25	0:15-2:00	
HISTORICAL	2008-09 ET Test Results										0:07-0:50
HISTORICAL	2009-10 HOT Table Values	0:05-0:25		0:10-1:00	0:15-1:40	0:10-1:05	0:05-0:50	0:05-1:20	0:05-0:25	0:15-2:00	0:05-0:50
HISTORICAL	2009-10 ET Test Results							0:06-0:50			
HISTORICAL	2010-11 HOT Table Values	0:05-0:25		0:10-1:00	0:15-1:40	0:10-1:05	0:05-0:50	0:05-0:50	0:05-0:25	0:15-2:00	0:05-0:50
CURRENT	2010-11 ET Test Results										
CURRENT	2011-12 HOT Table Values	0:05-0:25		0:10-1:00	0:15-1:40	0:10-1:05	0:08-0:50	0:06-0:50	0:05-0:25	0:15-2:00	0:07-0:50

This page intentionally left blank.

5. CHANGES TO THE TYPE III HOT GUIDELINES

Changes made to the Type III HOT guidelines for the winter of 2011-12 are documented in this chapter. The Transport Canada and FAA 2011-12 generic Type III HOT guidelines are included in Appendix F.

5.1 New Fluids/Data

No new Type III fluids were qualified during the winter of 2010-11. No additional holdover time data was collected with Type III fluids.

5.2 Changes to HOT Guidelines Format

No changes were made to the format of the Type III HOT guidelines for the winter of 2011-12.

5.3 Type III Generic Holdover Time Values

The current Type III generic holdover time values are based on the endurance times of Clariant Safewing MP III 2031 ECO, which was the first fluid qualified as a new generation Type III fluid. Holdover time testing was conducted with a neat sample of the fluid in 2003-04 and with diluted fluid samples (75/25 and 50/50) the following winter. The fluid-specific endurance times calculated for Clariant Safewing MP III 2031 ECO were reduced by 10 percent and changed to reasonably round values to obtain the generic values.

No changes have since been made to the Type III generic holdover time values.

5.4 Future Changes to the Type III HOT Guidelines

Tests conducted in previous winters have shown that endurance times of Type III fluids differ depending on the temperature of the fluid at the time of application. Endurance times are generally longer when fluid is applied heated and shorter when fluid is applied at ambient temperature; however, the effect of heat is not the same in all conditions and heated fluid was found to have shorter endurance times in some cases.

A review of this research was completed in the winter of 2008-09 and is documented in the Transport Canada report, TP 14936E, *Aircraft Ground Icing General Research*

Activities During the 2008-09 Winter (7). The review concluded that changes need to be made to the current protocols for obtaining holdover times [ARP5485 (3), ARP5718 (6) and ARP4737], specifically:

- The fluid manufacturer should identify whether the fluid is to be tested heated or at ambient temperature, or both, depending on what temperature the fluid will be applied in field operations;
- The test method should be changed to reflect that tests should be conducted separately for heated fluid applications and for ambient temperature fluid applications;
- Heated fluid should be tested in accordance with the existing Type I test protocol; and
- Regulators should publish fluid-specific and application temperature-specific HOT tables for Type III fluids.

As a result of these changes to the test protocols, changes will also be required to the methodology used to develop the Type III HOT guidelines:

- Type III HOT tables should be developed separately for heated and ambient fluid applications; and
- Fluid-specific HOT tables should be published for all new Type III fluids and if any fluid is tested both heated and at ambient temperature, two fluid-specific tables should be developed for the fluid.

ARP5718 (6) is currently in the process of being updated to reflect these changes. The updated document, ARP5718A, is expected to be balloted and approved prior to the publication of the winter 2012-13 HOT guidelines. As a result, it is expected that fluid-specific and application temperature-specific tables will be published in the winter 2012-13 HOT guidelines. Consideration will need to be given for how to grandfather the current Type III fluid into the new Type III table format.

6. CHANGES TO THE TYPE IV HOT GUIDELINES

Changes made to the Type IV HOT guidelines for the winter of 2011-12 are documented in this chapter. The Transport Canada and FAA 2011-12 Type IV HOT guidelines are included in Appendix F.

6.1 New Fluids/Data

One new Type IV fluid, Cryotech Polar Guard Advance, will be introduced to the HOT guidelines for the winter of 2011-12. In addition, the rounded Type IV holdover times were updated due to a change in the Type II/IV holdover time rounding protocol. Finally, a rounding discrepancy in the holdover time data for Octagon Max-Flight 04 was identified and corrected.

6.1.1 Cryotech Polar Guard Advance

Cryotech Polar Guard Advance is a new Type IV fluid that was tested in the winter of 2010-11. The detailed endurance time test results and analysis for the fluid are included in the fluid-specific report that was provided to the fluid manufacturer, a copy of which is included in Appendix D.

A fluid-specific HOT table was created for Cryotech Polar Guard Advance based on the results of the endurance time testing, and will be included in the 2011-12 HOT guidelines. The introduction of Cryotech Polar Guard Advance did not impact the generic Type IV holdover times.

6.1.2 Updated Rounded Type IV Holdover Times

Due to a change in the rounding protocol for Type II/IV holdover times, the Type IV fluid-specific holdover time data was re-examined in the winter of 2010-11 and updates were made to the winter 2011-12 HOT guidelines.

Previously, the rounding protocol that was used for Type II/IV holdover times was to round holdover times below 10 minutes down to 5 minutes. The new protocol is for holdover times below 10.0 minutes to be rounded down to the nearest 1 minute (for example, 9.8 minutes becomes 9 minutes). The new protocol also specifies that one decimal place be considered when looking at raw holdover times (i.e. 9.8 minutes).

The entire Type IV holdover time database was examined. All raw Type II holdover times less than 10.0 minutes were examined to determine the new appropriate rounded value. The changes made to the fluid-specific holdover times also resulted in several changes to the generic holdover times. The changes made as a result of this analysis are shown in Table 6.1.

Table 6.1: New Rounded Type IV Holdover Times

Fluid	Fluid Dilution	Cell			Raw HOT	Previous Rounded HOT	New Rounded HOT
		Precip.	Temp. (°C)	Lower/Upper			
Cryotech Polar Guard Advance*	75/25	Cold-Soaked Wing	1	lower	9.4	5*	9
Lyondell Arctic Shield	75/25	Cold-Soaked Wing	1	lower	9.6	5	9
ABAX AD-480 / Dow AD-480	50/50	Snow	-3	lower	9.6	10	9
Kilfrost ABC-4^{sustain}	50/50	Snow	-3	lower	7.9	5	7
Kilfrost ABC-S	50/50	Snow	-3	lower	7.6	5	7
Type IV Generic	50/50	Snow	-3	lower	7.6	5	7
ABAX AD-480 / Dow AD-480	50/50	Freezing Rain	-3	lower	9.0	5	9
Clariant Safewing 2001	50/50	Freezing Rain	-3	lower	8.0	5	8
Cryotech Polar Guard Advance*	50/50	Freezing Rain	-3	lower	8.4	5*	8
Kilfrost ABC-4^{sustain}	50/50	Freezing Rain	-3	lower	7.0	5	7
Kilfrost ABC-S	50/50	Freezing Rain	-3	lower	8.9	5	8
Type IV Generic	50/50	Freezing Rain	-3	lower	7.0	5	7

* As Cryotech Polar Guard Advance is new for the winter of 2011-12, the previous rounded HOT indicates the HOT the fluid would have been given in these cells using the old rounding protocol.

The new rounding protocol is detailed in ARP5718 (6).

6.1.3 Update to Octagon Max-Flight 04

A rounding discrepancy was identified in the holdover time data of Octagon MaxFlight 04 75/25. This discrepancy was corrected, resulting in a 5-minute increase in the snow, -3 to -14°C upper holdover time (from 1:20 to 1:25). This change did not affect the generic holdover times.

6.2 Removed Fluids/Data

The protocol for removing obsolete holdover time data is given in ARP5718 (6). As per the protocol, Octagon MaxFlo and Clariant Safewing 2012 Protect were removed from the Type IV guidelines for the winter of 2011-12. The removal of these two fluids had a significant impact on the Type IV generic holdover times.

6.3 Changes to HOT Guidelines Format

One change was made to the format of the Type IV HOT guidelines for the winter of 2011-12: the lower limit of the lowest temperature band in the fluid-specific HOT tables was changed from "-25°C or LOUT" to the actual numeric lowest operational use temperature (LOUT) value for the fluid.

6.4 Type IV Generic Holdover Time Values

The values in the Type IV generic HOT table are generated each year by taking the shortest holdover times of all fluids on the Transport Canada and FAA lists of Type IV fluids (given as Table 5-4 in the Transport Canada HOT Guidelines). It should be noted that this list also includes fluids whose qualifications have recently expired (i.e. within the previous four years). These "recently expired" fluids are also included in the Type IV generic analysis. When a fluid is removed from the list of qualified Type IV fluids – four years after its qualification has expired – it is also removed from the Type IV generic analysis.

6.4.1 Use of Generic Holdover Times in Very Cold Snow

Following the winter of 2003-04, a decision was made that fluid-specific holdover times would not be provided for Type IV fluids in snow at temperatures below -14°C.

This was due to the limited data that exits for most fluids at these temperatures. Instead, all Type IV fluids are given pre-established “generic” holdover times in very cold snow. These holdover times were determined based on historical data and analysis. An exception was made for the only ethylene glycol based fluid on the market, Dow UCAR Ultra+, which retains fluid-specific holdover times in very cold snow.

6.4.2 Impact of New and Removed Fluids/Data

The removal of Octagon MaxFlo resulted in two increases (5 minutes and 10 minutes) to the Type IV generic holdover times; the removal of Clariant Safewing 2012 Protect resulted in fourteen increases (ranging from 5 to 40 minutes) to the Type IV generic holdover times.

In addition, the updates made to the rounded Type IV holdover times resulted in three changes to the Type IV generic holdover times: two 2-minute increases and one 4-minute increase. The changes are detailed in Table 6.1.

6.4.3 Fluids Responsible for the Type IV Generic Holdover Time Values

The fluids responsible for the values in the generic Type IV HOT guidelines in 2011-12 are shown in Table 6.2, along with the year in which they were tested. 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 6.2: Fluids Responsible for the Type IV Generic Holdover Time Values

OAT °C	OAT °F	Type IV Fluid Concentration Neat Fluid/Water (vol % / vol %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes): FREEZING FOG	SNOW	FREEZING DRIZZLE	LIGHT FREEZING RAIN	RAIN ON COLD SOAKED WING
-3 and above	27 and above	100/0	C-2001 (99/00) **L** D-EG106 (05/06) **U** L-AS (06/07) **U**	D-Ultra+ (98/99) **B**	D-Ultra+ (98/99) **L** A/D-480 (99/00) **U**	D-Ultra+ (98/99) **B**	D-Ultra+ (98/99) **L** A/D-49 (08/09) **L** K-ABC-S (98/99) **U**
		75/25	K-ABC-4S (08/09) **L** K-ABC-S (98/99) **U**	K-ABC-S (98/99) **B** K-ABC-4S (08/09) **B** A/D-480 (99/00) **L**	C-2001 (97/98) **L** K-ABC-4S (08/09) **U**	C-2001 (97/98) **B** K-ABC-4S (08/09) **L**	L-AS (06/07) **L** CR-PGA (10/11) **L** K-ABC-S (98/99) **U**
		50/50	C-2001 (99/00) **L** K-ABC-S (98/99) **U** K-ABC-4S (08/09) **U**	K-ABC-S (98/99) **B** K-ABC-4S (08/09) **B** CR-PG (09/10) **U**	C-2001 (97/98) **B** K-ABC-4S (08/09) **B** K-ABC-S (98/99) **U**	K-ABC-4S (08/09) **B** K-ABC-S (98/99) **U**	
below -3 to -14	below 27 to 7	100/0	A/D-480 (99/00) **B** A/D-49 (08/09) **L**	D-Ultra+ (98/99) **L** C-2001 (97/98) **U**	K-ABC-S (98/99) **B**	K-ABC-S (98/99) **L** A/D-49 (08/09) **U**	
		75/25	A/D-480 (99/00) **B** K-ABC-S (98/99) **L**	C-2001 (97/98) **B** A/D-480 (99/00) **L** CR-PG (09/10) **L**	A/D-49 (08/09) **L** O-Max04 (00/01) **U**	K-ABC-S (98/99) **L** K-ABC-S+ (06/07) **U** A/D-49 (08/09) **U**	
below -14 to -25 or LOUT	below 7 to -13 or LOUT	100/0	A/D-480 (99/00) **B** K-ABC-S (98/99) **U** A/D-49 (08/09) **U** CR-PG (09/10) **U**	Historic Generic **B**			

LEGEND: **L = DRIVES LOWER LIMIT** **U = DRIVES UPPER LIMIT** **B = DRIVES BOTH**

M:\Groups\PM2169.003\Reports\HOT\Working Documents\Fluids Responsible for Generic Table Values At: Type IV

6.4.4 Evolution of Type IV Generic Holdover Time Values

The history of testing with Type IV fluids and the evolution of the fluid-specific and generic Type IV holdover time values are illustrated through a series of tables given in Tables 6.2 to 6.26. Each table represents one cell in the HOT guidelines and the title of each table links the table to the appropriate cell. Fluids that are no longer used in the generic analysis (see Subsection 6.2) are not included.

The first row in each table contains the values obtained in testing in 1996-97. These values were used as the holdover time values in 1997-98 winter operations. Each subsequent set of two rows represents a winter test season and the subsequent winter's holdover time values. The final line contains the generic and fluid-specific holdover time values for use in 2011-12 winter operations. It should be noted that because no Type IV fluids were tested in the winter of 2001-02 and the generic values did not change, no line has been included for the 2001-02 winter test season or the 2002-03 holdover time values.

Underlined values indicate the fluid or fluids responsible for the generic holdover time. Strikethrough values indicate endurance time test results that are no longer valid. If a fluid is no longer qualified, such as the Dow UCAR Ultra+ dilutions and the Octagon Max-Flight 1998-99 low viscosity sample, the test results become invalid. Alternately, if a fluid has been tested on multiple occasions, then only one test result, usually the shortest endurance time, is valid for a given fluid in a given cell. Details are typically provided in the HOT report written in the most recent year the fluid underwent testing.

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

- Kilfrost ABC-S (K-ABC-S);
- Dow UCAR Ultra+ (Ultra+);
- ABAX AD-480 / Dow UCAR FlightGuard AD-480 (A-480);
- Clariant Safewing MP IV 2001 (C-2001);
- Octagon Max-Flight 04 (O-Max 04);
- Clariant Safewing MP IV Launch (C-Launch);
- Dow UCAR Endurance EG106 (D-E106);
- Kilfrost ABC-S PLUS (K-ABCS+);
- Lyondell ARCTIC Shield® (L-AS);
- ABAX Ecowing AD-49 / Dow UCAR FlightGuard AD-49 (A-49);
- Kilfrost ABC-4sustain (K-ABC4S);
- Cryotech Polar Guard (CR-PG); and
- Cryotech Polar Guard Advance (CR-PGA).

Table 6.3: Type IV Neat Fluid, Snow, -3°C and Above

		GENERIC	K-ABC-S	Ultra+	A-480	C-2001	O-Max 04	C-Launch	D-E106	K-ABCS+	L-AS	A-49	K-ABC4S	CR-PG	CR-PGA
HISTORICAL	1996-97 Test Results and Table Values used in 97-98	0:35-1:00	1:00-1:40	0:35-1:15											
	1997-98 ET Test Results				~~1:05-2:00~~	1:00-1:55									
	1998-99 HOT Table Values	0:35-1:00	1:00-1:40	0:35-1:15	1:05-2:00	1:00-1:55									
	1998-99 ETTest Results		1:00-1:40	0:35-1:15	~~1:05-1:50~~										
	1999-00 HOT Table Values	0:30-0:55	1:00-1:40	0:35-1:15	1:05-1:50	1:00-1:55									
	1999-00 ET Test Results				0:40-1:20										
	2000-01 HOT Table Values	0:30-0:55	1:00-1:40	0:35-1:15	0:40-1:20	1:00-1:55									
	2000-01 ET Test Results						1:25-2:00								
	2001-02 HOT Table Values	0:30-0:55	1:00-1:40	0:35-1:15	0:40-1:20	1:00-1:55									
	2002-03 ET Test Results														
	2003-04 HOT Table Values	0:30-0:55	1:00-1:40	0:35-1:15	0:40-1:20	1:00-1:55									
	2003-04 ET Test Results														
	2004-05 HOT Table Values	0:30-0:55	1:00-1:40	0:35-1:15	0:40-1:20	1:00-1:55	1:25-2:00								
	2004-05 ET Test Results														
	2005-06 HOT Table Values	0:35-1:15	1:00-1:40	0:35-1:15	0:40-1:20	1:00-1:55	1:25-2:00								
	2005-06 ET Test Results							~~1:00-1:35~~	0:40-1:20	~~0:45-1:25~~					
	2006-07 HOT Table Values	0:35-1:15	1:00-1:40	0:35-1:15	0:40-1:20	1:00-1:55	1:25-2:00	1:00-1:35	0:40-1:20	0:45-1:25					
	2006-07 ET Test Results							1:05-1:45		1:15-2:00	0:50-1:25				
	2007-08 HOT Table Values	0:35-1:15	1:00-1:40	0:35-1:15	0:40-1:20	1:00-1:55	1:25-2:00	1:05-1:45	0:40-1:20	1:15-2:00	0:50-1:25				
	2007-08 ET Test Results														
	2008-09 HOT Table Values	0:35-1:15	1:00-1:40	0:35-1:15	0:40-1:20	1:00-1:55	1:25-2:00	1:05-1:45	0:40-1:20	1:15-2:00	0:50-1:25				
	2008-09 ET Test Results											1:10-1:50	1:00-1:45		
	2009-10 HOT Table Values	0:35-1:15	1:00-1:40	0:35-1:15	0:40-1:20	1:00-1:55	1:25-2:00	1:05-1:45	0:40-1:20	1:15-2:00	0:50-1:25	1:10-1:50	1:00-1:45		
	2009-10 ET Test Results													0:50-1:30	
	2010-11 HOT Table Values	0:35-1:15	1:00-1:40	0:35-1:15	0:40-1:20	1:00-1:55	1:25-2:00	1:05-1:45	0:40-1:20	1:15-2:00	0:50-1:25	1:10-1:50	1:00-1:45	0:50-1:30	
CURRENT	2010-11 ET Test Results														1:20-1:50
	2011-12 HOT Table Values	0:35-1:15	1:00-1:40	0:35-1:15	0:40-1:20	1:00-1:55	1:25-2:00	1:05-1:45	0:40-1:20	1:15-2:00	0:50-1:25	1:10-1:50	1:00-1:45	0:50-1:30	1:20-1:50

Table 6.4: Type IV 75/25 Fluid, Snow, -3°C and Above

		GENERIC	K-ABC-S	Ultra+	A-480	C-2001	O-Max 04	C-Launch	D-E106	K-ABCS+	L-AS	A-49	K-ABC4S	CR-PG	CR-PGA
HISTORICAL	1996-97 Test Results and Table Values used in 97-98	0:20-0:35	~~0:35-1:05~~	~~0:20-0:35~~											
HISTORICAL	1997-98 ET Test Results				~~0:45-1:25~~	0:35-1:00									
HISTORICAL	1998-99 HOT Table Values	0:20-0:35	0:35-1:05		0:45-1:25	0:35-1:00									
HISTORICAL	1998-99 ETTest Results		0:30-0:55		~~0:45-1:25~~										
HISTORICAL	1999-00 HOT Table Values	0:20-0:35	0:30-0:55		0:45-1:25	0:35-1:00									
HISTORICAL	1999-00 ET Test Results				0:30-1:05										
HISTORICAL	2000-01 HOT Table Values	0:20-0:35	0:30-0:55		0:30-1:05	0:35-1:00									
HISTORICAL	2000-01 ET Test Results						1:05-2:00								
HISTORICAL	2001-02 HOT Table Values	0:25-0:50	0:30-0:55		0:30-1:05	0:35-1:00									
HISTORICAL	2002-03 ET Test Results														
HISTORICAL	2003-04 HOT Table Values	0:25-0:50	0:30-0:55		0:30-1:05	0:35-1:00									
HISTORICAL	2003-04 ET Test Results														
HISTORICAL	2004-05 HOT Table Values	0:25-0:50	0:30-0:55		0:30-1:05	0:35-1:00	1:05-2:00								
HISTORICAL	2004-05 ET Test Results														
HISTORICAL	2005-06 HOT Table Values	0:20-0:55	0:30-0:55		0:30-1:05	0:35-1:00	1:05-2:00								
HISTORICAL	2005-06 ET Test Results							~~0:40-1:20~~		~~0:25-0:55~~					
HISTORICAL	2006-07 HOT Table Values	0:20-0:55	0:30-0:55		0:30-1:05	0:35-1:00	1:05-2:00	0:40-1:20		0:25-0:55					
HISTORICAL	2006-07 ET Test Results							1:00-1:45		0:45-1:15	0:40-1:05				
HISTORICAL	2007-08 HOT Table Values	0:20-0:55	0:30-0:55		0:30-1:05	0:35-1:00	1:05-2:00	1:00-1:45		0:45-1:15	0:40-1:05				
HISTORICAL	2007-08 ET Test Results														
HISTORICAL	2008-09 HOT Table Values	0:20-0:55	0:30-0:55		0:30-1:05	0:35-1:00	1:05-2:00	1:00-1:45		0:45-1:15	0:40-1:05				
HISTORICAL	2008-09 ET Test Results											1:20-1:40	0:30-0:55		
HISTORICAL	2009-10 HOT Table Values	0:20-0:55	0:30-0:55		0:30-1:05	0:35-1:00	1:05-2:00	1:00-1:45		0:45-1:15	0:40-1:05	1:20-1:40	0:30-0:55		
HISTORICAL	2009-10 ET Test Results													0:35-1:10	
HISTORICAL	2010-11 HOT Table Values	0:20-0:55	0:30-0:55		0:30-1:05	0:35-1:00	1:05-2:00	1:00-1:45		0:45-1:15	0:40-1:05	1:20-1:40	0:30-0:55	0:35-1:10	
CURRENT	2010-11 ET Test Results														0:45-1:20
CURRENT	2011-12 HOT Table Values	0:30-0:55	0:30-0:55		0:30-1:05	0:35-1:00	1:05-2:00	1:00-1:45		0:45-1:15	0:40-1:05	1:20-1:40	0:30-0:55	0:35-1:10	0:45-1:20

Table 6.5: Type IV 50/50 Fluid, Snow, -3°C and Above

		GENERIC	K-ABC-S	Ultra+	A-480	C-2001	O-Max 04	C-Launch	D-E106	K-ABCS+	L-AS	A-49	K-ABC4S	CR-PG	CR-PGA
HISTORICAL	1996-97 Test Results and Table Values used in 97-98	0:05-0:15	~~0:05-0:15~~	~~0:05-0:15~~											
	1997-98 ET Test Results				~~0:10-0:30~~	0:10-0:20									
	1998-99 HOT Table Values	0:05-0:15	0:05-0:15		0:10-0:30	0:10-0:20									
	1998-99 ETTest Results	0:05-0:15	0:07-0:15												
	1999-00 HOT Table Values	0:05-0:15	0:05-0:15		0:10-0:30	0:10-0:20									
	1999-00 ET Test Results				0:09-0:20										
	2000-01 HOT Table Values	0:05-0:15	0:05-0:15		0:10-0:20	0:10-0:20									
	2000-01 ET Test Results						0:25-1:15								
	2001-02 HOT Table Values	0:05-0:15	0:05-0:15		0:10-0:20	0:10-0:20									
	2002-03 ET Test Results														
	2003-04 HOT Table Values	0:05-0:15	0:05-0:15		0:10-0:20	0:10-0:20									
	2003-04 ET Test Results														
	2004-05 HOT Table Values	0:05-0:15	0:05-0:15		0:10-0:20	0:10-0:20	0:25-1:15								
	2004-05 ET Test Results														
	2005-06 HOT Table Values	0:05-0:15	0:05-0:15		0:10-0:20	0:10-0:20	0:25-1:15								
	2005-06 ET Test Results							~~0:10-0:25~~		~~0:05-0:15~~					
	2006-07 HOT Table Values	0:05-0:15	0:05-0:15		0:10-0:20	0:10-0:20	0:25-1:15	0:10-0:25		0:05-0:15					
	2006-07 ET Test Results							0:25-0:45		0:15-0:30	0:20-0:35				
	2007-08 HOT Table Values	0:05-0:15	0:05-0:15		0:10-0:20	0:10-0:20	0:25-1:15	0:25-0:45		0:15-0:30	0:20-0:35				
	2007-08 ET Test Results														
	2008-09 HOT Table Values	0:05-0:15	0:05-0:15		0:10-0:20	0:10-0:20	0:25-1:15	0:25-0:45		0:15-0:30	0:20-0:35				
	2008-09 ET Test Results											0:15-0:25	0:07-0:15		
	2009-10 HOT Table Values	0:05-0:15	0:05-0:15		0:10-0:20	0:10-0:20	0:25-1:15	0:25-0:45		0:15-0:30	0:20-0:35	0:15-0:25	0:05-0:15		
	2009-10 ET Test Results													0:10-0:15	
	2010-11 HOT Table Values	0:05-0:15	0:05-0:15		0:10-0:20	0:10-0:20	0:25-1:15	0:25-0:45		0:15-0:30	0:20-0:35	0:15-0:25	0:05-0:15	0:10-0:15	
CURRENT	2010-11 ET Test Results														0:15-0:35
	2011-12 HOT Table Values	0:07-0:15	0:07-0:15		0:09-0:20	0:10-0:20	0:25-1:15	0:25-0:45		0:15-0:30	0:20-0:35	0:15-0:25	0:07-0:15	0:10-0:15	0:15-0:35

Table 6.6: Type IV Neat Fluid, Snow, Below -3°C to -14°C

		GENERIC	K-ABC-S	Ultra+	A-480	C-2001	O-Max 04	C-Launch	D-E106	K-ABCS+	L-AS	A-49	K-ABC4S	CR-PG	CR-PGA
HISTORICAL	1996-97 Test Results and Table Values used in 97-98	0:20-0:40	0:45-1:20	0:25-0:55											
	1997-98 ET Test Results				~~0:20-0:40~~	0:30-0:50									
	1998-99 HOT Table Values	0:20-0:40	0:45-1:20	0:25-0:55	0:20-0:40	0:30-0:50									
	1998-99 ETTest Results		0:45-1:20	~~0:30-1:00~~	0:30-0:55										
	1999-00 HOT Table Values	0:20-0:40	0:45-1:20	0:25-0:55	0:30-0:55	0:30-0:50									
	1999-00 ET Test Results				0:30-0:55										
	2000-01 HOT Table Values	0:20-0:40	0:45-1:20	0:25-0:55	0:30-0:55	0:30-0:50									
	2000-01 ET Test Results						0:35-1:10								
	2001-02 HOT Table Values	0:20-0:40	0:45-1:20	0:25-0:55	0:30-0:55	0:30-0:50									
	2002-03 ET Test Results														
	2003-04 HOT Table Values	0:20-0:40	0:45-1:20	0:25-0:55	0:30-0:55	0:30-0:50									
	2003-04 ET Test Results														
	2004-05 HOT Table Values	0:20-0:40	0:45-1:20	0:25-0:55	0:30-0:55	0:30-0:50	0:35-1:10								
	2004-05 ET Test Results														
	2005-06 HOT Table Values	0:20-0:40	0:45-1:20	0:25-0:55	0:30-0:55	0:30-0:50	0:35-1:10								
	2005-06 ET Test Results							~~0:40-1:05~~	0:30-1:05	~~0:35-1:00~~					
	2006-07 HOT Table Values	0:20-0:40	0:45-1:20	0:25-0:55	0:30-0:55	0:30-0:50	0:35-1:10	0:40-1:05	0:30-1:05	0:35-1:00					
	2006-07 ET Test Results							0:50-1:20		1:00-1:45	0:45-1:15				
	2007-08 HOT Table Values	0:20-0:40	0:45-1:20	0:25-0:55	0:30-0:55	0:30-0:50	0:35-1:10	0:50-1:20	0:30-1:05	1:00-1:45	0:45-1:15				
	2007-08 ET Test Results														
	2008-09 HOT Table Values	0:20-0:40	0:45-1:20	0:25-0:55	0:30-0:55	0:30-0:50	0:35-1:10	0:50-1:20	0:30-1:05	1:00-1:45	0:45-1:15				
	2008-09 ET Test Results											1:10-1:50	1:00-1:45		
	2009-10 HOT Table Values	0:20-0:40	0:45-1:20	0:25-0:55	0:30-0:55	0:30-0:50	0:35-1:10	0:50-1:20	0:30-1:05	1:00-1:45	0:45-1:15	1:10-1:50	1:00-1:45		
	2009-10 ET Test Results													0:30-0:55	
	2010-11 HOT Table Values	0:20-0:40	0:45-1:20	0:25-0:55	0:30-0:55	0:30-0:50	0:35-1:10	0:50-1:20	0:30-1:05	1:00-1:45	0:45-1:15	1:10-1:50	1:00-1:45	0:30-0:55	
CURRENT	2010-11 ET Test Results														0:55-1:15
	2011-12 HOT Table Values	0:25-0:50	0:45-1:20	0:25-0:55	0:30-0:55	0:30-0:50	0:35-1:10	0:50-1:20	0:30-1:05	1:00-1:45	0:45-1:15	1:10-1:50	1:00-1:45	0:30-0:55	0:55-1:15

Table 6.7: Type IV 75/25 Fluid, Snow, Below -3°C to -14°C

		GENERIC	K-ABC-S	Ultra+	A-480	C-2001	O-Max 04	C-Launch	D-E106	K-ABCS+	L-AS	A-49	K-ABC4S	CR-PG	CR-PGA
HISTORICAL	1996-97 Test Results and Table Values used in 97-98	0:15-0:30	~~0:35-1:05~~	~~0:15-0:30~~											
HISTORICAL	1997-98 ET Test Results				~~0:15-0:25~~	0:20-0:35									
HISTORICAL	1998-99 HOT Table Values	0:15-0:25	0:35-1:05		0:15-0:25	0:20-0:35									
HISTORICAL	1998-99 ETTest Results		0:25-0:50		~~0:25-0:45~~										
HISTORICAL	1999-00 HOT Table Values	0:15-0:25	0:25-0:50		0:25-0:45	0:20-0:35									
HISTORICAL	1999-00 ET Test Results				0:20-0:45										
HISTORICAL	2000-01 HOT Table Values	0:15-0:25	0:25-0:50		0:20-0:45	0:20-0:35									
HISTORICAL	2000-01 ET Test Results						0:40-1:20								
HISTORICAL	2001-02 HOT Table Values	0:15-0:25	0:25-0:50		0:20-0:45	0:20-0:35									
HISTORICAL	2002-03 ET Test Results														
HISTORICAL	2003-04 HOT Table Values	0:20-0:35	0:25-0:50		0:20-0:45	0:20-0:35									
HISTORICAL	2003-04 ET Test Results														
HISTORICAL	2004-05 HOT Table Values	0:20-0:35	0:25-0:50		0:20-0:45	0:20-0:35	0:40-1:20								
HISTORICAL	2004-05 ET Test Results														
HISTORICAL	2005-06 HOT Table Values	0:15-0:35	0:25-0:50		0:20-0:45	0:20-0:35	0:40-1:20								
HISTORICAL	2005-06 ET Test Results							~~0:20-0:40~~		~~0:25-0:50~~					
HISTORICAL	2006-07 HOT Table Values	0:15-0:35	0:25-0:50		0:20-0:45	0:20-0:35	0:40-1:20	0:20-0:40		0:25-0:50					
HISTORICAL	2006-07 ET Test Results							0:45-1:25		0:35-1:00	0:35-0:55				
HISTORICAL	2007-08 HOT Table Values	0:15-0:35	0:25-0:50		0:20-0:45	0:20-0:35	0:40-1:20	0:45-1:25		0:35-1:00	0:35-0:55				
HISTORICAL	2007-08 ET Test Results														
HISTORICAL	2008-09 HOT Table Values	0:15-0:35	0:25-0:50		0:20-0:45	0:20-0:35	0:40-1:20	0:45-1:25		0:35-1:00	0:35-0:55				
HISTORICAL	2008-09 ET Test Results											1:20-1:40	0:30-0:55		
HISTORICAL	2009-10 HOT Table Values	0:15-0:35	0:25-0:50		0:20-0:45	0:20-0:35	0:40-1:20	0:45-1:25		0:35-1:00	0:35-0:55	1:20-1:40	0:30-0:55		
HISTORICAL	2009-10 ET Test Results													0:20-0:40	
HISTORICAL	2010-11 HOT Table Values	0:15-0:35	0:25-0:50		0:20-0:45	0:20-0:35	0:40-1:20	0:45-1:25		0:35-1:00	0:35-0:55	1:20-1:40	0:30-0:55	0:20-0:40	
CURRENT	2010-11 ET Test Results														0:35-1:00
CURRENT	2011-12 HOT Table Values	0:20-0:35	0:25-0:50		0:20-0:45	0:20-0:35	0:40-1:20	0:45-1:25		0:35-1:00	0:35-0:55	1:20-1:40	0:30-0:55	0:20-0:40	0:35-1:00

Table 6.8: Type IV Neat Fluid, Snow, Below -14ºC to -25ºC

		GENERIC	K-ABC-S	Ultra+	A-480	C-2001	O-Max 04	C-Launch	D-E106	K-ABCS+	L-AS	A-49	K-ABC4S	CR-PG	CR-PGA
HISTORICAL	1996-97 Test Results and Table Values used in 97-98	0:15-0:30	0:40-1:10	0:20-0:45											
HISTORICAL	1997-98 ET Test Results				~~0:15-0:30~~	0:20-0:35									
HISTORICAL	1998-99 HOT Table Values	0:15-0:30	0:40-1:10	0:20-0:45	0:15-0:30	0:20-0:35									
HISTORICAL	1998-99 ETTest Results		0:40-1:10	~~0:30-0:55~~	0:25-0:40										
HISTORICAL	1999-00 HOT Table Values	0:15-0:30	0:40-1:10	0:20-0:45	0:25-0:40	0:20-0:35									
HISTORICAL	1999-00 ET Test Results				~~0:25-0:50~~										
HISTORICAL	2000-01 HOT Table Values	0:15-0:30	0:40-1:10	0:20-0:45	0:25-0:40	0:20-0:35									
HISTORICAL	2000-01 ET Test Results						0:25-0:50								
HISTORICAL	2001-02 HOT Table Values	0:15-0:30	0:40-1:10	0:20-0:45	0:25-0:40	0:20-0:35									
HISTORICAL	2002-03 ET Test Results														
HISTORICAL	2003-04 HOT Table Values	0:15-0:30	0:40-1:10	0:20-0:45	0:25-0:40	0:20-0:35									
HISTORICAL	2003-04 ET Test Results														
HISTORICAL	2004-05 HOT Table Values	0:15-0:30	0:15-0:30*	0:20-0:45	0:15-0:30*	0:15-0:30*	0:15-0:30*								
HISTORICAL	2004-05 ET Test Results														
HISTORICAL	2005-06 HOT Table Values	0:15-0:30	0:15-0:30*	0:20-0:45	0:15-0:30*	0:15-0:30*	0:15-0:30*								
HISTORICAL	2005-06 ET Test Results							~~0:35-0:55~~	0:25-0:55	~~0:30-0:50~~					
HISTORICAL	2006-07 HOT Table Values	0:15-0:30	0:15-0:30*	0:20-0:45	0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*					
HISTORICAL	2006-07 ET Test Results							0:45-1:10		0:55-1:35	0:40-1:10				
HISTORICAL	2007-08 HOT Table Values	0:15-0:30	0:15-0:30*	0:20-0:45	0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*				
HISTORICAL	2007-08 ET Test Results														
HISTORICAL	2008-09 HOT Table Values	0:15-0:30	0:15-0:30*	0:20-0:45	0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*				
HISTORICAL	2008-09 ET Test Results											1:10-1:50	1:00-1:45		
HISTORICAL	2009-10 HOT Table Values	0:15-0:30	0:15-0:30*	0:20-0:45	0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*		
HISTORICAL	2009-10 ET Test Results													0:25-0:40	
HISTORICAL	2010-11 HOT Table Values	0:15-0:30	0:15-0:30*	0:20-0:45	0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*	
CURRENT	2010-11 ET Test Results														0:45-1:05
CURRENT	2011-12 HOT Table Values	0:15-0:30	0:15-0:30*	0:20-0:45	0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*	0:15-0:30*

*The generic HOT values were used for this cell

Table 6.9: Type IV Neat Fluid, Freezing Drizzle, -3°C and Above

		GENERIC	K-ABC-S	Ultra+	A-480	C-2001	O-Max 04	C-Launch	D-E106	K-ABCS+	L-AS	A-49	K-ABC4S	CR-PG	CR-PGA
HISTORICAL	1996-97 Test Results and Table Values used in 97-98	0:40-1:00	1:20-1:50	~~1:00-2:00~~											
	1997-98 ET Test Results		~~1:55-2:00~~		~~1:05-2:00~~	0:55-1:55									
	1998-99 HOT Table Values	0:40-1:00	1:20-1:50	1:00-2:00	1:05-2:00	0:55-1:55									
	1998-99 ETTest Results		~~2:00-2:00~~	0:45-1:35											
	1999-00 HOT Table Values	0:40-1:00	1:20-1:50	0:45-1:35	1:05-2:00	0:55-1:55									
	1999-00 ET Test Results				0:50-1:30										
	2000-01 HOT Table Values	0:40-1:00	1:20-1:50	0:45-1:35	0:50-1:30	0:55-1:55									
	2000-01 ET Test Results						2:00-2:00								
	2001-02 HOT Table Values	0:40-1:10	1:20-1:50	0:45-1:35	0:50-1:30	0:55-1:55									
	2002-03 ET Test Results														
	2003-04 HOT Table Values	0:40-1:10	1:20-1:50	0:45-1:35	0:50-1:30	0:55-1:55									
	2003-04 ET Test Results														
	2004-05 HOT Table Values	0:40-1:10	1:20-1:50	0:45-1:35	0:50-1:30	0:55-1:55	2:00-2:00								
	2004-05 ET Test Results														
	2005-06 HOT Table Values	0:40-1:10	1:20-1:50	0:45-1:35	0:50-1:30	0:55-1:55	2:00-2:00								
	2005-06 ET Test Results							1:30-2:00	1:10-2:00	~~1:15-1:55~~					
	2006-07 HOT Table Values	0:40-1:10	1:20-1:50	0:45-1:35	0:50-1:30	0:55-1:55	2:00-2:00	1:30-2:00	1:10-2:00	1:15-1:55					
	2006-07 ET Test Results									1:50-2:00	0:55-1:40				
	2007-08 HOT Table Values	0:40-1:10	1:20-1:50	0:45-1:35	0:50-1:30	0:55-1:55	2:00-2:00	1:30-2:00	1:10-2:00	1:50-2:00	0:55-1:40				
	2007-08 ET Test Results														
	2008-09 HOT Table Values	0:40-1:10	1:20-1:50	0:45-1:35	0:50-1:30	0:55-1:55	2:00-2:00	1:30-2:00	1:10-2:00	1:50-2:00	0:55-1:40				
	2008-09 ET Test Results											1:25-2:00	1:35-2:00		
	2009-10 HOT Table Values	0:40-1:10	1:20-1:50	0:45-1:35	0:50-1:30	0:55-1:55	2:00-2:00	1:30-2:00	1:10-2:00	1:50-2:00	0:55-1:40	1:25-2:00	1:35-2:00		
	2009-10 ET Test Results													1:15-2:00	
	2010-11 HOT Table Values	0:40-1:10	1:20-1:50	0:45-1:35	0:50-1:30	0:55-1:55	2:00-2:00	1:30-2:00	1:10-2:00	1:50-2:00	0:55-1:40	1:25-2:00	1:35-2:00	1:15-2:00	
CURRENT	2010-11 ET Test Results														1:35-2:00
	2011-12 HOT Table Values	0:45-1:30	1:20-1:50	0:45-1:35	0:50-1:30	0:55-1:55	2:00-2:00	1:30-2:00	1:10-2:00	1:50-2:00	0:55-1:40	1:25-2:00	1:35-2:00	1:15-2:00	1:35-2:00

Table 6.10: Type IV 75/25 Fluid, Freezing Drizzle, -3°C and Above

		GENERIC	K-ABC-S	Ultra+	A-480	C-2001	O-Max 04	C-Launch	D-E106	K-ABCS+	L-AS	A-49	K-ABC4S	CR-PG	CR-PGA
HISTORICAL	1996-97 Test Results and Table Values used in 97-98	0:30-1:00	~~0:50-1:25~~	~~0:30-1:00~~											
	1997-98 ET Test Results		~~0:50-1:10~~		~~0:50-1:20~~	0:35-1:10									
	1998-99 HOT Table Values	0:30-1:00	0:50-1:10		0:50-1:20	0:35-1:10									
	1998-99 ETTest Results		0:45-1:10												
	1999-00 HOT Table Values	0:30-1:00	0:45-1:10		0:50-1:20	0:35-1:10									
	1999-00 ET Test Results				0:50-1:15										
	2000-01 HOT Table Values	0:30-1:00	0:45-1:10		0:50-1:15	0:35-1:10									
	2000-01 ET Test Results						1:50-2:00								
	2001-02 HOT Table Values	0:35-0:50	0:45-1:10		0:50-1:15	0:35-1:10									
	2002-03 ET Test Results														
	2003-04 HOT Table Values	0:35-0:50	0:45-1:10		0:50-1:15	0:35-1:10									
	2003-04 ET Test Results														
	2004-05 HOT Table Values	0:35-0:50	0:45-1:10		0:50-1:15	0:35-1:10	1:50-2:00								
	2004-05 ET Test Results														
	2005-06 HOT Table Values	0:35-0:50	0:45-1:10		0:50-1:15	0:35-1:10	1:50-2:00								
	2005-06 ET Test Results							1:40-2:00		~~0:45-1:10~~					
	2006-07 HOT Table Values	0:35-0:50	0:45-1:10		0:50-1:15	0:35-1:10	1:50-2:00	1:40-2:00		0:45-1:10					
	2006-07 ET Test Results									1:00-1:20	0:55-1:25				
	2007-08 HOT Table Values	0:35-0:50	0:45-1:10		0:50-1:15	0:35-1:10	1:50-2:00	1:40-2:00		1:00-1:20	0:55-1:25				
	2007-08 ET Test Results														
	2008-09 HOT Table Values	0:35-0:50	0:45-1:10		0:50-1:15	0:35-1:10	1:50-2:00	1:40-2:00		1:00-1:20	0:55-1:25				
	2008-09 ET Test Results											1:55-2:00	0:40-1:05		
	2009-10 HOT Table Values	0:35-0:50	0:45-1:10		0:50-1:15	0:35-1:10	1:50-2:00	1:40-2:00		1:00-1:20	0:55-1:25	1:55-2:00	0:40-1:05		
	2009-10 ET Test Results													1:05-1:25	
	2010-11 HOT Table Values	0:35-0:50	0:45-1:10		0:50-1:15	0:35-1:10	1:50-2:00	1:40-2:00		1:00-1:20	0:55-1:25	1:55-2:00	0:40-1:05	1:05-1:25	
CURRENT	2010-11 ET Test Results														1:40-2:00
	2011-12 HOT Table Values	0:35-1:05	0:45-1:10		0:50-1:15	0:35-1:10	1:50-2:00	1:40-2:00		1:00-1:20	0:55-1:25	1:55-2:00	0:40-1:05	1:05-1:25	1:40-2:00

Table 6.11: Type IV 50/50 Fluid, Freezing Drizzle, -3°C and Above

		GENERIC	K-ABC-S	Ultra+	A-480	C-2001	O-Max 04	C-Launch	D-E106	K-ABCS+	L-AS	A-49	K-ABC4S	CR-PG	CR-PGA
HISTORICAL	1996-97 Test Results and Table Values used in 97-98	0:10-0:20	0:15-~~0:25~~	~~0:10-0:20~~											
	1997-98 ET Test Results		0:15-0:20		~~0:15-0:35~~	0:10-0:20									
	1998-99 HOT Table Values	0:10-0:20	0:15-0:20		0:15-0:35	0:10-0:20									
	1998-99 ETTest Results		0:15-0:20												
	1999-00 HOT Table Values	0:10-0:20	0:15-0:20		0:15-0:35	0:10-0:20									
	1999-00 ET Test Results				0:15-0:25										
	2000-01 HOT Table Values	0:10-0:20	0:15-0:20		0:15-0:25	0:10-0:20									
	2000-01 ET Test Results						0:35-1:10								
	2001-02 HOT Table Values	0:10-0:20	0:15-0:20		0:15-0:25	0:10-0:20									
	2002-03 ET Test Results														
	2003-04 HOT Table Values	0:10-0:20	0:15-0:20		0:15-0:25	0:10-0:20									
	2003-04 ET Test Results														
	2004-05 HOT Table Values	0:10-0:20	0:15-0:20		0:15-0:25	0:10-0:20	0:35-1:10								
	2004-05 ET Test Results														
	2005-06 HOT Table Values	0:10-0:20	0:15-0:20		0:15-0:25	0:10-0:20	0:35-1:10								
	2005-06 ET Test Results							0:30-0:50		~~0:10-0:20~~					
	2006-07 HOT Table Values	0:10-0:20	0:15-0:20		0:15-0:25	0:10-0:20	0:35-1:10	0:30-0:50		0:10-0:20					
	2006-07 ET Test Results									0:15-0:40	0:20-0:30				
	2007-08 HOT Table Values	0:10-0:20	0:15-0:20		0:15-0:25	0:10-0:20	0:35-1:10	0:30-0:50		0:15-0:40	0:20-0:30				
	2007-08 ET Test Results														
	2008-09 HOT Table Values	0:10-0:20	0:15-0:20		0:15-0:25	0:10-0:20	0:35-1:10	0:30-0:50		0:15-0:40	0:20-0:30				
	2008-09 ET Test Results											0:15-0:30	0:10-0:20		
	2009-10 HOT Table Values	0:10-0:20	0:15-0:20		0:15-0:25	0:10-0:20	0:35-1:10	0:30-0:50		0:15-0:40	0:20-0:30	0:15-0:30	0:10-0:20		
	2009-10 ET Test Results													0:15-0:25	
	2010-11 HOT Table Values	0:10-0:20	0:15-0:20		0:15-0:25	0:10-0:20	0:35-1:10	0:30-0:50		0:15-0:40	0:20-0:30	0:15-0:30	0:10-0:20	0:15-0:25	
CURRENT	2010-11 ET Test Results														0:20-0:45
	2011-12 HOT Table Values	0:10-0:20	0:15-0:20		0:15-0:25	0:10-0:20	0:35-1:10	0:30-0:50		0:15-0:40	0:20-0:30	0:15-0:30	0:10-0:20	0:15-0:25	0:20-0:45

Table 6.12: Type IV Neat Fluid, Freezing Drizzle, Below -3°C to -10°C

		GENERIC	K-ABC-S	Ultra+	A-480	C-2001	O-Max 04	C-Launch	D-E106	K-ABCS+	L-AS	A-49	K-ABC4S	CR-PG	CR-PGA
HISTORICAL	1996-97 Test Results and Table Values used in 97-98	0:30-1:00	~~0:35~~-1:00	~~0:50-1:35~~											
	1997-98 ET Test Results		~~0:40-1:20~~		0:25-1:20	0:55-1:35									
	1998-99 HOT Table Values	0:25-1:00	0:35-1:00	0:50-1:35	0:25-1:20	0:55-1:35									
	1998-99 ETTest Results		0:20-~~1:30~~	0:45-1:25											
	1999-00 HOT Table Values	0:20-0:55	0:20-1:00	0:45-1:25	0:25-1:20	0:55-1:35									
	1999-00 ET Test Results				0:25-1:20										
	2000-01 HOT Table Values	0:20-0:55	0:20-1:00	0:45-1:25	0:25-1:20	0:55-1:35									
	2000-01 ET Test Results						0:25-1:30								
	2001-02 HOT Table Values	0:20-0:45	0:20-1:00	0:45-1:25	0:25-1:20	0:55-1:35									
	2002-03 ET Test Results														
	2003-04 HOT Table Values	0:20-0:45	0:20-1:00	0:45-1:25	0:25-1:20	0:55-1:35									
	2003-04 ET Test Results														
	2004-05 HOT Table Values	0:20-0:45	0:20-1:00	0:45-1:25	0:25-1:20	0:55-1:35	0:25-1:30								
	2004-05 ET Test Results														
	2005-06 HOT Table Values	0:20-0:45	0:20-1:00	0:45-1:25	0:25-1:20	0:55-1:35	0:25-1:30								
	2005-06 ET Test Results							0:35-1:40	0:55-1:50	~~0:30-1:35~~					
	2006-07 HOT Table Values	0:20-0:45	0:20-1:00	0:45-1:25	0:25-1:20	0:55-1:35	0:25-1:30	0:35-1:40	0:55-1:50	0:30-1:35					
	2006-07 ET Test Results									0:25-1:35	0:25-1:30				
	2007-08 HOT Table Values	0:20-0:45	0:20-1:00	0:45-1:25	0:25-1:20	0:55-1:35	0:25-1:30	0:35-1:40	0:55-1:50	0:25-1:35	0:25-1:30				
	2007-08 ET Test Results														
	2008-09 HOT Table Values	0:20-0:45	0:20-1:00	0:45-1:25	0:25-1:20	0:55-1:35	0:25-1:30	0:35-1:40	0:55-1:50	0:25-1:35	0:25-1:30				
	2008-09 ET Test Results											0:25-1:25	0:35-1:50		
	2009-10 HOT Table Values	0:20-0:45	0:20-1:00	0:45-1:25	0:25-1:20	0:55-1:35	0:25-1:30	0:35-1:40	0:55-1:50	0:25-1:35	0:25-1:30	0:25-1:25	0:35-1:50		
	2009-10 ET Test Results													0:25-1:10	
	2010-11 HOT Table Values	0:20-0:45	0:20-1:00	0:45-1:25	0:25-1:20	0:55-1:35	0:25-1:30	0:35-1:40	0:55-1:50	0:25-1:35	0:25-1:30	0:25-1:25	0:35-1:50	0:25-1:10	
CURRENT	2010-11 ET Test Results														0:35-1:35
	2011-12 HOT Table Values	0:20-1:00	0:20-1:00	0:45-1:25	0:25-1:20	0:55-1:35	0:25-1:30	0:35-1:40	0:55-1:50	0:25-1:35	0:25-1:30	0:25-1:25	0:35-1:50	0:25-1:10	0:35-1:35

Table 6.13: Type IV 75/25 Fluid, Freezing Drizzle, Below -3°C to -10°C

		GENERIC	K-ABC-S	Ultra+	A-480	C-2001	O-Max 04	C-Launch	D-E106	K-ABCS+	L-AS	A-49	K-ABC4S	CR-PG	CR-PGA
HISTORICAL	1996-97 Test Results and Table Values used in 97-98	0:30-1:00	~~0:50-1:25~~												
	1997-98 ET Test Results		~~0:30~~-1:10		~~0:30-1:15~~	0:40-1:10									
	1998-99 HOT Table Values	0:30-1:00	0:30-1:10		0:30-1:15	0:40-1:10									
	1998-99 ETTest Results		0:20-~~1:30~~												
	1999-00 HOT Table Values	0:20-0:55	0:20-1:10		0:30-1:15	0:40-1:10									
	1999-00 ET Test Results				0:25-1:05										
	2000-01 HOT Table Values	0:20-0:50	0:20-1:10		0:25-1:05	0:40-1:10									
	2000-01 ET Test Results						0:20-1:00								
	2001-02 HOT Table Values	0:15-0:30	0:20-1:10		0:25-1:05	0:40-1:10									
	2002-03 ET Test Results														
	2003-04 HOT Table Values	0:15-0:30	0:20-1:10		0:25-1:05	0:40-1:10									
	2003-04 ET Test Results														
	2004-05 HOT Table Values	0:15-0:30	0:20-1:10		0:25-1:05	0:40-1:10	0:20-1:00								
	2004-05 ET Test Results														
	2005-06 HOT Table Values	0:15-0:30	0:20-1:10		0:25-1:05	0:40-1:10	0:20-1:00								
	2005-06 ET Test Results							0:25-1:10		~~0:25-1:15~~					
	2006-07 HOT Table Values	0:15-0:30	0:20-1:10		0:25-1:05	0:40-1:10	0:20-1:00	0:25-1:10		0:25-1:15					
	2006-07 ET Test Results									0:20-1:10	0:30-1:15				
	2007-08 HOT Table Values	0:15-0:30	0:20-1:10		0:25-1:05	0:40-1:10	0:20-1:00	0:25-1:10		0:20-1:10	0:30-1:15				
	2007-08 ET Test Results														
	2008-09 HOT Table Values	0:15-0:30	0:20-1:10		0:25-1:05	0:40-1:10	0:20-1:00	0:25-1:10		0:20-1:10	0:30-1:15				
	2008-09 ET Test Results											0:15-1:05	0:25-1:20		
	2009-10 HOT Table Values	0:15-0:30	0:20-1:10		0:25-1:05	0:40-1:10	0:20-1:00	0:25-1:10		0:20-1:10	0:30-1:15	0:15-1:05	0:25-1:20		
	2009-10 ET Test Results													0:25-1:05	
	2010-11 HOT Table Values	0:15-0:30	0:20-1:10		0:25-1:05	0:40-1:10	0:20-1:00	0:25-1:10		0:20-1:10	0:30-1:15	0:15-1:05	0:25-1:20	0:25-1:05	
CURRENT	2010-11 ET Test Results														0:25-1:05
	2011-12 HOT Table Values	0:15-1:00	0:20-1:10		0:25-1:05	0:40-1:10	0:20-1:00	0:25-1:10		0:20-1:10	0:30-1:15	0:15-1:05	0:25-1:20	0:25-1:05	0:25-1:05

Table 6.14: Type IV Neat Fluid, Light Freezing Rain, -3°C and Above

		GENERIC	K-ABC-S	Ultra+	A-480	C-2001	O-Max 04	C-Launch	D-E106	K-ABCS+	L-AS	A-49	K-ABC4S	CR-PG	CR-PGA
HISTORICAL	1996-97 Test Results and Table Values used in 97-98	0:35-0:55	1:00-1:25	~~0:35-1:00~~											
	1997-98 ET Test Results		~~1:20-2:00~~		~~0:50-1:10~~	0:40-1:00									
	1998-99 HOT Table Values	0:35-0:55	1:00-1:25	0:35-1:00	0:50-1:10	0:40-1:00									
	1998-99 ETTest Results		~~1:20-2:00~~	0:25-0:40											
	1999-00 HOT Table Values	0:25-0:40	1:00-1:25	0:25-0:40	0:50-1:10	0:40-1:00									
	1999-00 ET Test Results				0:35-0:55										
	2000-01 HOT Table Values	0:25-0:40	1:00-1:25		0:35-0:55	0:40-1:00									
	2000-01 ET Test Results						1:10-1:30								
	2001-02 HOT Table Values	0:25-0:40	1:00-1:25	0:25-0:40	0:35-0:55	0:40-1:00									
	2002-03 ET Test Results														
	2003-04 HOT Table Values	0:25-0:40	1:00-1:25	0:25-0:40	0:35-0:55	0:40-1:00									
	2003-04 ET Test Results														
	2004-05 HOT Table Values	0:25-0:40	1:00-1:25	0:25-0:40	0:35-0:55	0:40-1:00	1:10-1:30								
	2004-05 ET Test Results														
	2005-06 HOT Table Values	0:25-0:40	1:00-1:25	0:25-0:40	0:35-0:55	0:40-1:00	1:10-1:30								
	2005-06 ET Test Results							1:00-1:40	0:50-1:15	~~0:50-1:10~~					
	2006-07 HOT Table Values	0:25-0:40	1:00-1:25	0:25-0:40	0:35-0:55	0:40-1:00	1:10-1:30	1:00-1:40	0:50-1:15	0:50-1:10					
	2006-07 ET Test Results									1:05-2:00	0:45-1:05				
	2007-08 HOT Table Values	0:25-0:40	1:00-1:25	0:25-0:40	0:35-0:55	0:40-1:00	1:10-1:30	1:00-1:40	0:50-1:15	1:05-2:00	0:45-1:05				
	2007-08 ET Test Results														
	2008-09 HOT Table Values	0:25-0:40	1:00-1:25	0:25-0:40	0:35-0:55	0:40-1:00	1:10-1:30	1:00-1:40	0:50-1:15	1:05-2:00	0:45-1:05				
	2008-09 ET Test Results											1:00-1:25	1:05-1:30		
	2009-10 HOT Table Values	0:25-0:40	1:00-1:25	0:25-0:40	0:35-0:55	0:40-1:00	1:10-1:30	1:00-1:40	0:50-1:15	1:05-2:00	0:45-1:05	1:00-1:25	1:05-1:30		
	2009-10 ET Test Results													0:50-1:15	
	2010-11 HOT Table Values	0:25-0:40	1:00-1:25	0:25-0:40	0:35-0:55	0:40-1:00	1:10-1:30	1:00-1:40	0:50-1:15	1:05-2:00	0:45-1:05	1:00-1:25	1:05-1:30	0:50-1:15	
CURRENT	2010-11 ET Test Results														1:15-1:30
	2011-12 HOT Table Values	0:25-0:40	1:00-1:25	0:25-0:40	0:35-0:55	0:40-1:00	1:10-1:30	1:00-1:40	0:50-1:15	1:05-2:00	0:45-1:05	1:00-1:25	1:05-1:30	0:50-1:15	1:15-1:30

Table 6.15: Type IV 75/25 Fluid, Light Freezing Rain, -3°C and Above

		GENERIC	K-ABC-S	Ultra+	A-480	C-2001	O-Max 04	C-Launch	D-E106	K-ABCS+	L-AS	A-49	K-ABC4S	CR-PG	CR-PGA
HISTORICAL	1996-97 Test Results and Table Values used in 97-98	0:15-0:30	0:35-0:50	~~0:15-0:30~~											
	1997-98 ET Test Results		~~0:40-0:55~~		~~0:35-0:50~~	0:25-0:35									
	1998-99 HOT Table Values	0:15-0:30	0:35-0:50		0:35-0:50	0:25-0:35									
	1998-99 ETTest Results		0:35-0:50												
	1999-00 HOT Table Values	0:15-0:30	0:35-0:50		0:35-0:50	0:25-0:35									
	1999-00 ET Test Results				0:30-0:45										
	2000-01 HOT Table Values	0:15-0:30	0:35-0:50		0:30-0:45	0:25-0:35									
	2000-01 ET Test Results						1:00-1:20								
	2001-02 HOT Table Values	0:15-0:30	0:35-0:50		0:30-0:45	0:25-0:35									
	2002-03 ET Test Results														
	2003-04 HOT Table Values	0:15-0:30	0:35-0:50		0:30-0:45	0:25-0:35									
	2003-04 ET Test Results														
	2004-05 HOT Table Values	0:15-0:30	0:35-0:50		0:30-0:45	0:25-0:35	1:00-1:20								
	2004-05 ET Test Results														
	2005-06 HOT Table Values	0:15-0:30	0:35-0:50		0:30-0:45	0:25-0:35	1:00-1:20								
	2005-06 ET Test Results							0:45-1:15		~~0:30-0:45~~					
	2006-07 HOT Table Values	0:15-0:30	0:35-0:50		0:30-0:45	0:25-0:35	1:00-1:20	0:45-1:15		0:30-0:45					
	2006-07 ET Test Results									0:30-0:50	0:30-0:45				
	2007-08 HOT Table Values	0:15-0:30	0:35-0:50		0:30-0:45	0:25-0:35	1:00-1:20	0:45-1:15		0:30-0:50	0:30-0:45				
	2007-08 ET Test Results														
	2008-09 HOT Table Values	0:15-0:30	0:35-0:50		0:30-0:45	0:25-0:35	1:00-1:20	0:45-1:15		0:30-0:50	0:30-0:45				
	2008-09 ET Test Results											0:50-1:30	0:25-0:40		
	2009-10 HOT Table Values	0:15-0:30	0:35-0:50		0:30-0:45	0:25-0:35	1:00-1:20	0:45-1:15		0:30-0:50	0:30-0:45	0:50-1:30	0:25-0:40		
	2009-10 ET Test Results													0:35-1:00	
	2010-11 HOT Table Values	0:15-0:30	0:35-0:50		0:30-0:45	0:25-0:35	1:00-1:20	0:45-1:15		0:30-0:50	0:30-0:45	0:50-1:30	0:25-0:40	0:35-1:00	
CURRENT	2010-11 ET Test Results														0:40-1:10
	2011-12 HOT Table Values	0:25-0:35	0:35-0:50		0:30-0:45	0:25-0:35	1:00-1:20	0:45-1:15		0:30-0:50	0:30-0:45	0:50-1:30	0:25-0:40	0:35-1:00	0:40-1:10

Table 6.16: Type IV 50/50 Fluid, Light Freezing Rain, -3°C and Above

		GENERIC	K-ABC-S	Ultra+	A-480	C-2001	O-Max 04	C-Launch	D-E106	K-ABCS+	L-AS	A-49	K-ABC4S	CR-PG	CR-PGA
HISTORICAL	1996-97 Test Results and Table Values used in 97-98	0:05-0:10	~~0:10-0:15~~	~~0:05-0:10~~											
	1997-98 ET Test Results	0:05-0:10	~~0:10-0:15~~		~~0:10-0:25~~	0:08-0:15									
	1998-99 HOT Table Values	0:05-0:10	0:10-0:15		0:10-0:25	0:10-0:15									
	1998-99 ETTest Results	0:05-0:10	0:08-0:10												
	1999-00 HOT Table Values	0:05-0:10	0:05-0:10		0:10-0:25	0:05-0:15									
	1999-00 ET Test Results				0:09-0:15										
	2000-01 HOT Table Values	0:05-0:10	0:05-0:10		0:05-0:15	0:05-0:15									
	2000-01 ET Test Results						0:25-0:35								
	2001-02 HOT Table Values	0:05-0:10	0:05-0:10		0:05-0:15	0:05-0:15									
	2002-03 ET Test Results														
	2003-04 HOT Table Values	0:05-0:10	0:05-0:10		0:05-0:15	0:05-0:15									
	2003-04 ET Test Results														
	2004-05 HOT Table Values	0:05-0:10	0:05-0:10		0:05-0:15	0:05-0:15	0:25-0:35								
	2004-05 ET Test Results														
	2005-06 HOT Table Values	0:05-0:10	0:05-0:10		0:05-0:15	0:05-0:15	0:25-0:35								
	2005-06 ET Test Results							0:20-0:25		~~0:05-0:10~~					
	2006-07 HOT Table Values	0:05-0:10	0:05-0:10		0:05-0:15	0:05-0:15	0:25-0:35	0:20-0:25		0:05-0:10					
	2006-07 ET Test Results									0:15-0:20	0:10-0:15				
	2007-08 HOT Table Values	0:05-0:10	0:05-0:10		0:05-0:15	0:05-0:15	0:25-0:35	0:20-0:25		0:15-0:20	0:10-0:15				
	2007-08 ET Test Results														
	2008-09 HOT Table Values	0:05-0:10	0:05-0:10		0:05-0:15	0:05-0:15	0:25-0:35	0:20-0:25		0:15-0:20	0:10-0:15				
	2008-09 ET Test Results											0:10-0:15	0:07-0:10		
	2009-10 HOT Table Values	0:05-0:10	0:05-0:10		0:05-0:15	0:05-0:15	0:25-0:35	0:20-0:25		0:15-0:20	0:10-0:15	0:10-0:15	0:05-0:10		
	2009-10 ET Test Results													0:10-0:15	
	2010-11 HOT Table Values	0:05-0:10	0:05-0:10		0:05-0:15	0:05-0:15	0:25-0:35	0:20-0:25		0:15-0:20	0:10-0:15	0:10-0:15	0:05-0:10	0:10-0:15	
CURRENT	2010-11 ET Test Results														0:09-0:20
	2011-12 HOT Table Values	0:07-0:10	0:08-0:10		0:09-0:15	0:08-0:15	0:25-0:35	0:20-0:25		0:15-0:20	0:10-0:15	0:10-0:15	0:07-0:10	0:10-0:15	0:09-0:20

Table 6.17: Type IV Neat Fluid, Light Freezing Rain, Below -3°C to -10°C

		GENERIC	K-ABC-S	Ultra+	A-480	C-2001	O-Max 04	C-Launch	D-E106	K-ABCS+	L-AS	A-49	K-ABC4S	CR-PG	CR-PGA
HISTORICAL	1996-97 Test Results and Table Values used in 97-98	0:30-0:45	~~0:30-0:45~~	~~0:30-0:50~~											
	1997-98 ET Test Results		~~0:20-0:40~~		~~0:20-0:40~~	0:30-0:45									
	1998-99 HOT Table Values	0:15-0:30	0:20-0:40	0:30-0:50	0:20-0:40	0:30-0:45									
	1998-99 ETTest Results		0:10-0:30	0:30-0:45											
	1999-00 HOT Table Values	0:10-0:30	0:10-0:30	0:30-0:45	0:20-0:40	0:30-0:45									
	1999-00 ET Test Results				0:15-0:30										
	2000-01 HOT Table Values	0:10-0:30	0:10-0:30	0:30-0:45	0:15-0:30	0:30-0:45									
	2000-01 ET Test Results						0:20-0:40								
	2001-02 HOT Table Values	0:10-0:25	0:10-0:30	0:30-0:45	0:15-0:30	0:30-0:45									
	2002-03 ET Test Results														
	2003-04 HOT Table Values	0:10-0:25	0:10-0:30	0:30-0:45	0:15-0:30	0:30-0:45									
	2003-04 ET Test Results														
	2004-05 HOT Table Values	0:10-0:25	0:10-0:30	0:30-0:45	0:15-0:30	0:30-0:45	0:20-0:40								
	2004-05 ET Test Results														
	2005-06 HOT Table Values	0:10-0:25	0:10-0:30	0:30-0:45	0:15-0:30	0:30-0:45	0:20-0:40								
	2005-06 ET Test Results							0:25-0:45	0:45-1:10	~~0:25-0:35~~					
	2006-07 HOT Table Values	0:10-0:25	0:10-0:30	0:30-0:45	0:15-0:30	0:30-0:45	0:20-0:40	0:25-0:45	0:45-1:10	0:25-0:35					
	2006-07 ET Test Results									0:20-0:30	0:25-0:30				
	2007-08 HOT Table Values	0:10-0:25	0:10-0:30	0:30-0:45	0:15-0:30	0:30-0:45	0:20-0:40	0:25-0:45	0:45-1:10	0:20-0:30	0:25-0:30				
	2007-08 ET Test Results														
	2008-09 HOT Table Values	0:10-0:25	0:10-0:30	0:30-0:45	0:15-0:30	0:30-0:45	0:20-0:40	0:25-0:45	0:45-1:10	0:20-0:30	0:25-0:30				
	2008-09 ET Test Results											0:20-0:25	1:05-1:25		
	2009-10 HOT Table Values	0:10-0:25	0:10-0:30	0:30-0:45	0:15-0:30	0:30-0:45	0:20-0:40	0:25-0:45	0:45-1:10	0:20-0:30	0:25-0:30	0:20-0:25	1:05-1:25		
	2009-10 ET Test Results													0:15-0:35	
	2010-11 HOT Table Values	0:10-0:25	0:10-0:30	0:30-0:45	0:15-0:30	0:30-0:45	0:20-0:40	0:25-0:45	0:45-1:10	0:20-0:30	0:25-0:30	0:20-0:25	1:05-1:25	0:15-0:35	
CURRENT	2010-11 ET Test Results														0:35-0:45
	2011-12 HOT Table Values	0:10-0:25	0:10-0:30	0:30-0:45	0:15-0:30	0:30-0:45	0:20-0:40	0:25-0:45	0:45-1:10	0:20-0:30	0:25-0:30	0:20-0:25	1:05-1:25	0:15-0:35	0:35-0:45

Table 6.18: Type IV 75/25 Fluid, Light Freezing Rain, Below -3ºC to -10ºC

		GENERIC	K-ABC-S	Ultra+	A-480	C-2001	O-Max 04	C-Launch	D-E106	K-ABCS+	L-AS	A-49	K-ABC4S	CR-PG	CR-PGA
HISTORICAL	1996-97 Test Results and Table Values used in 97-98	0:15-0:30	~~0:35-0:50~~	~~0:15-0:30~~											
	1997-98 ET Test Results		~~0:25~~-0:35		~~0:20-0:35~~	0:20-0:30									
	1998-99 HOT Table Values	0:15-0:30	0:25-0:35		0:20-0:35	0:20-0:30									
	1998-99 ETTest Results		0:10-0:35												
	1999-00 HOT Table Values	0:10-0:30	0:10-0:35		0:20-0:35	0:20-0:30									
	1999-00 ET Test Results				0:15-0:30										
	2000-01 HOT Table Values	0:10-0:25	0:10-0:35		0:15-0:30	0:20-0:30									
	2000-01 ET Test Results						0:15-0:30								
	2001-02 HOT Table Values	0:10-0:20	0:10-0:35		0:15-0:30	0:20-0:30									
	2002-03 ET Test Results														
	2003-04 HOT Table Values	0:10-0:20	0:10-0:35		0:15-0:30	0:20-0:30									
	2003-04 ET Test Results														
	2004-05 HOT Table Values	0:10-0:20	0:10-0:35		0:15-0:30	0:20-0:30	0:15-0:30								
	2004-05 ET Test Results														
	2005-06 HOT Table Values	0:10-0:20	0:10-0:35		0:15-0:30	0:20-0:30	0:15-0:30								
	2005-06 ET Test Results							0:25-0:45		~~0:30-0:40~~					
	2006-07 HOT Table Values	0:10-0:20	0:10-0:35		0:15-0:30	0:20-0:30	0:15-0:30	0:25-0:45		0:30-0:40					
	2006-07 ET Test Results									0:15-0:25	0:25-0:30				
	2007-08 HOT Table Values	0:10-0:20	0:10-0:35		0:15-0:30	0:20-0:30	0:15-0:30	0:25-0:45		0:15-0:25	0:25-0:30				
	2007-08 ET Test Results														
	2008-09 HOT Table Values	0:10-0:20	0:10-0:35		0:15-0:30	0:20-0:30	0:15-0:30	0:25-0:45		0:15-0:25	0:25-0:30				
	2008-09 ET Test Results											0:15-0:25	0:15-0:40		
	2009-10 HOT Table Values	0:10-0:20	0:10-0:35		0:15-0:30	0:20-0:30	0:15-0:30	0:25-0:45		0:15-0:25	0:25-0:30	0:15-0:25	0:15-0:40		
	2009-10 ET Test Results													0:20-0:30	
	2010-11 HOT Table Values	0:10-0:20	0:10-0:35		0:15-0:30	0:20-0:30	0:15-0:30	0:25-0:45		0:15-0:25	0:25-0:30	0:15-0:25	0:15-0:40	0:20-0:30	
CURRENT	2010-11 ET Test Results														0:35-0:45
	2011-12 HOT Table Values	0:10-0:25	0:10-0:35		0:15-0:30	0:20-0:30	0:15-0:30	0:25-0:45		0:15-0:25	0:25-0:30	0:15-0:25	0:15-0:40	0:20-0:30	0:35-0:45

Table 6.19: Type IV Neat Fluid, Freezing Fog, -3°C and Above

		GENERIC	K-ABC-S	Ultra+	A-480	C-2001	O-Max 04	C-Launch	D-E106	K-ABCS+	L-AS	A-49	K-ABC4S	CR-PG	CR-PGA
HISTORICAL	1996-97 Test Results and Table Values used in 97-98	2:20-3:00													
	1997-98 ET Test Results														
	1998-99 HOT Table Values	2:00-3:00													
	1998-99 ETTest Results		2:35-4:00	1:35-3:35											
	1999-00 HOT Table Values	1:05-2:15	2:35-4:00	1:35-3:35	1:05-2:15	1:05-2:15									
	1999-00 ET Test Results				2:00-3:30	1:20-3:20									
	2000-01 HOT Table Values	1:05-2:15	2:35-4:00	1:35-3:35	2:00-3:30	1:20-3:20									
	2000-01 ET Test Results						2:40-4:00								
	2001-02 HOT Table Values	1:05-2:15	2:35-4:00	1:35-3:35	2:00-3:30	1:20-3:20									
	2002-03 ET Test Results														
	2003-04 HOT Table Values	1:05-2:15	2:35-4:00	1:35-3:35	2:00-3:30	1:20-3:20									
	2003-04 ET Test Results														
	2004-05 HOT Table Values	1:05-2:15	2:35-4:00	1:35-3:35	2:00-3:30	1:20-3:20	2:40-4:00								
	2004-05 ET Test Results														
	2005-06 HOT Table Values	1:15-2:30	2:35-4:00	1:35-3:35	2:00-3:30	1:20-3:20	2:40-4:00								
	2005-06 ET Test Results							4:00-4:00	2:05-3:10	~~1:50-3:40~~					
	2006-07 HOT Table Values	1:15-2:30	2:35-4:00	1:35-3:35	2:00-3:30	1:20-3:20	2:40-4:00	4:00-4:00	2:05-3:10	1:50-3:40					
	2006-07 ET Test Results									2:10-4:00	1:55-3:10				
	2007-08 HOT Table Values	1:15-2:30	2:35-4:00	1:35-3:35	2:00-3:30	1:20-3:20	2:40-4:00	4:00-4:00	2:05-3:10	2:10-4:00	1:55-3:10				
	2007-08 ET Test Results														
	2008-09 HOT Table Values	1:15-2:30	2:35-4:00	1:35-3:35	2:00-3:30	1:20-3:20	2:40-4:00	4:00-4:00	2:05-3:10	2:10-4:00	1:55-3:10				
	2008-09 ET Test Results											3:20-4:00	1:45-3:55		
	2009-10 HOT Table Values	1:15-2:30	2:35-4:00	1:35-3:35	2:00-3:30	1:20-3:20	2:40-4:00	4:00-4:00	2:05-3:10	2:10-4:00	1:55-3:10	3:20-4:00	1:45-3:55		
	2009-10 ET Test Results													2:15-3:30	
	2010-11 HOT Table Values	1:15-2:30	2:35-4:00	1:35-3:35	2:00-3:30	1:20-3:20	2:40-4:00	4:00-4:00	2:05-3:10	2:10-4:00	1:55-3:10	3:20-4:00	1:45-3:55	2:15-3:30	
CURRENT	2010-11 ET Test Results														2:50-4:00
	2011-12 HOT Table Values	1:20-3:10	2:35-4:00	1:35-3:35	2:00-3:30	1:20-3:20	2:40-4:00	4:00-4:00	2:05-3:10	2:10-4:00	1:55-3:10	3:20-4:00	1:45-3:55	2:15-3:30	2:50-4:00

Table 6.20: Type IV 75/25 Fluid, Freezing Fog, -3°C and Above

		GENERIC	K-ABC-S	Ultra+	A-480	C-2001	O-Max 04	C-Launch	D-E106	K-ABCS+	L-AS	A-49	K-ABC4S	CR-PG	CR-PGA
HISTORICAL	1996-97 Test Results and Table Values used in 97-98	1:05-2:00													
HISTORICAL	1997-98 ET Test Results														
HISTORICAL	1998-99 HOT Table Values	1:05-2:00													
HISTORICAL	1998-99 ETTest Results		1:05-<u>1:45</u>												
HISTORICAL	1999-00 HOT Table Values	1:05-1:45	1:05-1:45		1:05-1:45	1:05-1:45									
HISTORICAL	1999-00 ET Test Results				1:30-2:45	1:20-2:00									
HISTORICAL	2000-01 HOT Table Values	1:05-1:45	1:05-1:45		1:30-2:45	1:20-2:00									
HISTORICAL	2000-01 ET Test Results						2:05-3:15								
HISTORICAL	2001-02 HOT Table Values	1:05-1:45	1:05-1:45		1:30-2:45	1:20-2:00									
HISTORICAL	2002-03 ET Test Results														
HISTORICAL	2003-04 HOT Table Values	1:05-1:45	1:05-1:45		1:30-2:45	1:20-2:00									
HISTORICAL	2003-04 ET Test Results														
HISTORICAL	2004-05 HOT Table Values	1:05-1:45	1:05-1:45		1:30-2:45	1:20-2:00	2:05-3:15								
HISTORICAL	2004-05 ET Test Results														
HISTORICAL	2005-06 HOT Table Values	1:05-1:45	1:05-1:45		1:30-2:45	1:20-2:00	2:05-3:15								
HISTORICAL	2005-06 ET Test Results							3:40-4:00		~~1:10-2:10~~					
HISTORICAL	2006-07 HOT Table Values	1:05-1:45	1:05-1:45		1:30-2:45	1:20-2:00	2:05-3:15	3:40-4:00		1:10-2:10					
HISTORICAL	2006-07 ET Test Results									1:25-2:40	1:20-2:15				
HISTORICAL	2007-08 HOT Table Values	1:05-1:45	1:05-1:45		1:30-2:45	1:20-2:00	2:05-3:15	3:40-4:00		1:25-2:40	1:20-2:15				
HISTORICAL	2007-08 ET Test Results														
HISTORICAL	2008-09 HOT Table Values	1:05-1:45	1:05-1:45		1:30-2:45	1:20-2:00	2:05-3:15	3:40-4:00		1:25-2:40	1:20-2:15				
HISTORICAL	2008-09 ET Test Results											2:25-4:00	<u>1:00</u>-1:50		
HISTORICAL	2009-10 HOT Table Values	1:00-1:45	1:05-1:45		1:30-2:45	1:20-2:00	2:05-3:15	3:40-4:00		1:25-2:40	1:20-2:15	2:25-4:00	1:00-1:50		
HISTORICAL	2009-10 ET Test Results													1:40-2:40	
HISTORICAL	2010-11 HOT Table Values	1:00-1:45	1:05-1:45		1:30-2:45	1:20-2:00	2:05-3:15	3:40-4:00		1:25-2:40	1:20-2:15	2:25-4:00	1:00-1:50	1:40-2:40	
CURRENT	2010-11 ET Test Results														2:30-4:00
CURRENT	2011-12 HOT Table Values	1:00-1:45	1:05-1:45		1:30-2:45	1:20-2:00	2:05-3:15	3:40-4:00		1:25-2:40	1:20-2:15	2:25-4:00	1:00-1:50	1:40-2:40	2:30-4:00

Table 6.21: Type IV 50/50 Fluid, Freezing Fog, -3°C and Above

		GENERIC	K-ABC-S	Ultra+	A-480	C-2001	O-Max 04	C-Launch	D-E106	K-ABCS+	L-AS	A-49	K-ABC4S	CR-PG	CR-PGA
HISTORICAL	1996-97 Test Results and Table Values used in 97-98	0:20-0:45													
HISTORICAL	1997-98 ET Test Results														
HISTORICAL	1998-99 HOT Table Values	0:20-0:45													
HISTORICAL	1998-99 ETTest Results		0:20-0:35												
HISTORICAL	1999-00 HOT Table Values	0:20-0:35	0:20-0:35		0:20-0:35	0:20-0:35									
HISTORICAL	1999-00 ET Test Results				0:30-0:45	0:15-0:40									
HISTORICAL	2000-01 HOT Table Values	0:15-0:35	0:20-0:35		0:30-0:45	0:15-0:40									
HISTORICAL	2000-01 ET Test Results						0:55-1:45								
HISTORICAL	2001-02 HOT Table Values	0:15-0:35	0:20-0:35		0:30-0:45	0:15-0:40									
HISTORICAL	2002-03 ET Test Results														
HISTORICAL	2003-04 HOT Table Values	0:15-0:35	0:20-0:35		0:30-0:45	0:15-0:40									
HISTORICAL	2003-04 ET Test Results														
HISTORICAL	2004-05 HOT Table Values	0:15-0:35	0:20-0:35		0:30-0:45	0:15-0:40	0:55-1:45								
HISTORICAL	2004-05 ET Test Results														
HISTORICAL	2005-06 HOT Table Values	0:15-0:35	0:20-0:35		0:30-0:45	0:15-0:40	0:55-1:45								
HISTORICAL	2005-06 ET Test Results							1:25-2:45		~~0:20-0:40~~					
HISTORICAL	2006-07 HOT Table Values	0:15-0:35	0:20-0:35		0:30-0:45	0:15-0:40	0:55-1:45	1:25-2:45		0:20-0:40					
HISTORICAL	2006-07 ET Test Results									0:30-0:55	0:35-0:45				
HISTORICAL	2007-08 HOT Table Values	0:15-0:35	0:20-0:35		0:30-0:45	0:15-0:40	0:55-1:45	1:25-2:45		0:30-0:55	0:35-0:45				
HISTORICAL	2007-08 ET Test Results														
HISTORICAL	2008-09 HOT Table Values	0:15-0:35	0:20-0:35		0:30-0:45	0:15-0:40	0:55-1:45	1:25-2:45		0:30-0:55	0:35-0:45				
HISTORICAL	2008-09 ET Test Results											0:25-0:50	0:20-0:35		
HISTORICAL	2009-10 HOT Table Values	0:15-0:35	0:20-0:35		0:30-0:45	0:15-0:40	0:55-1:45	1:25-2:45		0:30-0:55	0:35-0:45	0:25-0:50	0:20-0:35		
HISTORICAL	2009-10 ET Test Results													0:25-0:40	
HISTORICAL	2010-11 HOT Table Values	0:15-0:35	0:20-0:35		0:30-0:45	0:15-0:40	0:55-1:45	1:25-2:45		0:30-0:55	0:35-0:45	0:25-0:50	0:20-0:35	0:25-0:40	
CURRENT	2010-11 ET Test Results														0:50-1:25
CURRENT	2011-12 HOT Table Values	0:15-0:35	0:20-0:35		0:30-0:45	0:15-0:40	0:55-1:45	1:25-2:45		0:30-0:55	0:35-0:45	0:25-0:50	0:20-0:35	0:25-0:40	0:50-1:25

Table 6.22: Type IV Neat Fluid, Freezing Fog, Below -3°C to -14°C

		GENERIC	K-ABC-S	Ultra+	A-480	C-2001	O-Max 04	C-Launch	D-E106	K-ABCS+	L-AS	A-49	K-ABC4S	CR-PG	CR-PGA
HISTORICAL	1996-97 Test Results and Table Values used in 97-98	0:40-3:00													
HISTORICAL	1997-98 ET Test Results														
HISTORICAL	1998-99 HOT Table Values	0:40-3:00													
HISTORICAL	1998-99 ETTest Results		0:45-2:05	1:25-3:00											
HISTORICAL	1999-00 HOT Table Values	0:40-1:30	0:45-2:05	1:25-3:00	0:40-1:30	0:40-1:30									
HISTORICAL	1999-00 ET Test Results				0:20-1:20	0:45-1:35									
HISTORICAL	2000-01 HOT Table Values	0:20-1:20	0:45-2:05	1:25-3:00	0:20-1:20	0:45-1:35									
HISTORICAL	2000-01 ET Test Results						0:50-2:30								
HISTORICAL	2001-02 HOT Table Values	0:20-1:20	0:45-2:05	1:25-3:00	0:20-1:20	0:45-1:35									
HISTORICAL	2002-03 ET Test Results														
HISTORICAL	2003-04 HOT Table Values	0:20-1:20	0:45-2:05	1:25-3:00	0:20-1:20	0:45-1:35									
HISTORICAL	2003-04 ET Test Results														
HISTORICAL	2004-05 HOT Table Values	0:20-1:20	0:45-2:05	1:25-3:00	0:20-1:20	0:45-1:35	0:50-2:30								
HISTORICAL	2004-05 ET Test Results														
HISTORICAL	2005-06 HOT Table Values	0:20-1:20	0:45-2:05	1:25-3:00	0:20-1:20	0:45-1:35	0:50-2:30								
HISTORICAL	2005-06 ET Test Results							1:00-1:55	1:50-3:20	~~0:40-1:25~~					
HISTORICAL	2006-07 HOT Table Values	0:20-1:20	0:45-2:05	1:25-3:00	0:20-1:20	0:45-1:35	0:50-2:30	1:00-1:55	1:50-3:20	0:40-1:25					
HISTORICAL	2006-07 ET Test Results									0:55-3:30	1:00-2:25				
HISTORICAL	2007-08 HOT Table Values	0:20-1:20	0:45-2:05	1:25-3:00	0:20-1:20	0:45-1:35	0:50-2:30	1:00-1:55	1:50-3:20	0:55-3:30	1:00-2:25				
HISTORICAL	2007-08 ET Test Results														
HISTORICAL	2008-09 HOT Table Values	0:20-1:20	0:45-2:05	1:25-3:00	0:20-1:20	0:45-1:35	0:50-2:30	1:00-1:55	1:50-3:20	0:55-3:30	1:00-2:25				
HISTORICAL	2008-09 ET Test Results											0:20-1:35	0:55-2:55		
HISTORICAL	2009-10 HOT Table Values	0:20-1:20	0:45-2:05	1:25-3:00	0:20-1:20	0:45-1:35	0:50-2:30	1:00-1:55	1:50-3:20	0:55-3:30	1:00-2:25	0:20-1:35	0:55-2:55		
HISTORICAL	2009-10 ET Test Results													0:45-1:45	
HISTORICAL	2010-11 HOT Table Values	0:20-1:20	0:45-2:05	1:25-3:00	0:20-1:20	0:45-1:35	0:50-2:30	1:00-1:55	1:50-3:20	0:55-3:30	1:00-2:25	0:20-1:35	0:55-2:55	0:45-1:45	
CURRENT	2010-11 ET Test Results														0:55-2:30
CURRENT	2011-12 HOT Table Values	0:20-1:20	0:45-2:05	1:25-3:00	0:20-1:20	0:45-1:35	0:50-2:30	1:00-1:55	1:50-3:20	0:55-3:30	1:00-2:25	0:20-1:35	0:55-2:55	0:45-1:45	0:55-2:30

Table 6.23: Type IV 75/25 Fluid, Freezing Fog, Below -3°C to -14°C

		GENERIC	K-ABC-S	Ultra+	A-480	C-2001	O-Max 04	C-Launch	D-E106	K-ABCS+	L-AS	A-49	K-ABC4S	CR-PG	CR-PGA
HISTORICAL	1996-97 Test Results and Table Values used in 97-98	0:35-2:00													
	1997-98 ET Test Results														
	1998-99 HOT Table Values	0:30-2:00													
	1998-99 ETTest Results		0:25-1:00												
	1999-00 HOT Table Values	0:25-1:00	0:25-1:00		0:25-1:00	0:25-1:00									
	1999-00 ET Test Results				0:25-0:50	0:30-1:00									
	2000-01 HOT Table Values	0:25-0:50	0:25-1:00		0:25-0:50	0:30-1:00									
	2000-01 ET Test Results						0:30-1:05								
	2001-02 HOT Table Values	0:25-0:50	0:25-1:00		0:25-0:50	0:30-1:00									
	2002-03 ET Test Results														
	2003-04 HOT Table Values	0:25-0:50	0:25-1:00		0:25-0:50	0:30-1:00									
	2003-04 ET Test Results														
	2004-05 HOT Table Values	0:25-0:50	0:25-1:00		0:25-0:50	0:30-1:00	0:30-1:05								
	2004-05 ET Test Results														
	2005-06 HOT Table Values	0:25-0:50	0:25-1:00		0:25-0:50	0:30-1:00	0:30-1:05								
	2005-06 ET Test Results							0:40-1:20		~~0:40-1:15~~					
	2006-07 HOT Table Values	0:25-0:50	0:25-1:00		0:25-0:50	0:30-1:00	0:30-1:05	0:40-1:20		0:40-1:15					
	2006-07 ET Test Results									0:45-1:50	0:50-1:45				
	2007-08 HOT Table Values	0:25-0:50	0:25-1:00		0:25-0:50	0:30-1:00	0:30-1:05	0:40-1:20		0:45-1:50	0:50-1:45				
	2007-08 ET Test Results														
	2008-09 HOT Table Values	0:25-0:50	0:25-1:00		0:25-0:50	0:30-1:00	0:30-1:05	0:40-1:20		0:45-1:50	0:50-1:45				
	2008-09 ET Test Results											0:30-1:10	0:35-2:10		
	2009-10 HOT Table Values	0:25-0:50	0:25-1:00		0:25-0:50	0:30-1:00	0:30-1:05	0:40-1:20		0:45-1:50	0:50-1:45	0:30-1:10	0:35-2:10		
	2009-10 ET Test Results													0:35-1:30	
	2010-11 HOT Table Values	0:25-0:50	0:25-1:00		0:25-0:50	0:30-1:00	0:30-1:05	0:40-1:20		0:45-1:50	0:50-1:45	0:30-1:10	0:35-2:10	0:35-1:30	
CURRENT	2010-11 ET Test Results														0:40-1:30
	2011-12 HOT Table Values	0:25-0:50	0:25-1:00		0:25-0:50	0:30-1:00	0:30-1:05	0:40-1:20		0:45-1:50	0:50-1:45	0:30-1:10	0:35-2:10	0:35-1:30	0:40-1:30

Table 6.24: Type IV Neat Fluid, Freezing Fog, Below -14°C to -25°C

		GENERIC	K-ABC-S	Ultra+	A-480	C-2001	O-Max 04	C-Launch	D-E106	K-ABCS+	L-AS	A-49	K-ABC4S	CR-PG	CR-PGA
HISTORICAL	1996-97 Test Results and Table Values used in 97-98	0:20-2:00													
	1997-98 ET Test Results														
	1998-99 HOT Table Values	0:20-2:00													
	1998-99 ETTest Results		0:20-0:40	0:40-2:10											
	1999-00 HOT Table Values	0:20-0:40	0:20-0:40	0:40-2:10	0:20-0:40	0:20-0:40									
	1999-00 ET Test Results				0:15-0:40	0:20-0:45									
	2000-01 HOT Table Values	0:15-0:40	0:20-0:40	0:40-2:10	0:15-0:40	0:20-0:45									
	2000-01 ET Test Results						0:20-0:45								
	2001-02 HOT Table Values	0:15-0:40	0:20-0:40	0:40-2:10	0:15-0:40	0:20-0:45									
	2002-03 ET Test Results														
	2003-04 HOT Table Values	0:15-0:40	0:20-0:40	0:40-2:10	0:15-0:40	0:20-0:45									
	2003-04 ET Test Results														
	2004-05 HOT Table Values	0:15-0:40	0:20-0:40	0:40-2:10	0:15-0:40	0:20-0:45	0:20-0:45								
	2004-05 ET Test Results														
	2005-06 HOT Table Values	0:15-0:40	0:20-0:40	0:40-2:10	0:15-0:40	0:20-0:45	0:20-0:45								
	2005-06 ET Test Results							0:30-0:50	0:30-1:05	~~0:20-0:45~~					
	2006-07 HOT Table Values	0:15-0:40	0:20-0:40	0:40-2:10	0:15-0:40	0:20-0:45	0:20-0:45	0:30-0:50	0:30-1:05	0:20-0:45					
	2006-07 ET Test Results									0:40-1:00	0:25-0:45				
	2007-08 HOT Table Values	0:15-0:40	0:20-0:40	0:40-2:10	0:15-0:40	0:20-0:45	0:20-0:45	0:30-0:50	0:30-1:05	0:40-1:00	0:25-0:45				
	2007-08 ET Test Results														
	2008-09 HOT Table Values	0:15-0:40	0:20-0:40	0:40-2:10	0:15-0:40	0:20-0:45	0:20-0:45	0:30-0:50	0:30-1:05	0:40-1:00	0:25-0:45				
	2008-09 ET Test Results											0:25-0:40	0:40-1:00		
	2009-10 HOT Table Values	0:15-0:40	0:20-0:40	0:40-2:10	0:15-0:40	0:20-0:45	0:20-0:45	0:30-0:50	0:30-1:05	0:40-1:00	0:25-0:45	0:25-0:40	0:40-1:00		
	2009-10 ET Test Results													0:20-0:40	
	2010-11 HOT Table Values	0:15-0:40	0:20-0:40	0:40-2:10	0:15-0:40	0:20-0:45	0:20-0:45	0:30-0:50	0:30-1:05	0:40-1:00	0:25-0:45	0:25-0:40	0:40-1:00	0:20-0:40	
CURRENT	2010-11 ET Test Results														0:25-0:50
	2011-12 HOT Table Values	0:15-0:40	0:20-0:40	0:40-2:10	0:15-0:40	0:20-0:45	0:20-0:45	0:30-0:50	0:30-1:05	0:40-1:00	0:25-0:45	0:25-0:40	0:40-1:00	0:20-0:40	0:25-0:50

Table 6.25: Type IV Neat Fluid, Rain on a Cold-Soaked Wing, Above 0°C

		GENERIC	K-ABC-S	Ultra+	A-480	C-2001	O-Max 04	C-Launch	D-E106	K-ABCS+	L-AS	A-49	K-ABC4S	CR-PG	CR-PGA
HISTORICAL	1996-97 Test Results and Table Values used in 97-98	~~0:10-0:50~~													
HISTORICAL	1997-98 ET Test Results		0:20-1:15												
HISTORICAL	1998-99 HOT Table Values	0:10-0:50													
HISTORICAL	1998-99 ETTest Results		~~0:30-2:00~~	0:10-1:20											
HISTORICAL	1999-00 HOT Table Values	0:10-0:50	0:20-1:15	0:10-1:20	0:10-0:50	0:10-0:50									
HISTORICAL	1999-00 ET Test Results				0:15-1:35	0:15-2:00									
HISTORICAL	2000-01 HOT Table Values	0:10-0:50	0:20-1:15	0:10-1:20	0:15-1:35	0:15-2:00									
HISTORICAL	2000-01 ET Test Results						0:20-2:00								
HISTORICAL	2001-02 HOT Table Values	0:10-0:50	0:20-1:15	0:10-1:20	0:15-1:35	0:15-2:00									
HISTORICAL	2002-03 ET Test Results														
HISTORICAL	2003-04 HOT Table Values	0:10-0:50	0:20-1:15	0:10-1:20	0:15-1:35	0:15-2:00									
HISTORICAL	2003-04 ET Test Results														
HISTORICAL	2004-05 HOT Table Values	0:10-0:50	0:20-1:15	0:10-1:20	0:15-1:35	0:15-2:00	0:20-2:00								
HISTORICAL	2004-05 ET Test Results														
HISTORICAL	2005-06 HOT Table Values	0:10-0:50	0:20-1:15	0:10-1:20	0:15-1:35	0:15-2:00	0:20-2:00								
HISTORICAL	2005-06 ET Test Results							0:15-1:40	0:20-2:00	~~0:15-1:40~~					
HISTORICAL	2006-07 HOT Table Values	0:10-0:50	0:20-1:15	0:10-1:20	0:15-1:35	0:15-2:00	0:20-2:00	0:15-1:40	0:20-2:00	0:15-1:40					
HISTORICAL	2006-07 ET Test Results									0:25-2:00	0:15-1:25				
HISTORICAL	2007-08 HOT Table Values	0:10-0:50	0:20-1:15	0:10-1:20	0:15-1:35	0:15-2:00	0:20-2:00	0:15-1:40	0:20-2:00	0:25-2:00	0:15-1:25				
HISTORICAL	2007-08 ET Test Results														
HISTORICAL	2008-09 HOT Table Values	0:10-1:05	0:20-1:15	0:10-1:20	0:15-1:35	0:15-2:00	0:20-2:00	0:15-1:40	0:20-2:00	0:25-2:00	0:15-1:25				
HISTORICAL	2008-09 ET Test Results											0:10-1:55	0:20-2:00		
HISTORICAL	2009-10 HOT Table Values	0:10-1:05	0:20-1:15	0:10-1:20	0:15-1:35	0:15-2:00	0:20-2:00	0:15-1:40	0:20-2:00	0:25-2:00	0:15-1:25	0:10-1:55	0:20-2:00		
HISTORICAL	2009-10 ET Test Results													0:15-1:25	
HISTORICAL	2010-11 HOT Table Values	0:10-1:05	0:20-1:15	0:10-1:20	0:15-1:35	0:15-2:00	0:20-2:00	0:15-1:40	0:20-2:00	0:25-2:00	0:15-1:25	0:10-1:55	0:20-2:00	0:15-1:25	
CURRENT	2010-11 ET Test Results														0:15-2:00
CURRENT	2011-12 HOT Table Values	0:10-1:15	0:20-1:15	0:10-1:20	0:15-1:35	0:15-2:00	0:20-2:00	0:15-1:40	0:20-2:00	0:25-2:00	0:15-1:25	0:10-1:55	0:20-2:00	0:15-1:25	0:15-2:00

Table 6.26: Type IV 75/25 Fluid, Rain on a Cold-Soaked Wing, Above 0°C

		GENERIC	K-ABC-S	Ultra+	A-480	C-2001	O-Max 04	C-Launch	D-E106	K-ABCS+	L-AS	A-49	K-ABC4S	CR-PG	CR-PGA
HISTORICAL	1996-97 Test Results and Table Values used in 97-98	~~0:05-0:35~~													
	1997-98 ET Test Results		0:10-0:50												
	1998-99 HOT Table Values	0:05-0:35													
	1998-99 ETTest Results		~~0:10-1:15~~												
	1999-00 HOT Table Values	0:05-0:35	0:10-0:50		0:05-0:35	0:05-0:35									
	1999-00 ET Test Results				0:10-1:15	0:10-1:25									
	2000-01 HOT Table Values	0:05-0:35	0:10-0:50		0:10-1:15	0:10-1:25									
	2000-01 ET Test Results						0:20-2:00								
	2001-02 HOT Table Values	0:05-0:35	0:10-0:50		0:10-1:15	0:10-1:25									
	2002-03 ET Test Results														
	2003-04 HOT Table Values	0:05-0:35	0:10-0:50		0:10-1:15	0:10-1:25									
	2003-04 ET Test Results														
	2004-05 HOT Table Values	0:05-0:35	0:10-0:50		0:10-1:15	0:10-1:25	0:20-2:00								
	2004-05 ET Test Results														
	2005-06 HOT Table Values	0:05-0:35	0:10-0:50		0:10-1:15	0:10-1:25	0:20-2:00								
	2005-06 ET Test Results							0:10-1:45		~~0:05-1:00~~					
	2006-07 HOT Table Values	0:05-0:35	0:10-0:50		0:10-1:15	0:10-1:25	0:20-2:00	0:10-1:45		0:05-1:00					
	2006-07 ET Test Results									0:10-1:20	0:09-1:20				
	2007-08 HOT Table Values	0:05-0:35	0:10-0:50		0:10-1:15	0:10-1:25	0:20-2:00	0:10-1:45		0:10-1:20	0:05-1:20				
	2007-08 ET Test Results														
	2008-09 HOT Table Values	0:05-0:40	0:10-0:50		0:10-1:15	0:10-1:25	0:20-2:00	0:10-1:45		0:10-1:20	0:05-1:20				
	2008-09 ET Test Results											0:10-1:40	0:10-1:20		
	2009-10 HOT Table Values	0:05-0:40	0:10-0:50		0:10-1:15	0:10-1:25	0:20-2:00	0:10-1:45		0:10-1:20	0:05-1:20	0:10-1:40	0:10-1:20		
	2009-10 ET Test Results													0:10-1:15	
	2010-11 HOT Table Values	0:05-0:40	0:10-0:50		0:10-1:15	0:10-1:25	0:20-2:00	0:10-1:45		0:10-1:20	0:05-1:20	0:10-1:40	0:10-1:20	0:10-1:15	
CURRENT	2010-11 ET Test Results														0:09-1:40
	2011-12 HOT Table Values	0:09-0:50	0:10-0:50		0:10-1:15	0:10-1:25	0:20-2:00	0:10-1:45		0:10-1:20	0:09-1:20	0:10-1:40	0:10-1:20	0:10-1:15	0:09-1:40

7. CONCLUSIONS

Testing was completed with seven fluids in the winter of 2010-11. The results of this testing, plus the results of supplemental testing, resulted in several changes being made to the HOT guidelines. The changes are described below.

7.1 Type I Fluids

No changes were made to the Type I fluid HOT guideline values for the winter of 2011-12. However, the format of the Type I holdover times changed. Specifically, the Type I HOT table was divided into two tables: one table containing holdover times for aluminum wing surfaces and a separate table for the holdover times for composite wing surfaces.

7.2 Type II Fluids

Several changes were made to the Type II fluid HOT guidelines for the winter of 2011-12:

1. Minor increases/decreases ranging from 1 to 4 minutes were made to all eight Type II fluid-specific HOT tables and to the generic Type II HOT table as a result of changes made to the Type II/IV HOT rounding protocol; and
2. The lower limit of the lowest temperature band in the Type II fluid-specific HOT tables was changed from "-25°C or LOUT" to the actual numeric lowest operational use temperature (LOUT) value for each fluid.

7.3 Type III Fluids

No changes were made to the Type III fluid HOT guideline values for the winter of 2011-12.

7.4 Type IV Fluids

Several changes were made to the Type IV fluid HOT guidelines for the winter of 2011-12:

1. A fluid-specific HOT table was added for Cryotech Polar Guard Advance, a new fluid;

2. Clariant Safewing MP IV 2012 Protect and Octagon MaxFlo were removed from the Type IV guidelines as per the protocol for removing obsolete data resulting in 16 increases being made to the generic Type IV holdover times;
3. Minor increases/decreases ranging from 1 to 4 minutes were made to six Type IV fluid-specific HOT tables and to the generic Type IV HOT table as a result of changes made to the Type II/IV HOT rounding protocol;
4. The lower limit of the lowest temperature band in the Type IV fluid-specific HOT tables was changed from "-25°C or LOUT" to the actual numeric LOUT value for each fluid; and
5. The upper value in the Octagon Max-Flight 04 75/25 below -3 to -14°C snow cell was increased from 1:20 to 1:25 due to a rounding error.

7.5 Other Changes to HOT Guidelines

In addition to the changes to the Type I, II, III and IV fluids noted above, several other changes were made to the HOT guidelines for winter 2011-12.

7.5.1 Frost Table

The Frost table was reformatted to clarify that dilutions apply only to Type II, III and IV fluids.

7.5.2 Ice Pellet Allowance Time Table

No changes were made to the ice pellet allowance times for the winter of 2011-12.

7.5.3 LOUT Table

The LOUT table was updated with new information received from the fluid manufacturers.

8. RECOMMENDATIONS

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

It is also recommended that fluid-specific and fluid application temperature specific HOT guidelines for Type III fluids be developed in the winter of 2011-12.

This page intentionally left blank.

REFERENCES

1. Bendickson, S., Campbell, R., Chaput, M., D'Avirro, J., Dawson, P., Mayodon, M., *Aircraft Ground De/Anti-Icing Fluid Holdover Time Development Program for the 2002-03 Winter*, APS Aviation Inc., Transportation Development Centre, Montreal, December 2003, TP 14144E, XX (to be published).

2. *Guidelines for Aircraft Ground Icing Operations (Second Edition)*, Transport Canada, April 2005, TP 14052E.

3. Society of Automotive Engineers Aerospace Recommended Practice 5485, *Endurance Time Tests for Aircraft Deicing/Anti-Icing Fluids: SAE Type II, III, and IV*, July 2004.

4. SAE International Aerospace Recommended Practice 5945, *Endurance Time Tests for Aircraft Deicing/Anti-Icing Fluids: SAE Type I*, July 2007.

5. Bendickson, S., D'Avirro, J., Gravito, P., Ruggi, M., Youssef, D., Zoitakis, V., *Aircraft Ground Icing General Research Activities During the 2010-11 Winter,* APS Aviation Inc., Transportation Development Centre, Montreal, January 2012, TP 15158E, XX (to be published).

6. SAE International Aerospace Recommended Practice 5718, *Qualification Process for SAE AMS1428 Type II, III, and IV Fluids*, March 2008.

7. Bendickson, S., Dawson, P., Pineau, M., Zoitakis, V., *Aircraft Ground Icing General Research Activities During the 2008-09 Winter*, APS Aviation Inc., Transportation Development Centre, Montreal, December 2009, TP 14936E, XX (to be published).

This page intentionally left blank.

APPENDIX A

TRANSPORTATION DEVELOPMENT CENTRE WORK STATEMENT EXCERPT – AIRCRAFT & ANTI-ICING FLUID WINTER TESTING 2010-11

TRANSPORTATION DEVELOPMENT CENTRE
WORK STATEMENT EXCERPT –
AIRCRAFT & ANTI-ICING FLUID
WINTER TESTING 2010-11

6.2 DE/ANTI-ICING FLUIDS RESEARCH (AND HOLDOVER TIME CREATION)

6.2.1 Infrastructure for FAA/TC HOT Guideline Development

This program element does not include the actual endurance time testing of newly submitted fluids; the description of the fluid endurance time testing has been included as Attachment 1 of this document and will be funded by the fluid manufacturers.

6.2.1.1 Preparation and Setup for Natural Snow Testing at Trudeau International Airport

a) Prepare the P.E.T. test site at Trudeau International Airport (YUL) for conducting tests in the winter of 2010-11;

b) Prepare an updated procedure for testing fluids outdoors during snow events;

c) Evaluate current methods for measuring snowfall intensity; and

d) Develop improved, more efficient methods to measure snowfall intensity, if appropriate.

6.2.1.2 Preparation and Setup for Simulated Precipitation Testing at NRC

a) Prepare a test plan to coordinate all simulated precipitation required by the winter 2010-11 research program. Testing will be conducted at the NRC Climatic Environment Facility (CEF) in U89 at Uplands, Ottawa;

b) Note: The NRC facility costs associated with testing at U89 are not included in this task and are dealt with directly with TC through a M.O.U. agreement with NRC;

c) Coordinate scheduling and test plans with NRC CEF personnel;

d) Prepare a test procedure for the conduct of endurance time tests in simulated precipitation at the NRC CEF;

e) Conduct calibration to attain appropriate test conditions for each weather condition represented in the holdover time tables; and

f) As the cost for this activity is highly weighted on calibration of precipitation rates, evaluate and, if possible, develop an improved, more efficient method to measure intensity of precipitation.

ATTACHMENT 1

Aircraft Ground De/Anti-Icing Fluid Endurance Time 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.

a) Conduct flat plate 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 5945 under conditions of:

   i. Natural snow at the P.E.T. test site (under a wide range of temperature, precipitation rate, precipitation type, and wind conditions);

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

b) Record individual fluid endurance times; and

c) Analyze the data collected, report the findings, and prepare presentation material for the SAE G-12 annual meeting.

APPENDIX B

PROCEDURES FOR HOLDOVER TIME TESTING

- Test Requirements for Natural Precipitation Flat Plate Testing
- Determination of Endurance Times of Type I Fluids Under Natural Snow Precipitation at Dorval
- Test Requirements for Simulated Freezing Precipitation Flat Plate Testing
- Overall Program of Tests at NRC, April 2011
- Overall Program of Tests at NRC, July 2011

TEST REQUIREMENTS
FOR NATURAL PRECIPITATION FLAT PLATE TESTING

CM1892.001

TEST REQUIREMENTS
FOR NATURAL PRECIPITATION FLAT PLATE TESTING

Winter 2004-05

Prepared for

Transportation Development Centre
Transport Canada

Prepared by: Nicoara Moc

Reviewed by: John D'Avirro

APS Aviation Inc.

December 23, 2004
Version 1.0

TEST REQUIREMENTS
FOR NATURAL PRECIPITATION FLAT PLATE TESTING
2004-05

This document provides a brief summary of the test requirements and data forms needed for natural precipitation flat plate tests in the 2004-05 winter season. The procedure containing a detailed description of the test parameters, snow measurement methods, testing procedure and test equipment for conducting endurance time tests for SAE Type II, III and IV de/anti-icing fluids is stored on APS's local network and can be found at the following location: M:\Groups\CM1892 (TC-Deicing 03-04)\Procedures\AS5485\

This document is based on the aforementioned procedure, and was developed for documentation purposes, to be inserted in the final report after the completion of endurance time testing, and to provide the latest data forms.

Also included in this document there is a list of steps required for testing (see Attachment 1).

1. TEST PLAN

The test plan, shown in Table 1.1 provides the temperature and requirements for fluid type testing. Test will be conducted at the Dorval test site located adjacent to the Meteorological Services of Canada. These tests shall be conducted during natural snow conditions.

Table 1.1: Natural Snow Precipitation Test Plan New Fluids

Temperature Range	Type II/IV Neat	Type II/IV 75/25	Type II/IV 50/50	Type III
>0°C	Yes	Yes	Yes	Yes
0 to -3°C	Yes	Yes	Yes	Yes
-3 to -14°C	Yes	Yes	No	Yes
-14 to -25°C	Yes	No	No	Yes
Below -25°C	Yes	No	No	Yes

2. DATA FORMS

The data forms are included in Tables 2.1 to 2.4. Table 2.1 represents the data form developed for the end-condition tester. Table 2.2 shows the data form for the meteo/video tester. Table 2.3 and Table 2.4 present two data forms to be filled in each testing session and winter season, respectively.

Table 2.1: End Condition Data Form for Natural Snow

REMEMBER TO SYNCHRONIZE TIME WITH MSC - USE LOCAL TIME

LOCATION: DATE: RUN NUMBER: STAND # :

TIME TO FAILURE FOR INDIVIDUAL CROSSHAIRS (real time)

	Plate 1	Plate 2	Plate 3	Plate 4	Plate 5	Plate 6
Time of Fluid Application:						
Initial Plate Temperature (°C) (NEEDS TO BE WITHIN 2°C OF AIR TEMP)						
Initial Fluid Temperature (°C) (NEEDS TO BE WITHIN 3°C OF AIR TEMP)						
FLUID NAME/DILUTION						
B1 B2 B3						
C1 C2 C3						
D1 D2 D3						
E1 E2 E3						
F1 F2 F3						
TIME TO FIRST PLATE FAILURE WITHIN WORK AREA						

	Plate 7	Plate 8	Plate 9	Plate 10	Plate 11	Plate 12
Time of Fluid Application:						
Initial Plate Temperature (°C) (NEEDS TO BE WITHIN 2°C OF AIR TEMP)						
Initial Fluid Temperature (°C) (NEEDS TO BE WITHIN 3°C OF AIR TEMP)						
FLUID NAME/DILUTION						
B1 B2 B3						
C1 C2 C3						
D1 D2 D3						
E1 E2 E3						
F1 F2 F3						
TIME TO FIRST PLATE FAILURE WITHIN WORK AREA						

AMBIENT TEMPERATURE: ________ °C

COMMENTS:

NOTE: PLEASE ENSURE CORRECT FUNCTIONING OF PLATE TEMPERATURE LOGGING SYSTEM AT START OF TEST. AT THE END OF TEST SESSION, SAVE THE ELECTRONIC LOGGER FILE ON A FLOPPY DISK AND ALSO E-MAIL IT TO THE OFFICE. LABEL THE DISKETTE AND PLACE IT WITHIN THE DATA FORM ENVELOPE.

FAILURES CALLED BY: ____________

LEADER / MANAGER: ____________

Table 2.2: Meteorological and Precipitation Rate Data Form

REMEMBER TO SYNCHRONIZE TIME WITH MSC - USE LOCAL TIME

LOCATION: DATE: RUN # : STAND # :

HAND HELD VIDEO CASSETTE #:

PLATE PAN WEIGHT MEASUREMENTS *

PAN #	t TIME BEFORE (h:min:s)	BUFFER TIME (s)	t TIME AFTER (h:min:s)	BUFFER TIME (s)	w WEIGHT BEFORE (g)	w WEIGHT AFTER (g)	COMPUTE RATE (Δw*4.7/Δt) (g/dm²/h)	WIND SPEED** (km/h)	WIND DIR*** (°)

* Measurements every 10 min. and at failure time of each test panel

** Wind speed measurements required every time the precipitation rate is measured and only if data not available from MSC

*** Wind direction shall be recorded at least every 15 minutes

METEO OBSERVATIONS ****

TIME (h:min)	TYPE (Table 1) ZR, ZL, S, SG	CLASSIF. (See snow classification diagram.)	If SNOW, WET or DRY

**** Observations at beginning, end, and every 10 min. intervals. Additional observations when there are significant changes

AIR TEMPERATURE AT START OF TEST ________ °C

WIND DIRECTION AT START OF TEST ________ °

TEST STAND ORIENTATION (measured along long axes of the test panels) ________

COMMENTS :

	PRINT	SIGN
WRITTEN & PERFORMED BY :		
VIDEO BY :		
TEST SITE LEADER :		

Table 2.3: General Form for Each Testing Session – Natural Snow

LOCATION: APS TEST SITE   DATE:

	PLATE 1	PLATE 6	PLATE 7	PLATE 12
Angle of the Test Stands (°): (the angle shall be within 10° ± 0.2)	☐	☐	☐	☐

Synchronize the timing devices and the computer clock with atomic time (www.time.gov): ☐
(check the box if the timing devices are synchronized)

Plate Temperature Files:
(to be recorded by APS at the end of the each test session, saved on floppy disks and included in the envelope along with the forms)
The plate temperature data is saved to the following files (provide filename and extension):

COMMENTS:

LEADER: ________________

Table 2.4: General Form for Each Winter Season – Natural Snow

LOCATION: APS TEST SITE   DATE INTERVAL:

Safety Issues Discussed ☐

Test Plate Material: ☐
(check the box if material used is Aluminum alloy AMS 4037 or 4041)

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

Surface Finish: ☐
(check the box if the average surface roughness is ≤ 1.0 µm)
Refer to Verification Procedure "A-Verif" for methodology

Ice-catch Pan Dimensions: ☐
(check the box if the dimensions are 30 cm by 43 cm)

COMMENTS:

LEADER: ________________

ATTACHMENT 1
SUMMARY OF STEPS TO CONDUCT TESTS

The following are the major steps required to conduct flat plate tests at Dorval.

Upon Entering Trailer

a) Turn on lights (outside and inside) and sign-in;
b) Determine tests to be conducted and fluids (Type II, III, IV to be placed outdoors);
c) Remove snow and clear access to stands; and
d) Synchronize all clocks and stop watches, if used.

For Each Test

a) Fill in general material on Table 2.3, and prepare plate pans for start of test;
b) Place fluids by stand;
c) Ensure stand is into wind;
d) Record end condition times of all panels (care to be taken for the 5th crosshair of each panel);
e) Measure plate pan weights over the course of the test;
f) Video record start of test, progression of failures, and when the end condition (5 of 15 crosshairs) is being called on each panel (OPTIONAL);
g) Ensure forms are properly completed and signed; and
h) Start a new test.

To Close Trailer

a) Replenish fluids;
b) Log and document date, times, test #'s, etc. on all media;
c) After major events (more than 10 tests), start new tapes for next occasion;
d) Place all media and test forms in large envelope for delivery to office;
e) Clean trailer and all garbage;
f) Ensure outdoor is left clean and presentable; and
g) Close lights and sign-out.

This page intentionally left blank.

DETERMINATION OF ENDURANCE TIMES OF TYPE I FLUIDS UNDER NATURAL SNOW PRECIPITATION AT DORVAL

CM2103.001 (07-08)

EXPERIMENTAL PROGRAM

DETERMINATION OF ENDURANCE TIMES OF TYPE I FLUIDS UNDER NATURAL SNOW PRECIPITATION AT DORVAL

Winter 2007-08

Prepared for

Transportation Development Centre
Transport Canada

Prepared by: John D'Avirro

Reviewed by: John D'Avirro

APS Aviation Inc.

December 14, 2007
Version 1.0

EXPERIMENTAL PROGRAM
DETERMINATION OF ENDURANCE TIMES OF TYPE I FLUIDS
UNDER NATURAL SNOW PRECIPITATION AT DORVAL
Winter 2007-08

1. BACKGROUND

From the early 1990s, the Type I fluid holdover time range for snow conditions was 6 to 15 minutes. Based on a series of SAE Type I fluid endurance time trials on flat plates conducted in the 1999-2000 winter and discussions at a SAE G-12 Holdover Time Subcommittee meeting held in Toulouse, France in May 2000, the holdover times for snow were reduced to values significantly shorter than 6 to 15 minutes. The reduction in fluid endurance times coincided with the general realization that the test methodology was suspect.

As a result, APS was directed to develop a test protocol for measuring endurance times for SAE Type I fluids that would reflect real field operations. Following examination of several test surfaces and various procedures for fluid application, it was concluded that an insulated 7.5 cm cold-soak box, empty, when treated with 0.5 L of fluid at 60ºC, was found to be a reasonable representation of the temperature decay rate demonstrated by wings in natural outdoor conditions. The fluid was applied along the top edge of the test surface using a specially designed 12-hole fluid spreader.

In the winter of 2001-02, a series of natural snow tests was conducted at Dorval Airport and at Chicoutimi, Quebec using the newly developed Type I protocol. Based on these tests, holdover time tables were produced and presented to the industry at the SAE G-12 Holdover Time Subcommittee meeting in Frankfurt, Germany in June 2002. A full account of these tests can be found in TP 13994E, *Generation of Holdover Times Using the New Type I Fluid Test Protocol*, November 2002.

2. OBJECTIVES

The objective of this project is to ensure that new Type I fluids do not behave inferior, from an endurance time perspective, to the fluids used to generate the currently accepted values in the holdover time table.

To achieve this objective, a series of tests will be conducted using new SAE Type I fluids, on the empty aluminum box surfaces.

3. PURPOSE

As stated in the objective, this project is to ensure new Type I fluids have endurance times greater than or equal to currently accepted holdover times. ARP 5945 describes procedures to carry out Type I tests in natural snow. While these tests are material, the tester cannot determine early on whether the fluid has reasonable performance or not.

This document describes additional tests that provide this missing information during testing. Comparing the new fluid, on a side-by-side basis, with a "grandfather" provides ongoing analysis of the performance of the new fluid,

4. PROCEDURE/TEST REQUIREMENTS

The 7.5 cm cold-soak box, insulated on all sides but the top, empty, will be used as the test surface for the outdoor tests.

The fluid temperature will be 60ºC with an acceptance range of +2ºC and -0ºC. The fluid quantity will be 0.5 L, and the fluid will be applied on the surface through a 12-hole spreader. The fluid used will be diluted to a freeze point 10ºC below ambient temperature, unless otherwise specified by the fluid manufacturer.

For this experiment, two cold-soak boxes will be placed on the stand at the same time. In an attempt to keep the precipitation rate and temperature as constant as possible, the new fluids and the reference fluid will be run simultaneously. At least 20 tests will be conducted.

The tests will be conducted until the last fluid on the stand fails, and repeated following the same procedure.

In order to have a more accurate representation of the holdover time obtained in real field deicing operations, the trials need to be performed at different temperatures and rates, over several snowstorms.

The steps to be followed in conducting these tests are:

1. Synchronize computer and test clocks to atomic clock;
2. Follow standard procedures for ET tests except as described below;
3. Prepare surfaces on the stand in accordance with Table 3.1;
4. Prepare fluid (Section 4.2) for testing. The types of surfaces, positions and fluid amounts to be tested are shown in Table 3.1;

Table 3.1

Test Stand Positions

STAND POS.	SURFACE TYPE	FLUID		Fluid Conc.	Fluid Type
		AMOUNT (L)	TEMP (°C)		
1	RATE PAN				
2	7.5 cm box (empty)	0.5	60	10° Buffer	Battelle D3 ADF Type I
3	7.5 cm box (empty)	0.5	60	10° Buffer	Reference Fluid (E or P)*

* E – Ethylene (UCAR EG ADF)
P – Propylene (PG ADF)

5. Pour required amount of heated fluid into thermos containers for application;

6. Apply the fluid to the cold-soak boxes on the stand. Pour the fluid on the test surfaces in quick succession to avoid cooling of the spreader between pours. The spreader is modified (taped) to allow fluid to come out through only 12 holes. Just before pouring, the box surfaces should be cleaned according to the following procedure:
   - Clean the surface of all contamination with scraper and squeegee; and
   - Whenever surface wetting is found to be deficient, a clean wiper cloth with fluid at ambient temperature can be used to wipe the plate over its entire surface. (This is intended to ensure that the surface is wetted as well as clean, to assist in complete coverage with the applied fluid.)

7. Standing behind the stand, place a shield device to deflect the air and pour the test fluid from the thermos into the spreader. Remove the shield when the spreader has emptied;

8. Determine failure times on test surfaces, and record using standard ET data forms (Attachment I);

9. Measure precipitation rates and record using the Meteo/Plate data form (Attachment II); and

10. Record rates. As per Table 3.1, position 1 on the stand will be used for measuring snow deposition rates. Use two rate pans in a 5 minute routine. At the time that a measurement is required, the pan that needs to be weighed will be replaced on the stand by the other pan. This cycle will continue until the last surface failed. While pouring the fluid on the test surfaces care should be taken that no contamination falls in the rate pans (use a shield device if necessary). The bottom and sides of the pan MUST BE WETTED (before each pre-test weighing) with Type IV anti-icing fluid to prevent blowing snow from escaping the pan.

5. EQUIPMENT AND FLUIDS

5.1 Equipment

Use the same equipment that is used for ET trials. Candidate test surfaces used for these trials will be:

- Two 7.5 cm cold-soak boxes (empty)

A wind shield and fluid spreader device will be used for applying fluids.

5.2 Fluids

Tests shall be conducted with the following Type I fluids:

- Battelle D3 ADF Type I; and
- PG ADF or UCAR EG ADF (reference fluid).

Fluids are to be mixed to a freeze point 10ºC below OAT. The dilution table for these three fluids is presented in Attachment III.

Fluids to be applied to the cold soak box test surfaces will be heated to 60ºC.

6. PERSONNEL

Three technicians are needed to conduct the tests:

- First calls failures, prepares fluid samples;
- Second helps prepare and pour fluids; and
- Third measures rates and wind.

7. DATA FORMS

Use end condition forms from standard Endurance Time procedure (Attachment I). For rate measurements, see Attachment II.

DETERMINATION OF ENDURANCE TIMES OF TYPE I FLUIDS UNDER NATURAL SNOW PRECIPITATION AT DORVAL

ATTACHMENT I
END CONDITION DATA FORM

REMEMBER TO SYNCHRONIZE TIME WITH ATOMIC CLOCK - USE REAL TIME

VERSION 1.0 Winter 2002/2003

LOCATION: DORVAL TEST SITE **DATE:** **RUN #:** **STAND # :**

LOCATION OF SURFACES ON THE STAND

Rate Pan	ColdSoak BOX	ColdSoak BOX	ColdSoak BOX	ColdSoak BOX
1	2	3	4	5

***TIME (After Fluid Application) TO FAILURE FOR INDIVIDUAL CROSSHAIRS (hr:min)**

Time of Fluid Application: _______ hr:min:ss _______ hr:min:ss _______ hr:min:ss

	BOX ____			BOX ____			BOX ____		
FLUID NAME									
B1 B2 B3									
C1 C2 C3									
D1 D2 D3									
F1 F2 F3									
TIME TO FIRST PLATE FAILURE WITHIN WORK AREA									
CALCULATED FAILURE TIME (MINUTES)									
BRIX / FLUID TEMPERATURE AT START	/			/			/		

Time of Fluid Application: _______ hr:min:ss _______ hr:min:ss _______ hr:min:ss

	BOX ____			BOX ____			BOX ____		
FLUID NAME									
B1 B2 B3									
C1 C2 C3									
D1 D2 D3									
E1 E2 E3									
F1 F2 F3									
TIME TO FIRST PLATE FAILURE WITHIN WORK AREA									
CALCULATED FAILURE TIME (MINUTES)									
BRIX / FLUID TEMPERATURE AT START	/			/			/		

OTHER COMMENTS (Fluid Batch, etc):

____

____

____

____

____

____

____

	PRINT	SIGN
FAILURES CALLED BY :	____________	____________

Cm1747\Procedures\Type I protocol\Type I ET\Attachment I

M:\Groups\PM2103.001 (TC-Deicing 07-08)\Procedures\Type I Fluids (Nat. Snow)\Version 1.0.doc
Version 1.0,December 07

Page 6 of 8

DETERMINATION OF ENDURANCE TIMES OF TYPE I FLUIDS UNDER NATURAL SNOW PRECIPITATION AT DORVAL

ATTACHMENT II
METEO/PLATE PAN DATA FORM

REMEMBER TO SYNCHRONIZE TIME WITH ATOMIC CLOCK - USE REAL TIME

VERSION 1.0 Winter 2002/2003

LOCATION: DORVAL TEST SITE **DATE:** **RUN # :** **STAND # :**

PLATE PAN WEIGHT MEASUREMENTS

PAN #	t TIME BEFORE (hh:mm:ss)	BUFFER TIME (Seconds)	t TIME AFTER (hh:mm:ss)	BUFFER TIME (Seconds)	w WEIGHT BEFORE (grams)	w WEIGHT AFTER (grams)	COMPUTE RATE (Δw*4.7/ Δt) ($g/dm^2/h$)

Precipitation rate will be measured every 5 minutes.

METEO OBSERVATIONS *

TIME (hr:min)	TYPE ZR, ZLS, SG IP, IC, BS, SP	SNOW CLASSIF. (See Fig. 3)

*observations at beginning, end, and every 5 min. intervals. Additional observations when there are significant changes.

Cm1747\Procedures\Type I protocol\Type I ET\Attachment 2

COMMENTS : ______________________

____

____

____

	PRINT	SIGN
WRITTEN & PERFORMED BY :	____________	________
PHOTO BY :	____________	________

M:\Groups\PM2103.001 (TC-Deicing 07-08)\Procedures\Type I Fluids (Nat. Snow)\Version 1.0.doc
Version 1.0,December 07

Page 7 of 8

ATTACHMENT III
FLUID DILUTION FOR TYPE I TESTING

OAT (°C)	FFP (°C)	Octagon Octaflo / EF				UCAR ADF (EG)				Battelle D3 1006A			
		% Glycol	Brix	Glycol for 8 Litres	Water for 8 Litres	% Glycol	Brix	Glycol for 8 Litres	Water for 8 Litres	% Glycol	Brix	Glycol for 8 Litres	Water for 8 Litres
5	-5	15	9.75	12.0	6.8	12	8	1.0	7.0				
4	-6					14.5	9.5	1.2	6.8	20	14.75	1.6	6.4
3	-7					16	10.5	1.3	6.7	25.9	18.50	2.1	5.9
2	-8					18.5	12	1.5	6.5	28	20	2.24	5.76
1	-9	27.5	18.5	2.2	5.8	21.5	13.5	1.7	6.3	29	21.25	2.32	5.68
0	-10	29	19	2.3	5.7	22	14	1.8	6.2	30	22.75	2.4	5.6
-1	-11	30	20	2.4	5.6	23	15	1.8	6.2	33	24	2.64	5.36
-2	-12	31	20.5	2.5	5.5	24.5	16	2.0	6.0	35	25.5	2.8	5.2
-3	-13	32	21.25	2.6	5.4	26	17	2.1	5.9	37	26.75	2.96	5.04
-4	-14	34	22.5	2.7	5.3	28	18	2.2	5.8	38	28	3.04	4.96
-5	-15	35	23	2.8	5.2	30	19	2.4	5.6	39	29	3.12	4.88
-6	-16	36	23.5	2.9	5.1	31	19.75	2.5	5.5	40	29.75	3.2	4.8
-7	-17	37	24	3.0	5.0	32	20.5	2.6	5.4	44	31.5	3.52	4.48
-8	-18	38.5	25	3.1	4.9	33.5	21.25	2.7	5.3	45	32.5	3.6	4.4
-9	-19	40	26	3.2	4.8	34.5	21.75	2.8	5.2	47	33.75	3.76	4.24
-10	-20	42	27	3.4	4.6	36	22.5	2.9	5.1	48	34.75	3.84	4.16
-11	-21	44	28	3.5	4.5	37	23	3.0	5.0	49	35.75	3.92	4.08
-12	-22	45	28.5	3.6	4.4	38	23.75	3.0	5.0	50	36.5	4	4
-13	-23	46	29	3.7	4.3	39	24.5	3.1	4.9	52	37.5	4.16	3.84
-14	-24	47	29.5	3.8	4.2	40	25	3.2	4.8	53	38.5	4.24	3.76
-15	-25	47.5	30	3.8	4.2	41	25.5	3.3	4.7	54	39.5	4.32	3.68
-16	-26	48.5	30.5	3.9	4.1	42	26	3.4	4.6	55	39.5	4.4	3.6
-17	-27	49	31	3.9	4.1	43	26.5	3.4	4.6	57	41	4.56	3.44
-18	-28	50	31.5	4.0	4.0	44	27	3.5	4.5	58	41.75	4.64	3.36
-19	-29	51	32	4.1	3.9	45	27.5	3.6	4.4	60	42.25	4.8	3.2
-20	-30	52	32.5	4.2	3.8	45.75	28	3.7	4.3	61	43	4.88	3.12
-22	-32	53.5	33.5	4.3	3.7	47	28.75	3.8	4.2	62	44.25	4.96	3.04
-25	-35	56	34.5	4.5	3.5	49	30	3.9	4.1	65	46	5.2	2.8
-30	-40	60	37	4.8	3.2	53	32	4.2	3.8	70	48.25	5.6	2.4

PM2020 (TC-Deicing 05-06)\Procedures\Type I ET\Fluid Dilution for Type I Testing

TEST REQUIREMENTS
FOR SIMULATED FREEZING PRECIPITATION FLAT PLATE TESTING

CM1892.001

TEST REQUIREMENTS
FOR SIMULATED FREEZING PRECIPITATION FLAT PLATE TESTING

- Freezing Fog
- Freezing Drizzle and Light Freezing Rain
- Rain on a Cold-Soaked Surface

Winter 2003-04

Prepared for

Transportation Development Centre
Transport Canada

Prepared by: Richard Campbell

Reviewed by: John D'Avirro

APS Aviation Inc.

January 15, 2004
Version 1.0

TEST REQUIREMENTS FOR SIMULATED FREEZING PRECIPITATION FLAT PLATE TESTING

Winter 2003-04

This document provides a brief summary of the test requirements and data forms needed for the conduct of simulated freezing fog, freezing drizzle, light freezing rain and rain on a cold-soaked surface holdover time tests. The list of tests and schedule of tests are described in the separate document "Overall Program of Tests at NRC, April, 2004". These tests will be conducted at NRC's Climatic Engineering Facility (CEF) in Ottawa. The procedure containing a detailed description of the test parameters, precipitation measurement methods, testing procedure and test equipment for conducting endurance time tests for SAE Type II, III and IV de/anti-icing fluids is stored on APS's local network and can be found at the following location: M:\Groups\CM1892 (TC-Deicing 03-04)\Procedures\AS5485\

This document is based on the aforementioned procedure, and was developed for documentation purposes, to be inserted in the final report after the completion of endurance time testing, and to provide the latest data forms.

1. CHARACTERISTICS OF SIMULATED PRECIPITATION PRODUCED

The following is a point-form summary of the set of test conditions under which data for freezing drizzle, light freezing rain, rain on a cold-soaked surface, and freezing fog are collected:

1. Freezing Drizzle:
   High precipitation rate: 13 g/dm²/h;
   Droplet median volume diameter: 350 μm;
   Air temperature: -3 and -10°C.

   Low Precipitation rate: 5 g/dm²/h;
   Droplet median volume diameter: 250 μm;
   Air temperature: -3 and -10°C.

2. Light Freezing Rain:
   High precipitation rate: 25 g/dm²/h;
   Droplet median volume diameter: 1 000 μm;
   Air temperature: -3 and -10°C.

   Low precipitation rate: 13 g/dm²/h;
   Droplet median volume diameter: 1 000 μm;
   Air temperature: -3 and -10°C.

3. Drizzle on Cold-Soaked Surface:
   Precipitation rate: 5 g/dm²/h;
   Droplet median volume diameter: 250 μm;
   Air temperature: +1°C.

4. Moderate Rain on Cold-Soaked Surface:
   Precipitation rate: 75 g/dm²/h;
   Droplet median volume diameter: 1 400 μm;
   Air temperature: +1°C.

5. Freezing Fog:
   Precipitation rate: 2 and 5 g/dm²/h;
   Droplet median volume diameter: 30 μm; and
   Air temperature: -3°C, -14°C and -25°C.

2. DATA FORMS

The data forms used for tests conducted in simulated conditions are as follows:

Figure 2.1: Test Stand Location for Each Condition at NRC;

Figure 2.2: General Form for Each Session at NRC;

Figure 2.3: General Form for Each Condition at NRC;

Figure 2.4: De/Anti-icing Data Form for Freezing Precipitation at NRC;

Figure 2.5: De/Anti-icing Data Form for Cold Soak Box;

Figure 2.6: Chamber Setting for Each Condition at NRC;

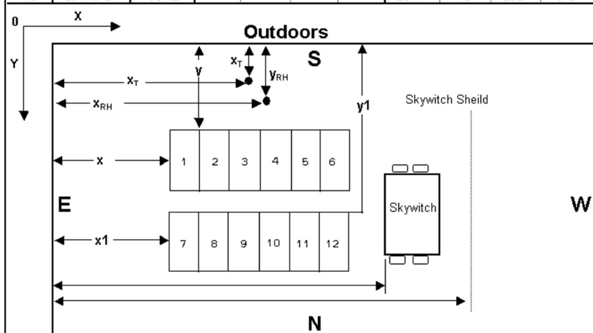
Figure 2.7: Rate Management Form at NRC, and;

Table 2.1: Condition Checklist

TEST REQUIREMENTS FOR SIMULATED FREEZING PRECIPITATION FLAT PLATE TESTING

LOCATION: CEF (Ottawa)   DATE: CONDITION: ZR3H ZR3L ZR10H ZR10L ZD3H ZD3L ZD10H ZD10L ZF3H ZF3L ZF10H ZF10L ZF14H ZF14L ZF25H ZF25L CSWH CSWL

Test	Date of Final Position	Condition	Sensor Position				Stand Position				Skywitch Position	Skywitch Sheild Position (*)	Nozzle Position (**)	Rate	Height of nozzle over plate	Comments
			X_T	Y_T	X_{RH}	Y_{RH}	x	y	x1	y1						
1	04-Apr-01	ZR3H					24' 2"	7'	22' 7"	9' 10"				Very Good		Top Stand 19' from snow fence
2	04-Apr-01	ZR3L					24' 2"	7'	22' 7"	9' 10"				Very Good		Top Stand 19' from snow fence
3	02/04/2001	ZR10H					24'	6' 9"	24' 5"	9' 6"				Very Good		Top stand is 20 ft. from snow fence
4	02-Apr-01	ZR10L					24'	6' 9"	24' 5"	9' 6"				Very Good		Top stand is 20 ft. from snow fence
5	27-Mar-01	ZD3H					24' 5"	6'6"	22'	10'4"				Very Good		
6	28-Mar-01	ZD3L					25' 3"	7'3"	25' 3"	9' 6"				Good		
7	02-Apr-01	ZD10H					24'	7'11"	25' 3"	9' 6"				Very Good		
8	02-Apr-01	ZD10L					24'	7' 7"	24' 7"	9' 11"				Good		20 ft. from Snow Fence
9	10-Apr-01	ZFog3H					24'	6'6"	21'11"	8'10"	34' 2"from x	40'2" from x	top of plate 11	Good	144"	
10	10-Apr-01	ZFog3L					24'	6'6"	21'11"	8'10"	34' 2"from x	40'2" from x	top of plate 11	Good	144"	
11	10-Apr-01	ZFog10H					24'	6'6"	21'11"	8'10"	34' 2"from x	40'2" from x	top of plate 11	Good	144"	
12	10-Apr-01	ZFog10L					24'	6'6"	21'11"	8'10"	34' 2"from x	40'2" from x	top of plate 11	Good	144"	
13	09-Apr-01	ZFog14H					24'	6'6"	21'11"	8'10"	34' 2"from x	40'2" from x	top of plate 11	Good	144"	
14	09-Apr-01	ZFog14L					24'	6'6"	21'11"	8'10"	34' 2"from x	40'2" from x	top of plate 11	Good	144"	
15	06-Apr-01	ZFog25H					24'	6'6"	21'11"	8'10"	34' 2"from x	40'2" from x	top of plate 11	Good	144"	
16	06-Apr-01	ZFog25L					24'	6'6"	21'11"	8'10"	34' 2"from x	40'2" from x	top of plate 11	Good	144"	
17	29-Mar-01	CSWH					25'3"		25'3"	9' 6"						
18	29-Mar-01	CSWL					23'11"	7'3"	25'3"	9' 6"						



Notes:

* - "From X" refers to the distance from the East wall.
** - The nozzle should be between positions 5 and 11
RH - Relative Humidity Sensor
T - Temperature Sensor

WEIGH SCALE TECHNICIAN: ____________________

LEADER: ____________________

NEW VALUES (IF DIFFERENT)

Test	Date of Final Position	Condition	Sensor Position				Stand Position				Skywitch Position	Skywitch Sheild Position (*)	Nozzle Position (**)	Rate	Height of nozzle over plate	Comments
			X_T	Y_T	X_{RH}	Y_{RH}	x	y	x1	y1						

Figure 2.1: Test Stand Location for Each Condition at NRC

LOCATION: CEF (Ottawa) DATE INTERVAL:

Safety Issues Discussed ☐

Test Plate Material: ☐
(check the box if material used is Aluminum alloy AMS 4037 or 4041)

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)
Refer to Verification Procedure "A-Verif" for methodology

Ice-catch Pan Dimensions: ☐
(check the box if the dimensions are 27,7 cm by 54 cm)

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

Weigh Scale verification: 2g ☐ 50 g ☐
(see verification procedure)

Air Temperature (°C):
(to be recorded by the NRC at a sampling rate of minimum 1 datum per minute and handed in to APS at the end of the session on floppy disks)
The air temperature data is saved to the following files (provide filename and extension):

....
....
....
....

Relative humidity (%):
(to be recorded by APS and saved at the end of the session on floppy disks)
The humidity data is saved to the following files (provide filename and extension):

....
....
....

COMMENTS:

....
....
....

LEADER: ____________

Figure 2.2: General Form for Each Session at NRC

TEST REQUIREMENTS FOR SIMULATED FREEZING PRECIPITATION FLAT PLATE TESTING

LOCATION: CEF (Ottawa)	DATE:	CONDITION: ZR3H ZR3L ZR10H ZR10L ZD3H ZD3L ZD10H ZD10L ZF3H ZF3L ZF10H ZF10L ZF14H ZF14L ZF25H ZF25L CSWH CSWL

Angle of the Test Stands (°): PLATE 1 ☐ PLATE 6 ☐ PLATE 7 ☐ PLATE 12 ☐

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

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

Plate Temperature (°C):
(to be recorded by APS at the end of the each condition, saved on floppy disks and included in the envelope along with the forms)
The plate temperature data is saved to the following files (provide filename and extension):

....
....
....
....
....
....

COMMENTS:
....
....
....
....

COMPUTER TECHNICIAN: ____________________

LEADER: ____________________

Figure 2.3: General Form for Each Condition at NRC

M:\Projects\PM1892 (TC Deicing 03-04)\Procedures\HOT-NRC\Version 1.0.doc
Version 1.0, January 04

5

REMEMBER TO SYNCHRONIZE TIME

LOCATION: CEF (Ottawa) DATE: RUN NUMBER: STAND # :

TIME TO FAILURE FOR INDIVIDUAL CROSSHAIRS (real time)

Time of Fluid Application	______	______	______	______	______
Initial BOX Temperature (°C) (NEEDS TO BE -10 ± 1)	______	______	______	______	______
Initial Fluid Temperature (°C) (NEEDS TO BE WITHIN 3°C OF AIR TEMP)	______	______	______	______	______
Enter Box Number	Box #	Box #	Box #	Box #	Box #
FLUID NAME/BATCH					
B1 B2 B3					
C1 C2 C3					
D1 D2 D3					
E1 E2 E3					
F1 F2 F3					
TIME TO FIRST PLATE FAILURE WITHIN WORK AREA					
FAILURE CALL (circle)	V. Difficult Difficult. Easy	V. Difficult Difficult. Easy	V. Difficult Difficult. Easy	V. Difficult Difficult. Easy	V. Difficult Difficult. Easy
HRZ. AIR VELOCITY * (circle)	A B	A B	A B	A B	A B

Time of Fluid Application	______	______	______	______	______
Initial BOX Temperature (°C) (NEEDS TO BE -10 ± 1)	______	______	______	______	______
Initial Fluid Temperature (°C) (NEEDS TO BE WITHIN 3°C OF AIR TEMP)	______	______	______	______	______
Enter Box Number	Box #	Box #	Box #	Box #	Box #
FLUID NAME/BATCH					
B1 B2 B3					
C1 C2 C3					
D1 D2 D3					
E1 E2 E3					
F1 F2 F3					
TIME TO FIRST PLATE FAILURE WITHIN WORK AREA					
FAILURE CALL (circle)	V. Difficult Difficult. Easy	V. Difficult Difficult. Easy	V. Difficult Difficult. Easy	V. Difficult Difficult. Easy	V. Difficult Difficult. Easy
HRZ. AIR VELOCITY * (circle)	A B	A B	A B	A B	A B

AMBIENT TEMPERATURE:________ °C PRE-START COOLANT TEMPERATURE: ________ °C
(Code requirements are -12 ± 1 °C)

COMMENTS:

NOTE:
* A: HORIZONTAL AIR VELOCITY ≤ 1.0 m/s
B: HORIZONTAL AIR VELOCITY > 1.0 m/s

LEADER / MANAGER:

Figure 2.4: De/Anti-icing Data Form for Freezing Precipitation at NRC

TEST REQUIREMENTS FOR SIMULATED FREEZING PRECIPITATION FLAT PLATE TESTING

REMEMBER TO SYNCHRONIZE TIME

LOCATION: CEF (Ottawa) DATE: RUN NUMBER: STAND # :

TIME TO FAILURE FOR INDIVIDUAL CROSSHAIRS (real time)

Time of Fluid Application: ______ ______ ______ ______ ______ ______

Initial Plate Temperature (°C)
(NEEDS TO BE WITHIN 0.5°C OF AIR TEMP) ______ ______ ______ ______ ______ ______

Initial Fluid Temperature (°C)
(NEEDS TO BE WITHIN 3°C OF AIR TEMP) ______ ______ ______ ______ ______ ______

	Plate 1	Plate 2	Plate 3	Plate 4	Plate 5	Plate 6
FLUID NAME/BATCH						
B1 B2 B3						
C1 C2 C3						
D1 D2 D3						
E1 E2 E3						
F1 F2 F3						
TIME TO FIRST PLATE FAILURE WITHIN WORK AREA						
FAILURE CALL (circle)	V. Difficult Difficult. Easy	V. Difficult Difficult. Easy	V. Difficult Difficult. Easy	V. Difficult Difficult. Easy	V. Difficult Difficult. Easy	V. Difficult Difficult. Easy
HRZ. AIR VELOCITY * (circle)	A B C	A B C	A B C	A B C	A B C	A B C

Time of Fluid Application: ______ ______ ______ ______ ______ ______

Initial Plate Temperature (°C)
(NEEDS TO BE WITHIN 0.5°C OF AIR TEMP) ______ ______ ______ ______ ______ ______

Initial Fluid Temperature (°C)
(NEEDS TO BE WITHIN 3°C OF AIR TEMP) ______ ______ ______ ______ ______ ______

	Plate 7	Plate 8	Plate 9	Plate 10	Plate 11	Plate 12
FLUID NAME/BATCH						
B1 B2 B3						
C1 C2 C3						
D1 D2 D3						
E1 E2 E3						
F1 F2 F3						
TIME TO FIRST PLATE FAILURE WITHIN WORK AREA						
FAILURE CALL (circle)	V. Difficult Difficult. Easy	V. Difficult Difficult. Easy	V. Difficult Difficult. Easy	V. Difficult Difficult. Easy	V. Difficult Difficult. Easy	V. Difficult Difficult. Easy
HRZ. AIR VELOCITY * (circle)	A B C	A B C	A B C	A B C	A B C	A B C

PRECIP (circle): ZF , ZD , ZR-, MOD

AMBIENT TEMPERATURE: ________°C

NOTE:
* A: HORIZONTAL AIR VELOCITY ≤ 0.4 m/s
B: 0.4 m/s < HORIZONTAL AIR VELOCITY ≤ 1.0 m/s
C: HORIZONTAL AIR VELOCITY > 1.0 m/s

COMMENTS: ______________________________

LEADER / MANAGER: ______________

Figure 2.5: De/Anti-icing Data Form for Cold Soak Box

M:\Projects\PM1892 (TC Deicing 03-04)\Procedures\HOT-NRC\Version 1.0.doc
Version 1.0, January 04

7

TEST REQUIREMENTS FOR SIMULATED FREEZING PRECIPITATION FLAT PLATE TESTING

LOCATION: CEF (Ottawa) **DATE:** **CONDITION: ZR3H ZR3L ZR10H ZR10L ZD3H ZD3L ZD10H ZD10L ZF3H ZF3L ZF10H ZF10L ZF14H ZF14L ZF25H ZF25L CSWH CSWL**

CONDITION	Needles Used	Flow Rate of Water *	Line Air Pressure (psi)	Line Air Temperature (Celsius)	Line Water Pressure (psi)	Line Water Temperature (Celsius)	Relative Humidity (%)	X Axis Area	Speed	Y Axis Area	Speed	Brace Height (inches)	LT'S on						MT'S on						Last Date
													1	2	3	4	5	6	1	2	3	4	5	6	
ZR 3 L	**2x20**	**1 GPM**	**60**	**12.5**	**78**	**2**	**75**	**full**	**low**	**full**	**high**		**y**	**y**					**y**	**y**	**y**				**04-Apr-01**
ZR 10 L	2x20	1 GPM	60	12.5	82	2.5	75	full	low	full	high			y					y	y	y				03-Apr-01
ZR 3 H	**2x20**	**1 GPM**	**60**	**12.5**	**61**	**2**	**75**	**partial**	**low**	**full**	**high**								**y**	**y**	**y**				**04-Apr-01**
ZR 10 H	2x20	1 GPM	60	12.5	78	2.5	73	partial	low	full	high			y					y	y	y				03-Apr-01
ZD 3 L	2x24	1 GPM	60	13	65	2.5	75	partial	low	full	high								y	y	y				28-Mar-01
ZD 10 L	2x24	1 GPM	60	12	43	2	76	full	low	full	high			y					y	y	y				30-Mar-00
ZD 3 H	2x23	1 GPM	60	13	62	2.5	90	partial	low	full	high								y	y	y				27-Mar-01
ZD 10 H	2x23	1 GPM	60	12	55	2.5	72	partial	low	full	high		y	y					y	y	y				30-Mar-00
FOG 3 L	1 X 20/50/120	80	80	80	-	73.3	96	full	low	full	low	144							y	y	y				05-Apr-01
FOG 14 L	1 x 20/50/120	55	40	72	-	72.8	80	full	low	full	low	144							Y	Y	Y				11-Apr-01
FOG 25 L	1 x 20/50/120	50	40	72	-	72.8	80	full	low	full	low	144	y	y	y										06-Apr-01
FOG 3 H	1X 20/50/120	75	40	72	-	73.2	95	full	low	full	low	144							y	y	y				10-Apr-01
FOG 14 H	1 x 20/50/120	75	40	73	-	72.8	76	full	low	full	low		y						y	y	y				09-Apr-01
FOG 25 H	1 x 20/50/120	75	40	73	-	73.2	73	full	low	full	low	144	y	y	y										06-Apr-01
CSW 1 H	2x17	1 GPM	60	13.5	75	2	85	part	low	full	high										y	y		y	04-Jun-01
CSW 1 L	2 x 24	1 GPM	60	12.5	30	2.5	89	full	low	full	high										y	y			04-Jun-01
ZD 10 5	2 x 24	1 GPM	60	15	35	4.5	-												y	y	y				16-Jul-99
FOG 35 H	1 X 20/50	12	40	74	-	-	-	partial	low	partial	low	104	y	y	y	y									19-Jul-99
FOG 35 L	1 x 20/50	10	40	73	-	-	-	full	low	partial	low	104	y	y	y	y									19-Jul-99
FOG 30 L	1 x 20/50	10	40	73	-	-	-	full	low	partial	low	104	y	y	y	y									19-Jul-99
FOG 32 L	1 x 20/50	13	40	-	-	-	-	partial	low	full	low	104	y	y	y	y									20-Jul-99
FOG 32 H	1 x 20/50	24	40	-	-	-	-	full	low	full	low	144	y	y	y	y									20-Jul-99
FOG 10 H	1 x 20/50	75	40	74	-	72.6	-	full	low	full	low	144							y	y	y				09-Apr-01
FOG 10 L	1 X 20/50	55	40	-	-	-	-	full	low	full	low	144							y	y	y				09-Apr-01
FOG25L	1x20/50/120	15	40	73	-	70.9	-	full	low	full	low	144		y	y	y									31-Mar-00
FOG25h	1x20/50/120	24	40	79	-	72.9	-	full	low	full	low	144	y	y	y										04-Apr-00
ZR3H-2	2X20	1GPM	60	12.5	90	1.5	-	partial	low	full	high								y	y	y				06-Apr-00

* Dial Readings=X ⟶ Flow Rate for Fog (ml/min) = 0.0033*X² + 3.3605*X - 17.512

Brace height 12'6"

NEW VALUES (IF DIFFERENT)

CONDITION	Needles Used	Flow Rate of Water*	Line Air Pressure (psi)	Line Air Temperature (Celsius)	Line Water Pressure (psi)	Line Water Temperature (Celsius)	Relative Humidity (%)	X Axis Area	Speed	Y Axis Area	Speed	Brace Height (inches)	LT'S on						MT'S on						Date
													1	2	3	4	5	6	1	2	3	4	5	6	

COMPUTER TECHNICIAN:______________________ LEADER: ______________________

Figure 2.6: Chamber Setting for Each Condition at NRC

TEST REQUIREMENTS FOR SIMULATED FREEZING PRECIPITATION FLAT PLATE TESTING

RATE MANAGEMENT FORM AT NRC

CONDITION: ____________

DATE: ____________ WEIGH SCALE TECHNICIAN: ____________

PAN #	TIME OUT	1st or 2nd Rate

TIME*	Chamber Temperature	STDEV

* One reading every 30 minutes (Check procedure for air temp. STDEV requirements).
This form is for guidance to manage the sequencing of pans measurement and to verify the chamber temperature STDEV.
(At the end of condition file this form in the same envelope with the endurance time data form)

Figure 2.7: Rate Management Form at NRC

Table 2.1: Condition Checklist

Beginning of the condition

TASKS	DONE - INITIALS
Start the computer and spreadsheet	
Start the scale program (Wedge software)	
Start, reset and level the scale	
Check that the scale is correctly verified to 2g and 50g	
Start the camera and video	
Verify the functionality of the walky-talky system	
Synchronize all clocks to atomic clock (computers, stopwatches)	
Prepare a dated envelope	

End of the condition

TASKS	DONE - INITIALS
Print all results (spreadsheet pages)	
Write on the envelope the tests that have been achieved	
Shut down the computer / Shut down the scale	
The coordinator should write a summary each night	
Stop and shut down the intercoms, camera and video	
Clean stand area (if needed)	
Prepare fluids for the next day	
Save all results on hard drive	
Zip all the results with *Winzip,* save them on a marked diskette	
Provide instructions to laboratory technician for the next day conditions	
Put all results sheets, checklists, and the diskette in the envelope. Forward the envelope to the office	

CO-ORDINATOR / MANAGER ____________________ **DATE** ____/____/_____

This page intentionally left blank.

OVERALL PROGRAM OF TESTS AT NRC, APRIL 2011

CM2169.003 (10-11)

OVERALL PROGRAM OF TESTS AT NRC, APRIL 2011

Winter 2010-11

Prepared for

Transportation Development Centre
Transport Canada

for Prepared by: Stephanie Bendickson

Reviewed by: John D'Avirro

APS Aviation Inc.

April 1, 2011
Final Version 1.0

OVERALL PROGRAM OF TESTS AT NRC, APRIL 2011

Winter 2010-11

1. INTRODUCTION

This document was prepared to bring together several projects that require testing at the National Research Council Climactic Engineering Facility (NRC) in Ottawa. Tests will be carried out from April 5-12, 2011.

The primary objective of the test session is to measure the endurance times of new de/anti-icing fluids. During this time, testing for other related projects will be scheduled around the endurance time tests as time and space permit. This document provides the schedule, personnel, fluid, and equipment requirements for each of the projects involved.

A tentative test schedule is included in Figure 1.

2. PROJECTS, PROCEDURES AND OBJECTIVES

The projects that will be tested at the NRC at the April 2011 test session are listed in this section. The objectives and procedures for each project are provided. Each project has been given a shortened name (shown in brackets following full title) which will be used in subsequent sections of the document.

The test procedures for some projects are provided in separate detailed documents. These documents are referenced in the appropriate subsection and listed in Section 9.

There will be two test stands (main stand, side stand) positioned under the sprayer as shown in Figure 2. The stands that can be used for each project are noted in the following subsections.

2.1 Endurance Times of New Fluids (New Fluid ETs)

The objective of this project is to measure endurance times of new fluids in simulated freezing precipitation.

Two Type IV fluids will be tested:

- Cryotech HV1 (Batch #1.035.1600); and
- Cryotech LV2 (Batch #1.042.1430).

The procedure for conducting these tests is given in the document *Test Requirements for Simulated Freezing Precipitation Flat Plate Testing* (1). The test stands should be situated in the cold chamber as per the measurements provided in Figure 3. The cold soak boxes should be prepared using the procedure provided in Attachment 1.

The test plan for Endurance Time tests is given in Table 1. All tests will be conducted on the main test stand.

2.2 Thickness of New Fluids (Fluid Thickness)

The objective of these tests is to measure thicknesses of new fluids on flat plates. The procedure for conducting these tests is entitled *Experimental Program to Establish Film Thickness Profiles for De-Icing and Anti-Icing Fluids on Flat Plates* (2) and can be found in Transport Canada Report TP 13991E, Appendix I.

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.

2.3 Effect of Ice Phobic Products on Fluid Holdover Times (Ice Phobic)

The objective of this project is to investigate the holdover time performance of fluids applied to surfaces treated with ice phobic products. Limited testing will also look at the performance of bare plates treated with ice phobic products.

The procedure for the conduct of these tests is provided in the document *Effect of Ice Phobic Products on HOT – Simulated Freezing Precipitation Tests* (3). The procedure details three types of tests that will be conducted:

- Fluid Thickness Tests: These tests will be carried out using the protocol used to measure fluid thickness of new endurance time fluids (see Section 2.2). The ice phobic fluid thickness test plan is given in Table 3.

- Endurance Time Tests: These tests will be carried out using standard endurance time testing protocol. Brix and fluid thickness measurements will be taken as detailed in the test plan. The ice phobic endurance time test plan is given in Table 4.

- Adherence Tests: These tests will be conducted without fluid to measure the progression of adhesion on surfaces treated with ice phobic products. The test plan for the ice phobic adherence tests is given in Table 5.

Testing will be conducted on five test surfaces on three test plates:

- Plate 1: Baseline aluminum plate;
- Plate 2: Treated with 2 Nusil products (Nusil 7 / Nusil 8); and
- Plate 3: Treated with 2 other Nusil products (Nusil 9 / Nusil 10).

The endurance and adherence tests will be conducted on the main and/or side stand. The thickness tests will be conducted at the small end of the chamber outside of the spray area.

2.4 Endurance Times for Aircraft Hangar Anti-Icing Applications (Hangar)

Previous research has indicted the use of warm fluid on a warm aircraft may result in anti-icing fluid holdover times that are shorter than those experienced in a standard operation (cold fluid, cold aircraft). This is a result of warm fluid on a warm wing flowing off at a faster rate than cold fluid on a cold wing. As operations conducted in hangars are often conducted with warm fluid on warm aircraft, it is not clear if the current anti-icing fluid holdover times (developed for cold fluids on cold aircraft) are valid for hangar operations. The objective of this project is to compare endurance times of anti-icing fluids applied warm on a warm test surface to those of the same fluids applied cold (ambient temperature) on a cold (ambient) test surface.

Tests will be run to compare endurance times of fluids applied at ambient temperature to test plates at ambient temperature (standard protocol) to fluids applied at 20°C to test plates at 20°C (simulated hangar protocol).

Additional measurements (fluid thickness, Brix, plate temperature) will be taken as detailed in the test plan, which is given in Table 6. The tests will be conducted on the main and/or side stand.

2.5 Endurance Times on Deployed Flaps (Deployed Flaps)

The objective of this project is to evaluate the endurance time performance of anti-icing fluids on wing surfaces with deployed flaps. The procedure for the conduct of these tests is provided in the document *Evaluation of Endurance Times on Deployed Flaps* (4). The procedure was written for testing in outdoor conditions; changes to the procedure required for indoor testing are provided in this document.

Comparison tests will be conducted using standard holdover time testing procedures. Three types of tests will be conducted:

1. Baseline Tests: Conducted on plates inclined to a 10° slope.
2. Standard Flap Tests: Conducted on plates inclined to a 20° or 35° slope.
3. Nested Flap Tests: Plates inclined to either a 20° or 35° slope placed below a plate inclined to 10°. The 10° plate will overhang the 20°/35° plate by approximately 2.5 cm. 1 L of fluid will be applied to each plate. Endurance times will be measured on the plate inclined to 20°/35°.

Additional measurements (fluid thickness, Brix) will be taken as detailed in the test plan, which is given in Table 7. The tests will be conducted on the main and/or side stand, with the exception of the nested flap tests, which must be conducted on positions 7-12 (main stand) or 1S-3S (side stand).

2.6 Impact of Wing Anti-Ice Heating System Tests on Fluid Endurance Times (Leading Edge)

Prior to take off, some operators require pilots to perform a 30 second test to ensure that the wing anti-ice heating is working. To do so, hot bleed air from the engine is passed through the 'piccolo' tubes at the leading edge of the wing on the ground for 30 seconds. The bleed air leaving the engine is approximately 200°C; however, the air reaching the leading edge may be significantly cooler (approximately 100°C). Currently, there is a lack of understanding of the effect of this test on de/anti-icing fluid protection times, and as a result, some airframe manufacturers recommend not performing the test due to potential adverse effects on de/anti-icing fluid.

The objective of this project is to conduct preliminary tests to investigate the effect of a 30 second heated leading edge on de/anti-icing fluid endurance times. Due to limited funding, limited tests (3-4 runs) will be completed.

Each run will consist of one plate test (standard baseline test) and an uninsulated leading edge thermal equivalent box test (heated box test). The following procedure should be followed:

- Ensure box and plate are cooled to ambient temperature;
- Apply fluid to box and plate, wait 5 minutes;
- Heat box using 2 hot flame burners for 1-minute. This will result in a 40ºC rise in temperature at the box 6" line, and will take approximately 20 minutes to cool back to ambient (note: one test will be conducted with the box heated to 100°C).

- Heating rate is approx 20ºC/torch/minute at 6" line
- By pointing the hot flame burners downwards into the box, the temperature is higher on 6" line than at the point of entry, eliminating potential fluid burning issues
- Could potentially use more or less hot flame burners to achieve higher or lower temperatures
- Could potentially blow cold air into box to accelerate cooling;

- Monitor box surface temperature at entry to ensure temperature does not heat to more than 100ºC;
- Monitor and record surface temperature at entry point and 15cm line at 1 minute; and
- Record fluid failure on both box and plate.

Additional measurements (fluid thickness, Brix, plate temperature) will be taken as detailed in the test plan, which is given in Table 8. The heated tests will be conducted on the side stand.

2.7 Effect of Runway Deicers on Endurance Times (Runway Deicers)

Recent discussions at SAE G-12 industry meetings have indicated that there could be a significant degradation of thickened anti-icing fluid effectiveness as a result of cross-contamination with runway deicing fluids (RDF). This is believed to occur in two situations:

a) When aircraft use reverse thrusters during a landing prior to a preventative anti-icing treatment; and
b) When anti-iced aircraft are exposed to RDF when taxiing to the runway.

The objective of this project is to conduct limited flat plate endurance time tests in outdoor and indoor conditions to investigate the effects of RDF on anti-icing fluid endurance times. The procedure for the conduct of the outdoor tests is provided in a separate document - *Evaluation Of Degraded Fluid Performance Following Contamination With Runway Deicer Fluid Phase II: Endurance Time Testing Of De/Anti-Icing Fluid Contaminated With Runway Deicer Fluid* (5). The procedure for indoor tests is provided in this document.

Indoor testing will consist of comparative test runs. Each comparative run will include three tests:

1. Standard Baseline Test: 1 L of fluid applied as per standard protocol.
2. Preventative Anti-Icing Operation Test: RDF sprayed/misted onto test plate and immediately after 1 litre of fluid applied.
3. Regular Take-Off Operation Test: 1 L of fluid applied, 5-minute wait time while fluid settles and dilutes, RDF sprayed/misted onto test plate.

RDF will be applied using a spray bottle to achieve an even mist. The RDF spray bottle will be measured before and after application to document the amount applied.

The concentration of runway deicer fluid to be applied in each of the two scenarios is under investigation and may change prior to testing. Currently, two concentrations are proposed to simulate a high and low concentration.

- High Concentration – 25% RDF by Volume
  - RDF is typically sprayed by operators in 50% concentration;
  - RDF is typically sprayed on a wet runway;
  - Assume RDF is diluted by another 50% due to moisture on ground, resulting in a total of 25% concentration by volume;
  - Test assumes immediate dilution due to contact with wet runway.

- Low Concentration – 5% RDF by Volume
  - RDF will dilute during active conditions;
  - Assume RDF is diluted to $1/10^{th}$ of original concentration due to active precipitation;
  - Previous wind tunnel data has also been collected with 5% concentration by volume;
  - Test assumes extensive dilution due to active precipitation.

- Application Quantity - 0.1 g/dm² of RDF (1.5ml on a std. test plate)
  - Previous flat plate and wind tunnel testing used 0.1 and 0.2 g/dm² of RDF on the test surface respectively;
  - It is recommended that these quantities continue to be used unless any new data indicates otherwise;
  - This simulated a light misting on the test surface (no large beads of moisture formed).

Additional measurements (fluid thickness, Brix) will be taken as detailed in the test plan, which is given in Table 9. The tests will be conducted on the main and/or side stands.

2.8 Ice Pellet Allowance Time Expansion (Ice Pellets)

Ice pellet allowance times were issued for neat Type IV fluids within the Transport Canada HOT Guidelines and the Federal Aviation Administration Approved Deicing Program updates for the winter of 2007-08. Allowance times for operations during mixed conditions with ice pellets have been generated based on results obtained from testing in the Wind Tunnel and with the Falcon 20 aircraft during the winters of 2005-06 through 2009-10. Restrictions for the allowance times were issued based on residual contamination observed on the airfoil, lift characteristics, and limitations of the data collected regarding rotation speeds, test temperatures and fluid types and dilution, and other pertinent parameters. The objective of this project is to conduct a series of flat plate tests with Type IV fluids to provide support for the ongoing expansion and validation of the current ice pellet guidelines.

The procedure for conducting these tests is given in the document *Experimental Program Adhesion of Aircraft De/Anti-Icing Fluids on Aluminum Surfaces During Mixed Precipitation Conditions – Ice Pellets/Freezing Rain* (6). The duration of the tests (target allowance time) has been derived based on previous full scale testing conducted. Fluid thickness will be measured 5 minutes after fluid application; fluid Brix will be measured at failure.

The test plan for Ice Pellets tests is given in Table 10. These tests will be conducted at the small end of the chamber outside of the main spray area.

2.9 Documentation of Stand Setup and Sprayer Characteristics (Sprayer)

The objective of this activity is to document the characteristics of the test stand setup and sprayer system at the NRC climate chamber. In each of the 18 precipitation conditions that will be simulated at this test session, each of the following measurements will be taken:

1. Final stand position
2. Area of spray zone
3. Cycle time
4. Time that plate is impacted

This activity will be done at the end of each condition (when the last plate has failed) by the project manager. Additional guidance is provided on the data form (see Section 6). No test plan is required for this project.

3. PERSONNEL REQUIREMENTS/RESPONSIBILITIES

The personnel requirements for each project are listed below.

1. New Fluid ETs:
    - Manager: JD (pours fluids, calls failures)
    - Assistant: VZ (preps fluids/data forms)
    - Rates Team: SB, YOW
2. Fluid Thickness:
    - Manager: MR (runs tests, takes measurements)
    - Assistant: DY (records measurements)
3. a) Ice Phobic Thickness Tests:
    - Manager: MR (runs tests, takes measurements)
    - Assistant: DY (records measurements)

   b) Ice Phobic Adherence Tests:
    - Manager: MR (takes measurements, manages test surfaces)
    - Assistant: DY (records measurements)
    - Rates Team: SB, YOW

   c) Ice Phobic Endurance Tests:
    - Manager: MR (pours fluids, calls failures, takes measurements)
    - Assistant: DY (preps fluids/data forms, records measurements)
    - Rates Team: SB, YOW
4. Hangar:
    - Manager: MR (pours fluids, calls failures, takes measurements)
    - Assistant: DY (preps fluids/data forms, records measurements)
    - Rates Team: SB, YOW
5. Deployed Flaps:
    - Manager: MR (pours fluids, calls failures, takes measurements)
    - Assistant: DY (preps fluids/data forms, records measurements)
    - Rates Team: SB, YOW
6. Heated Leading Edge:
    - Manager: MR (pours fluids, calls failures, takes measurements)
    - Assistant: DY (preps fluids/data forms, records measurements)
    - Rates Team: SB, YOW

7. Runway Deicers
    - Manager: MR (pours fluids, calls failures, takes measurements)
    - Assistant: DY (preps fluids/data forms, records measurements)
    - Rates Team: SB, YOW

8. Ice Pellets:
    - Manager: MR
    - Assistant 1: DY
    - Assistant 2: VZ

9. Sprayer:
    - Manager: VZ (takes measurements and video)

The Rates Team will consist of:

- Rate Manager: SB (runs rate station)
- Rate Assistant: YOW1 (runs pans, refills fluids)

In the condition of Cold Soak Wing, additional personnel will be required:

- Box Prep Manager: MR
- Box Prep Assistants: DY, VZ

In addition, personnel will be designated responsible for:

- Equipment: MR
- Pre-test Setup: MR
- Data Form Manager: VZ
- HOT Data Management: SB
- Fluid Manager: DY

In some conditions, SB (Rate Manager) may switch responsibilities with DY/VZ.

The individual task assignments are shown by test condition in Table 11.

4. FLUIDS

The required fluids and fluid quantities are shown in Table 12. Type I fluids will be diluted prior to testing using the dilution tables provided in Table 13.

5. EQUIPMENT

Table 14 provides a list of the equipment required.

6. DATA FORMS

The data forms required for each project are listed below.

1. New Fluid ETs:
   - Freezing Precipitation Endurance Time Data Form (Figure 4)
   - Rate Management Form (Figure 5)
2. Fluid Thickness:
   - Fluid Thickness Data Form (Figure 6)
3. a) Ice Phobic Fluid Thickness Tests
   - Ice Phobic Fluid Thickness Data Form (Figure 7)

   b) Ice Phobic Endurance Time Tests
   - End Condition Data Form for Ice Phobic Tests (Figure 8)

   c) Ice Phobic Adherence Tests
   - End Condition Data Form for Ice Phobic Tests (Figure 8)
4. Hangar:
   - Freezing Precipitation Endurance Time Data Form (Figure 4)
   - Fluid Brix/Fluid Thickness/Plate Temperature Data Form (Figure 9)
5. Deployed Flaps:
   - Freezing Precipitation Endurance Time Data Form (Figure 4)
   - Fluid Brix / Thickness Data Form (Figure 10)
6. Heated Leading Edge:
   - Freezing Precipitation Endurance Time Data Form (Figure 4)
   - Fluid Brix/Fluid Thickness/Plate Temperature Data Form (Figure 9)
7. Runway Deicers:
   - Freezing Precipitation Endurance Time Data Form (Figure 4)
   - Fluid Brix / Thickness Data Form (Figure 10)
8. Ice Pellets:
   - Freezing Precipitation Endurance Time Data Form (Figure 4)
   - Fluid Brix/Thickness Data Form (Figure 10)
   - Adherence of Fluid Failure Data Form (Figure 11)
   - Position of Ice Pellet Dispenser System Data Form (Figure 12)
9. Sprayer:
   - Stand Position / Sprayer Characteristics Form (Figure 13)

7. PRE–TEST SET–UP ACTIVITIES

The following activities need to be completed prior to arrival at the NRC:

1. Mark plates and boxes, including RDF plates (MR).
2. Check rate pans: check quantity, check for holes, and check all pans are properly labelled (VZ).
3. Ensure plates and boxes are equipped with operational and verified thermistors (MR).
4. Determine number of loggers required (loggers are on stands already) (MR).
5. Prepare PC for logging plate temperatures (MR).
6. Ensure fluids are prepared in advance according to Table 12 (MR).
7. Prepare labels for pour containers (MP).
8. Empty 1 litre containers must be labelled and cleaned for pouring (MR).
9. Check laptops (2) work for rate station (MR).
10. Rent cube van (VZ).
11. Book hotel (VZ).
12. Update chamber settings file (DY).
13. Print data forms and procedures (VZ).
14. Print chamber condition sheets (SB).

The following items should be purchased prior to arrival at the NRC (VZ):

1. Ink cartridge for printer (1)
2. Nuts (100)
3. Propane bottles (4)
4. Propane torches with auto trigger (4)
5. Shelving Unit (1)

8. SAFETY ISSUES

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 MSDS sheets are available for review.
2. Waterproof clothing and gloves are available.
3. Rubber mats must be properly placed in and around the test area and cleaned as necessary.
4. Care should be taken when circulating near the test stand due to slipperiness.
5. First aid kit, water and fire extinguisher are available.
6. All NRC safety guidelines must be followed.

9. REFERENCES

1. Test Requirements For Simulated Freezing Precipitation Flat Plate Testing, Version 1.0, January 15, 2004.
2. Experimental Program to Establish Film Thickness Profiles for De-Icing and Anti-Icing Fluids on Flat Plates, Version 1.0, April 3, 2002.
3. Procedure: Effect of Ice Phobic Products on HOT – Simulated Freezing Precipitation Tests, Final Version 1.0, March 25, 2010.
4. Evaluation of Endurance Times on Deployed Flaps, Final Version 1.0, December 23, 2010.
5. Evaluation Of Degraded Fluid Performance Following Contamination With Runway Deicer Fluid Phase II: Endurance Time Testing Of De/Anti-Icing Fluid Contaminated With Runway Deicer Fluid, Final Version 1.0, February 17, 2011.
6. Experimental Program: Adhesion of Aircraft De/Anti-Icing Fluids on Aluminum Surfaces During Mixed Precipitation Conditions – Snow and Rain, Final Version 1.0, March 31, 2008.

FIGURE 1: TEST SCHEDULE

	Apr 05	Wed Apr 6	Thurs Apr 7	Fri Apr 8	Mon Apr 11	Tue Apr 12	Apr 13
9:00	Packup Drive to YOW	**ZD, -10, 5** ET = 8 **DF = 2 + 1 (m)** HG = 2 LE = 2 RDF = 3	**ZR, -3, 25** ET = 12 DF = 2 + 1 HG = 2 RDF = 3 TH = 6 PH-T = 9	**ZD, -3, 5** ET = 12 DF = 3 + 2 HG = 4 PH = 3 (TI) RDF = 3 Make Ice Pellets	**ZF, -25, 5** ET = 4 DF = 2 + 1	**ZF, -3, 2** ET = 12 DF = 2 + 1 IP = 4	Spare Test Day
9:30							
10:00							
10:30							
11:00					**ZF, -25, 2** ET = 4 DF = 2 + 1		
11:30							
12:00			**ZR, -3, 13** ET = 12 DF = 2 + 1 **HG = 2 (m)** RDF = 3 Make Ice Pellets				
12:30		**ZD, -10, 13** ET = 8 DF = 2 + 1 HG = 2 LE = 2 **PH = 3 (m)** RDF = 5					
13:00	Setup at NRC			Warm to +1°C	Warm to -14°C		
13:30				**CSW, 1, 5** ET = 8			
14:00							
14:30					**ZF, -14, 2** ET = 8 DF = 2 + 1		
15:00		**ZR, -10, 13** ET = 8 DF = 2 + 1 HG = 2 **LE = 2 (m)** PH = 6 + 3 (TI) PH-A = 3 RDF = 3				**ZF, -3, 5** ET = 12 DF = 2 + 1 IP = 4	
15:30			**ZD, -3, 13** ET = 12 **DF = 2 + 1 (m)** HG = 2 PH = 3 RDF = 3 Make Ice Pellets				
16:00							
16:30							
17:00							
17:30				**CSW, 1, 75** ET = 8			
18:00		**ZR, -10, 25** ET = 8 DF = 2 + 1 HG = 4 **LE = 2 (m)** PH = 3					
18:30					**ZF, -14, 5** ET = 8 DF = 2 + 1		
19:00							
19:30							
20:00							
20:30							
21:00							
21:30							

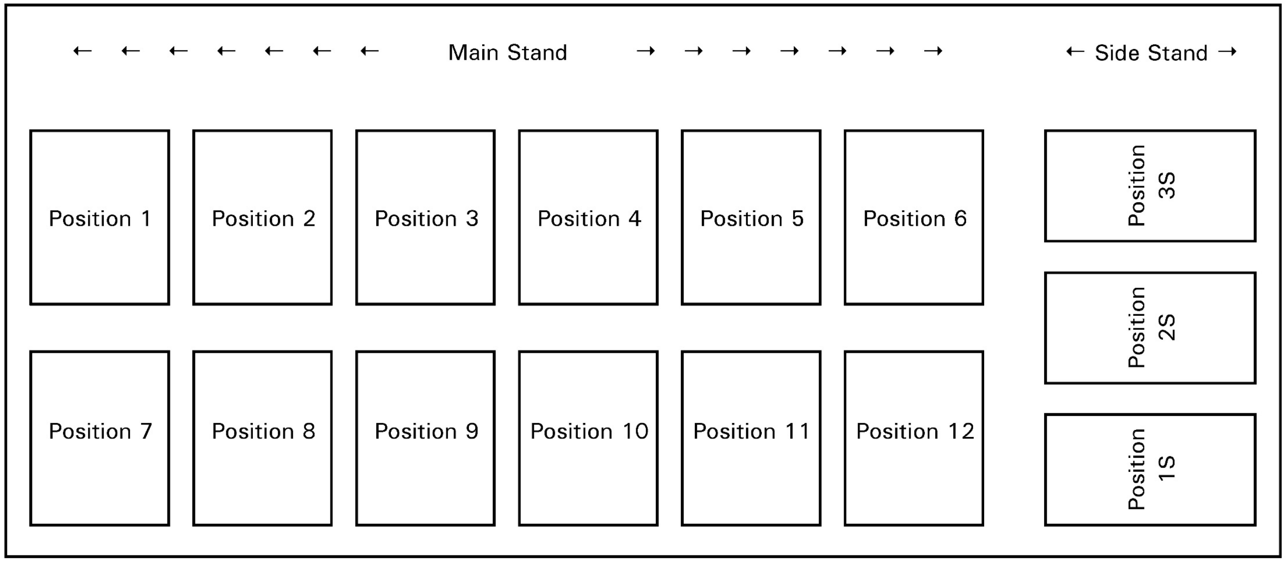
DF = Deployed Flaps
ET = Endurance Time (HOT)
HG = Hangar
IP = Ice Pellets
LE = Heated Leading Edge
PH = Ice Phobic ET
PH-A = Ice Phobic Adherence
PH-T = Ice Phobic Thickness
RDF = Runway Deicing Fluid
TH = Thickness (HOT Fluids)

Projects per Condition

- (pale yellow) ET only
- (orange) ET, DF
- (magenta) ET, DF, IP
- (yellow) ET, DF, HG, RDF, PH
- (green) ET, DF, HG, RDF, LE
- (blue) ET, DF, HG, RDF, LE, PH
- (pale green) ET, DF, HG, RDF, TH/PH-TH

#s indicate tests per project per condition
(m) = extra measurements required

FIGURE 2: TEST STANDS UNDER SPRAYER

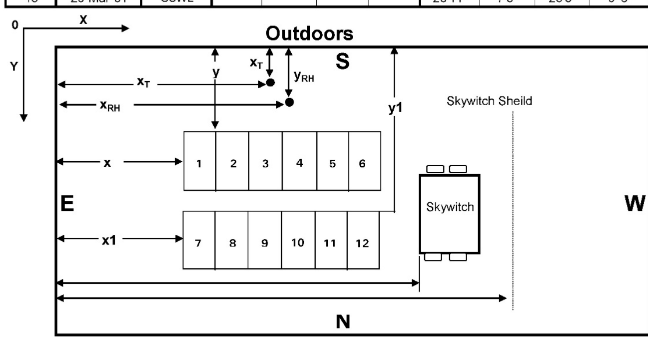


OVERALL PROGRAM OF TESTS AT NRC, APRIL 2011

FIGURE 3: TEST STAND LOCATION MEASUREMENTS

LOCATION: CEF (Ottawa) **DATE:** **CONDITION: ZR3H ZR3L ZR10H ZR10L ZD3H ZD3L ZD10H ZD10L ZF3H ZF3L ZF10H ZF10L ZF14H ZF14L ZF25H ZF25L CSWH CSWL**

Test	Date of Final Position	Condition	Sensor Position				Stand Position				Skywitch Position	Skywitch Sheild Position (*)	Nozzle Position (**)	Rate	Height of nozzle over plate	Comments
			X_T	Y_T	X_{RH}	Y_{RH}	x	y	x1	y1						
1	04-Apr-01	ZR3H					24' 2"	7'	22' 7"	9' 10"				Very Good		Top Stand 19' from snow fence
2	04-Apr-01	ZR3L					24' 2"	7'	22' 7"	9' 10"				Very Good		Top Stand 19' from snow fence
3	02/04/2001	ZR10H					24'	6' 9"	24' 5"	9' 6"				Very Good		Top stand is 20 ft. from snow fence
4	02-Apr-01	ZR10L					24'	6' 9"	24' 5"	9' 6"				Very Good		Top stand is 20 ft. from snow fence
5	27-Mar-01	ZD3H					24' 5"	6'6"	22'	10'4"				Very Good		
6	28-Mar-01	ZD3L					25' 3"	7'3"	25' 3"	9' 6"				Good		
7	02-Apr-01	ZD10H					24'	7'11"	25' 3"	9' 6"				Very Good		
8	02-Apr-01	ZD10L					24'	7' 7"	24' 7"	9' 11"				Good		20 ft. from Snow Fence
9	10-Apr-01	ZFog3H					24'	6'6"	21'11"	8'10"	34' 2"from x	40'2" from x	top of plate 11	Good	144"	
10	10-Apr-01	ZFog3L					24'	6'6"	21'11"	8'10"	34' 2"from x	40'2" from x	top of plate 11	Good	144"	
11	10-Apr-01	ZFog10H					24'	6'6"	21'11"	8'10"	34' 2"from x	40'2" from x	top of plate 11	Good	144"	
12	10-Apr-01	ZFog10L					24'	6'6"	21'11"	8'10"	34' 2"from x	40'2" from x	top of plate 11	Good	144"	
13	09-Apr-01	ZFog14H					24'	6'6"	21'11"	8'10"	34' 2"from x	40'2" from x	top of plate 11	Good	144"	
14	09-Apr-01	ZFog14L					24'	6'6"	21'11"	8'10"	34' 2"from x	40'2" from x	top of plate 11	Good	144"	
15	06-Apr-01	ZFog25H					24'	6'6"	21'11"	8'10"	34' 2"from x	40'2" from x	top of plate 11	Good	144"	
16	06-Apr-01	ZFog25L					24'	6'6"	21'11"	8'10"	34' 2"from x	40'2" from x	top of plate 11	Good	144"	
17	29-Mar-01	CSWH					25'3"		25'3"	9' 6"						
18	29-Mar-01	CSWL					23'11"	7'3"	25'3"	9' 6"						



Notes:

* - "From X" refers to the distance from the East wall.
** - The nozzle should be between positions 5 and 11
RH - Relative Humidity Sensor
T - Temperature Sensor

WEIGH SCALE TECHNICIAN: ____________________

LEADER: ____________________

NEW VALUES (IF DIFFERENT)

Test	Date of Final Position	Condition	Sensor Position				Stand Position				Skywitch Position	Skywitch Sheild Position (*)	Nozzle Position (**)	Rate	Height of nozzle over plate	Comments
			X_T	Y_T	X_{RH}	Y_{RH}	x	y	x1	y1						

ATTACHMENT 1: COLD SOAK BOX PREPARATION PROCEDURE

1. Put containers (20 L) of CSW box fluid (propylene 65/35) 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: ENDURANCE TIME TEST PLAN

Test #	Precipitation Type	Temp (°C)	Precip. Rate (g/dm²/h)	Fluid Name	Fluid Dilution (%)	Test Surface	Comments
1	Freezing Fog	-3	2	Cryotech HV1	100	Plate	
2	Freezing Fog	-3	2	Cryotech HV1	100	Plate	
3	Freezing Fog	-3	2	Cryotech LV2	100	Plate	
4	Freezing Fog	-3	2	Cryotech LV2	100	Plate	
5	Freezing Fog	-3	2	Cryotech HV1	75	Plate	
6	Freezing Fog	-3	2	Cryotech HV1	75	Plate	
7	Freezing Fog	-3	2	Cryotech LV2	75	Plate	
8	Freezing Fog	-3	2	Cryotech LV2	75	Plate	
9	Freezing Fog	-3	2	Cryotech HV1	50	Plate	
10	Freezing Fog	-3	2	Cryotech HV1	50	Plate	
11	Freezing Fog	-3	2	Cryotech LV2	50	Plate	
12	Freezing Fog	-3	2	Cryotech LV2	50	Plate	
13	Freezing Fog	-3	5	Cryotech HV1	100	Plate	
14	Freezing Fog	-3	5	Cryotech HV1	100	Plate	
15	Freezing Fog	-3	5	Cryotech LV2	100	Plate	
16	Freezing Fog	-3	5	Cryotech LV2	100	Plate	
17	Freezing Fog	-3	5	Cryotech HV1	75	Plate	
18	Freezing Fog	-3	5	Cryotech HV1	75	Plate	
19	Freezing Fog	-3	5	Cryotech LV2	75	Plate	
20	Freezing Fog	-3	5	Cryotech LV2	75	Plate	
21	Freezing Fog	-3	5	Cryotech HV1	50	Plate	
22	Freezing Fog	-3	5	Cryotech HV1	50	Plate	
23	Freezing Fog	-3	5	Cryotech LV2	50	Plate	
24	Freezing Fog	-3	5	Cryotech LV2	50	Plate	
25	Freezing Fog	-14	2	Cryotech HV1	100	Plate	
26	Freezing Fog	-14	2	Cryotech HV1	100	Plate	
27	Freezing Fog	-14	2	Cryotech LV2	100	Plate	
28	Freezing Fog	-14	2	Cryotech LV2	100	Plate	
29	Freezing Fog	-14	2	Cryotech HV1	75	Plate	
30	Freezing Fog	-14	2	Cryotech HV1	75	Plate	
31	Freezing Fog	-14	2	Cryotech LV2	75	Plate	
32	Freezing Fog	-14	2	Cryotech LV2	75	Plate	
33	Freezing Fog	-14	5	Cryotech HV1	100	Plate	
34	Freezing Fog	-14	5	Cryotech HV1	100	Plate	
35	Freezing Fog	-14	5	Cryotech LV2	100	Plate	
36	Freezing Fog	-14	5	Cryotech LV2	100	Plate	
37	Freezing Fog	-14	5	Cryotech HV1	75	Plate	
38	Freezing Fog	-14	5	Cryotech HV1	75	Plate	
39	Freezing Fog	-14	5	Cryotech LV2	75	Plate	
40	Freezing Fog	-14	5	Cryotech LV2	75	Plate	
41	Freezing Fog	-25	2	Cryotech HV1	100	Plate	
42	Freezing Fog	-25	2	Cryotech HV1	100	Plate	
43	Freezing Fog	-25	2	Cryotech LV2	100	Plate	
44	Freezing Fog	-25	2	Cryotech LV2	100	Plate	
45	Freezing Fog	-25	5	Cryotech HV1	100	Plate	
46	Freezing Fog	-25	5	Cryotech HV1	100	Plate	
47	Freezing Fog	-25	5	Cryotech LV2	100	Plate	
48	Freezing Fog	-25	5	Cryotech LV2	100	Plate	

TABLE 1: ENDURANCE TIME TEST PLAN (cont'd)

Test #	Precipitation Type	Temp (°C)	Precip. Rate (g/dm²/h)	Fluid Name	Fluid Dilution (%)	Test Surface	Comments
49	Light Freezing Rain	-3	13	Cryotech HV1	100	Plate	
50	Light Freezing Rain	-3	13	Cryotech HV1	100	Plate	
51	Light Freezing Rain	-3	13	Cryotech LV2	100	Plate	
52	Light Freezing Rain	-3	13	Cryotech LV2	100	Plate	
53	Light Freezing Rain	-3	13	Cryotech HV1	75	Plate	
54	Light Freezing Rain	-3	13	Cryotech HV1	75	Plate	
55	Light Freezing Rain	-3	13	Cryotech LV2	75	Plate	
56	Light Freezing Rain	-3	13	Cryotech LV2	75	Plate	
57	Light Freezing Rain	-3	13	Cryotech HV1	50	Plate	
58	Light Freezing Rain	-3	13	Cryotech HV1	50	Plate	
59	Light Freezing Rain	-3	13	Cryotech LV2	50	Plate	
60	Light Freezing Rain	-3	13	Cryotech LV2	50	Plate	
61	Light Freezing Rain	-3	25	Cryotech HV1	100	Plate	
62	Light Freezing Rain	-3	25	Cryotech HV1	100	Plate	
63	Light Freezing Rain	-3	25	Cryotech LV2	100	Plate	
64	Light Freezing Rain	-3	25	Cryotech LV2	100	Plate	
65	Light Freezing Rain	-3	25	Cryotech HV1	75	Plate	
66	Light Freezing Rain	-3	25	Cryotech HV1	75	Plate	
67	Light Freezing Rain	-3	25	Cryotech LV2	75	Plate	
68	Light Freezing Rain	-3	25	Cryotech LV2	75	Plate	
69	Light Freezing Rain	-3	25	Cryotech HV1	50	Plate	
70	Light Freezing Rain	-3	25	Cryotech HV1	50	Plate	
71	Light Freezing Rain	-3	25	Cryotech LV2	50	Plate	
72	Light Freezing Rain	-3	25	Cryotech LV2	50	Plate	
73	Light Freezing Rain	-10	13	Cryotech HV1	100	Plate	
74	Light Freezing Rain	-10	13	Cryotech HV1	100	Plate	
75	Light Freezing Rain	-10	13	Cryotech LV2	100	Plate	
76	Light Freezing Rain	-10	13	Cryotech LV2	100	Plate	
77	Light Freezing Rain	-10	13	Cryotech HV1	75	Plate	
78	Light Freezing Rain	-10	13	Cryotech HV1	75	Plate	
79	Light Freezing Rain	-10	13	Cryotech LV2	75	Plate	
80	Light Freezing Rain	-10	13	Cryotech LV2	75	Plate	
81	Light Freezing Rain	-10	25	Cryotech HV1	100	Plate	
82	Light Freezing Rain	-10	25	Cryotech HV1	100	Plate	
83	Light Freezing Rain	-10	25	Cryotech LV2	100	Plate	
84	Light Freezing Rain	-10	25	Cryotech LV2	100	Plate	
85	Light Freezing Rain	-10	25	Cryotech HV1	75	Plate	
86	Light Freezing Rain	-10	25	Cryotech HV1	75	Plate	
87	Light Freezing Rain	-10	25	Cryotech LV2	75	Plate	
88	Light Freezing Rain	-10	25	Cryotech LV2	75	Plate	
89	Freezing Drizzle	-3	5	Cryotech HV1	100	Plate	
90	Freezing Drizzle	-3	5	Cryotech HV1	100	Plate	
91	Freezing Drizzle	-3	5	Cryotech LV2	100	Plate	
92	Freezing Drizzle	-3	5	Cryotech LV2	100	Plate	
93	Freezing Drizzle	-3	5	Cryotech HV1	75	Plate	
94	Freezing Drizzle	-3	5	Cryotech HV1	75	Plate	
95	Freezing Drizzle	-3	5	Cryotech LV2	75	Plate	
96	Freezing Drizzle	-3	5	Cryotech LV2	75	Plate	

OVERALL PROGRAM OF TESTS AT NRC, APRIL 2011

TABLE 1: ENDURANCE TIME TEST PLAN (cont'd)

Test #	Precipitation Type	Temp (°C)	Precip. Rate (g/dm²/h)	Fluid Name	Fluid Dilution (%)	Test Surface	Comments
97	Freezing Drizzle	-3	5	Cryotech HV1	50	Plate	
98	Freezing Drizzle	-3	5	Cryotech HV1	50	Plate	
99	Freezing Drizzle	-3	5	Cryotech LV2	50	Plate	
100	Freezing Drizzle	-3	5	Cryotech LV2	50	Plate	
101	Freezing Drizzle	-3	13	Cryotech HV1	100	Plate	
102	Freezing Drizzle	-3	13	Cryotech HV1	100	Plate	
103	Freezing Drizzle	-3	13	Cryotech LV2	100	Plate	
104	Freezing Drizzle	-3	13	Cryotech LV2	100	Plate	
105	Freezing Drizzle	-3	13	Cryotech HV1	75	Plate	
106	Freezing Drizzle	-3	13	Cryotech HV1	75	Plate	
107	Freezing Drizzle	-3	13	Cryotech LV2	75	Plate	
108	Freezing Drizzle	-3	13	Cryotech LV2	75	Plate	
109	Freezing Drizzle	-3	13	Cryotech HV1	50	Plate	
110	Freezing Drizzle	-3	13	Cryotech HV1	50	Plate	
111	Freezing Drizzle	-3	13	Cryotech LV2	50	Plate	
112	Freezing Drizzle	-3	13	Cryotech LV2	50	Plate	
113	Freezing Drizzle	-10	5	Cryotech HV1	100	Plate	
114	Freezing Drizzle	-10	5	Cryotech HV1	100	Plate	
115	Freezing Drizzle	-10	5	Cryotech LV2	100	Plate	
116	Freezing Drizzle	-10	5	Cryotech LV2	100	Plate	
117	Freezing Drizzle	-10	5	Cryotech HV1	75	Plate	
118	Freezing Drizzle	-10	5	Cryotech HV1	75	Plate	
119	Freezing Drizzle	-10	5	Cryotech LV2	75	Plate	
120	Freezing Drizzle	-10	5	Cryotech LV2	75	Plate	
121	Freezing Drizzle	-10	13	Cryotech HV1	100	Plate	
122	Freezing Drizzle	-10	13	Cryotech HV1	100	Plate	
123	Freezing Drizzle	-10	13	Cryotech LV2	100	Plate	
124	Freezing Drizzle	-10	13	Cryotech LV2	100	Plate	
125	Freezing Drizzle	-10	13	Cryotech HV1	75	Plate	
126	Freezing Drizzle	-10	13	Cryotech HV1	75	Plate	
127	Freezing Drizzle	-10	13	Cryotech LV2	75	Plate	
128	Freezing Drizzle	-10	13	Cryotech LV2	75	Plate	
129	Cold Soak Box	1	5	Cryotech HV1	100	Box	
130	Cold Soak Box	1	5	Cryotech HV1	100	Box	
131	Cold Soak Box	1	5	Cryotech LV2	100	Box	
132	Cold Soak Box	1	5	Cryotech LV2	100	Box	
133	Cold Soak Box	1	5	Cryotech HV1	75	Box	
134	Cold Soak Box	1	5	Cryotech HV1	75	Box	
135	Cold Soak Box	1	5	Cryotech LV2	75	Box	
136	Cold Soak Box	1	5	Cryotech LV2	75	Box	
137	Cold Soak Box	1	75	Cryotech HV1	100	Box	
138	Cold Soak Box	1	75	Cryotech HV1	100	Box	
139	Cold Soak Box	1	75	Cryotech LV2	100	Box	
140	Cold Soak Box	1	75	Cryotech LV2	100	Box	
141	Cold Soak Box	1	75	Cryotech HV1	75	Box	
142	Cold Soak Box	1	75	Cryotech HV1	75	Box	
143	Cold Soak Box	1	75	Cryotech LV2	75	Box	
144	Cold Soak Box	1	75	Cryotech LV2	75	Box	

TABLE 2: FLUID THICKNESS TEST PLAN

Test #	Fluid	Fluid Dilution	Test Surface	Ambient Air Temperature
TH1	Cryotech HV1	100/0	Std. Aluminum	-3°C
TH2	Cryotech HV1	100/0	Std. Aluminum	-3°C
TH3	Cryotech HV1	75/25	Std. Aluminum	-3°C
TH4	Cryotech HV1	75/25	Std. Aluminum	-3°C
TH5	Cryotech HV1	50/50	Std. Aluminum	-3°C
TH6	Cryotech HV1	50/50	Std. Aluminum	-3°C
TH7	Cryotech LV2	100/0	Std. Aluminum	-3°C
TH8	Cryotech LV2	100/0	Std. Aluminum	-3°C
TH9	Cryotech LV2	75/25	Std. Aluminum	-3°C
TH10	Cryotech LV2	75/25	Std. Aluminum	-3°C
TH11	Cryotech LV2	50/50	Std. Aluminum	-3°C
TH12	Cryotech LV2	50/50	Std. Aluminum	-3°C

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 2 minutes, 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

TABLE 3: ICE PHOBIC FLUID THICKNESS TEST PLAN

Test #	Fluid Manufacturer	Fluid Dilution	Test Surface	Ambient Air Temperature
PH-TH1	Dow UCAR ADF (EG)	10°B (B=17.0)	Std. Aluminum	-3°C
PH-TH2	Dow UCAR ADF (EG)	10°B (B=17.0)	Nusil 7 / Nusil 8	-3°C
PH-TH3	Dow UCAR ADF (EG)	10°B (B=17.0)	Nusil 9 / Nusil 10	-3°C
PH-TH4	Dow UCAR ADF (EG)	32°B (B=30.0)	Std. Aluminum	-3°C
PH-TH5	Dow UCAR ADF (EG)	32°B (B=30.0)	Nusil 7 / Nusil 8	-3°C
PH-TH6	Dow UCAR ADF (EG)	32°B (B=30.0)	Nusil 9 / Nusil 10	-3°C
PH-TH7	Kilfrost ABC-S Plus	100/0	Std. Aluminum	-3°C
PH-TH8	Kilfrost ABC-S Plus	100/0	Nusil 7 / Nusil 8	-3°C
PH-TH9	Kilfrost ABC-S Plus	100/0	Nusil 9 / Nusil 10	-3°C

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 2 minutes, 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

TABLE 4: ICE PHOBIC ENDURANCE TIME TEST PLAN

Test #	Precipitation Type	Temp (°C)	Precip. Rate (g/dm²/h)	Fluid Name	Fluid Dilution	Test Surface	Measurements
PH1	Light Freezing Rain	-10	13 (25)	Octagon Octaflo EF	10°B(B=27.0)	Standard Plate	Thickness at 5 mins, Brix at failure
PH2	Light Freezing Rain	-10	13 (25)	Octagon Octaflo EF	10°B(B=27.0)	Nusil 7 / Nusil 8	Thickness at 5 mins, Brix at failure
PH3	Light Freezing Rain	-10	13 (25)	Octagon Octaflo EF	10°B(B=27.0)	Nusil 9 / Nusil 10	Thickness at 5 mins, Brix at failure
PH4	Freezing Drizzle	-10	13 (5)	Kilfrost ABC-S+	100/0	Standard Plate	Brix/thickness every 15 mins
PH5	Freezing Drizzle	-10	13 (5)	Kilfrost ABC-S+	100/0	Nusil 7 / Nusil 8	Brix/thickness every 15 mins
PH6	Freezing Drizzle	-10	13 (5)	Kilfrost ABC-S+	100/0	Nusil 9 / Nusil 10	Brix/thickness every 15 mins
PH7	Light Freezing Rain	-10	25 (13)	Dow UCAR EG106	100/0	Standard Plate	Thickness at 5 mins, Brix at failure
PH8	Light Freezing Rain	-10	25 (13)	Dow UCAR EG106	100/0	Nusil 7 / Nusil 8	Thickness at 5 mins, Brix at failure
PH9	Light Freezing Rain	-10	25 (13)	Dow UCAR EG106	100/0	Nusil 9 / Nusil 10	Thickness at 5 mins, Brix at failure
PH10	Light Freezing Rain	-10	13 (25)	Kilfrost ABC-S+	75/25	Standard Plate	Thickness at 5 mins, Brix at failure
PH11	Light Freezing Rain	-10	13 (25)	Kilfrost ABC-S+	75/25	Nusil 7 / Nusil 8	Thickness at 5 mins, Brix at failure
PH12	Light Freezing Rain	-10	13 (25)	Kilfrost ABC-S+	75/25	Nusil 9 / Nusil 10	Thickness at 5 mins, Brix at failure
PH13	Freezing Drizzle	-3	5 (13)	Dow UCAR ADF (EG)	10°B(B=17.0)	Standard Plate	Thickness at 5 mins, Brix at failure
PH14	Freezing Drizzle	-3	5 (13)	Dow UCAR ADF (EG)	10°B(B=17.0)	Nusil 7 / Nusil 8	Thickness at 5 mins, Brix at failure
PH15	Freezing Drizzle	-3	5 (13)	Dow UCAR ADF (EG)	10°B(B=17.0)	Nusil 9 / Nusil 10	Thickness at 5 mins, Brix at failure
PH16	Freezing Drizzle	-3	13 (5)	Kilfrost ABC-S+	50/50	Standard Plate	Thickness at 5 mins, Brix at failure
PH17	Freezing Drizzle	-3	13 (5)	Kilfrost ABC-S+	50/50	Nusil 7 / Nusil 8	Thickness at 5 mins, Brix at failure
PH18	Freezing Drizzle	-3	13 (5)	Kilfrost ABC-S+	50/50	Nusil 9 / Nusil 10	Thickness at 5 mins, Brix at failure

Note: Type I tests should be conducted using 1 L of fluid applied at 20°C

TABLE 5: ICE PHOBIC ADHERENCE TEST PLAN

Test #	Precipitation Type	Temp (°C)	Precip. Rate (g/dm²/h)	Fluid Name	Fluid Dilution	Test Surface	Comments
PH-AD1	Light Freezing Rain	-10	13	No fluid	n/a	Standard Plate	Measure adherence
PH-AD2	Light Freezing Rain	-10	13	No fluid	n/a	Nusil 7 / Nusil 8	Measure adherence
PH-AD3	Light Freezing Rain	-10	13	No fluid	n/a	Nusil 9 / Nusil 10	Measure adherence

TABLE 6: HANGAR TEST PLAN

Test #	Precipitation Type	Temp (°C)	Precip. Rate (g/dm²/h)	Fluid	Fluid Dilution	Test Surface	Measurements	Comments
HG1	Freezing Drizzle	-3	5	Cryotech HV1	75/25	Std. Plate	Thickness at 5 mins, Brix at failure	Fluid/plate at OAT
HG2	Freezing Drizzle	-3	5	Cryotech HV1	75/25	Warm Plate	Thickness at 5 mins, Brix at failure	Fluid/plate @ 20°C
HG3	Freezing Drizzle	-3	5	Cryotech HV1	50/50	Std. Plate	Thickness at 5 mins, Brix at failure	Fluid/plate at OAT
HG4	Freezing Drizzle	-3	5	Cryotech HV1	50/50	Warm Plate	Thickness at 5 mins, Brix at failure	Fluid/plate @ 20°C
HG5	Freezing Drizzle	-3	13	Cryotech LV2	100/0	Std. Plate	Thickness at 5 mins, Brix at failure	Fluid/plate at OAT
HG6	Freezing Drizzle	-3	13	Cryotech LV2	100/0	Warm Plate	Thickness at 5 mins, Brix at failure	Fluid/plate @ 20°C
HG7	Freezing Drizzle	-10	5	Cryotech HV1	100/0	Std. Plate	Thickness at 5 mins, Brix at failure	Fluid/plate at OAT
HG8	Freezing Drizzle	-10	5	Cryotech HV1	100/0	Warm Plate	Thickness at 5 mins, Brix at failure	Fluid/plate @ 20°C
HG9	Freezing Drizzle	-10	13	Kilfrost ABC-S+	100/0	Std. Plate	Thickness at 5 mins, Brix at failure	Fluid/plate at OAT
HG10	Freezing Drizzle	-10	13	Kilfrost ABC-S+	100/0	Warm Plate	Thickness at 5 mins, Brix at failure	Fluid/plate @ 20°C
HG11	Light Freezing Rain	-3	13	Dow EG106	100/0	Std. Plate	Brix/thickness/plate temp every 15 mins	Fluid/plate at OAT
HG12	Light Freezing Rain	-3	13	Dow EG106	100/0	Warm Plate	Brix/thickness/plate temp every 15 mins	Fluid/plate @ 20°C
HG13	Light Freezing Rain	-3	25	Clariant Launch	100/0	Std. Plate	Thickness at 5 mins, Brix at failure	Fluid/plate at OAT
HG14	Light Freezing Rain	-3	25	Clariant Launch	100/0	Warm Plate	Thickness at 5 mins, Brix at failure	Fluid/plate @ 20°C
HG15	Light Freezing Rain	-10	13	Dow EG106	100/0	Std. Plate	Thickness at 5 mins, Brix at failure	Fluid/plate at OAT
HG16	Light Freezing Rain	-10	13	Dow EG106	100/0	Warm Plate	Thickness at 5 mins, Brix at failure	Fluid/plate @ 20°C
HG17	Light Freezing Rain	-10	25	Kilfrost ABC-S+	75/25	Std. Plate	Thickness at 5 mins, Brix at failure	Fluid/plate at OAT
HG18	Light Freezing Rain	-10	25	Kilfrost ABC-S+	75/25	Warm Plate	Thickness at 5 mins, Brix at failure	Fluid/plate @ 20°C
HG19	Light Freezing Rain	-10	25	Cryotech HV1	75/25	Std. Plate	Thickness at 5 mins, Brix at failure	Fluid/plate at OAT
HG20	Light Freezing Rain	-10	25	Cryotech HV1	75/25	Warm Plate	Thickness at 5 mins, Brix at failure	Fluid/plate @ 20°C

TABLE 7: DEPLOYED FLAPS TEST PLAN

Test #	Precipitation Type	Temp (°C)	Precip. Rate (g/dm²/h)	Fluid	Fluid Dilution	Test Surface	Measurements
DF1	Freezing Drizzle	-3	5	Cryotech HV1	100/0	Plate (10°)	Thickness at 5 mins, Brix at failure
DF2	Freezing Drizzle	-3	5	Cryotech HV1	100/0	Plate (20°)	Thickness at 5 mins, Brix at failure
DF3	Freezing Drizzle	-3	5	Cryotech HV1	100/0	Plate (35°)	Thickness at 5 mins, Brix at failure
DF4	Freezing Drizzle	-3	5	Cryotech HV1	100/0	Nested Plate (20°)	Thickness at 5 mins, Brix at failure
DF5	Freezing Drizzle	-3	5	Cryotech HV1	100/0	Nested Plate (35°)	Thickness at 5 mins, Brix at failure
DF6	Freezing Drizzle	-3	13	Cryotech LV2	100/0	Plate (10°)	Brix/thickness every 15 mins
DF7	Freezing Drizzle	-3	13	Cryotech LV2	100/0	Plate (35°)	Brix/thickness every 15 mins
DF8	Freezing Drizzle	-3	13	Cryotech LV2	100/0	Nested Plate (35°)	Brix/thickness every 15 mins
DF9	Freezing Drizzle	-10	5	Cryotech HV1	75/25	Plate (10°)	Brix/thickness every 15 mins
DF10	Freezing Drizzle	-10	5	Cryotech HV1	75/25	Plate (20°)	Brix/thickness every 15 mins
DF11	Freezing Drizzle	-10	5	Cryotech HV1	75/25	Nested Plate (20°)	Brix/thickness every 15 mins
DF12	Freezing Drizzle	-10	13	Kilfrost ABC-S+	100/0	Plate (10°)	Thickness at 5 mins, Brix at failure
DF13	Freezing Drizzle	-10	13	Kilfrost ABC-S+	100/0	Plate (35°)	Thickness at 5 mins, Brix at failure
DF14	Freezing Drizzle	-10	13	Kilfrost ABC-S+	100/0	Nested Plate (35°)	Thickness at 5 mins, Brix at failure
DF15	Light Freezing Rain	-3	13	Dow Endurance EG106	100/0	Plate (10°)	Thickness at 5 mins, Brix at failure
DF16	Light Freezing Rain	-3	13	Dow Endurance EG106	100/0	Plate (35°)	Thickness at 5 mins, Brix at failure
DF17	Light Freezing Rain	-3	13	Dow Endurance EG106	100/0	Nested Plate (35°)	Thickness at 5 mins, Brix at failure
DF18	Light Freezing Rain	-3	25	Clariant Launch	100/0	Plate (10°)	Thickness at 5 mins, Brix at failure
DF19	Light Freezing Rain	-3	25	Clariant Launch	100/0	Plate (20°)	Thickness at 5 mins, Brix at failure
DF20	Light Freezing Rain	-3	25	Clariant Launch	100/0	Nested Plate (20°)	Thickness at 5 mins, Brix at failure
DF21	Light Freezing Rain	-10	13	Dow Endurance EG106	100/0	Plate (10°)	Thickness at 5 mins, Brix at failure
DF22	Light Freezing Rain	-10	13	Dow Endurance EG106	100/0	Plate (35°)	Thickness at 5 mins, Brix at failure
DF23	Light Freezing Rain	-10	13	Dow Endurance EG106	100/0	Nested Plate (35°)	Thickness at 5 mins, Brix at failure
DF24	Light Freezing Rain	-10	25	Kilfrost ABC-S+	75/25	Plate (10°)	Thickness at 5 mins, Brix at failure
DF25	Light Freezing Rain	-10	25	Kilfrost ABC-S+	75/25	Plate (35°)	Thickness at 5 mins, Brix at failure
DF26	Light Freezing Rain	-10	25	Kilfrost ABC-S+	75/25	Nested Plate (35°)	Thickness at 5 mins, Brix at failure

Note: For nested flap tests, pour 1 L on 10° plate, then pour 1 L on nested 20°/35° plate

TABLE 7: DEPLOYED FLAPS TEST PLAN (CONT'D)

Test #	Precipitation Type	Temp (°C)	Precip. Rate ($g/dm^2/h$)	Fluid	Fluid Dilution	Test Surface	Measurements
DF27	Freezing Fog	-3	2	Cryotech HV1	50/50	Plate (10°)	Thickness at 5 mins, Brix at failure
DF28	Freezing Fog	-3	2	Cryotech HV1	50/50	Plate (20°)	Thickness at 5 mins, Brix at failure
DF29	Freezing Fog	-3	2	Cryotech HV1	50/50	Nested Plate (20°)	Thickness at 5 mins, Brix at failure
DF30	Freezing Fog	-3	5	Cryotech LV2	50/50	Plate (10°)	Thickness at 5 mins, Brix at failure
DF31	Freezing Fog	-3	5	Cryotech LV2	50/50	Plate (35°)	Thickness at 5 mins, Brix at failure
DF32	Freezing Fog	-3	5	Cryotech LV2	50/50	Nested Plate (35°)	Thickness at 5 mins, Brix at failure
DF33	Freezing Fog	-14	2	Kilfrost ABC-S+	100/0	Plate (10°)	Thickness at 5 mins, Brix at failure
DF34	Freezing Fog	-14	2	Kilfrost ABC-S+	100/0	Plate (35°)	Thickness at 5 mins, Brix at failure
DF35	Freezing Fog	-14	2	Kilfrost ABC-S+	100/0	Nested Plate (35°)	Thickness at 5 mins, Brix at failure
DF36	Freezing Fog	-14	5	Clariant Launch	100/0	Plate (10°)	Thickness at 5 mins, Brix at failure
DF37	Freezing Fog	-14	5	Clariant Launch	100/0	Plate (35°)	Thickness at 5 mins, Brix at failure
DF38	Freezing Fog	-14	5	Clariant Launch	100/0	Nested Plate (35°)	Thickness at 5 mins, Brix at failure
DF39	Freezing Fog	-25	2	Dow Endurance EG106	100/0	Plate (10°)	Thickness at 5 mins, Brix at failure
DF40	Freezing Fog	-25	2	Dow Endurance EG106	100/0	Plate (20°)	Thickness at 5 mins, Brix at failure
DF41	Freezing Fog	-25	2	Dow Endurance EG106	100/0	Nested Plate (20°)	Thickness at 5 mins, Brix at failure
DF42	Freezing Fog	-25	5	Kilfrost ABC-S+	100/0	Plate (10°)	Thickness at 5 mins, Brix at failure
DF43	Freezing Fog	-25	5	Kilfrost ABC-S+	100/0	Plate (35°)	Thickness at 5 mins, Brix at failure
DF44	Freezing Fog	-25	5	Kilfrost ABC-S+	100/0	Nested Plate (35°)	Thickness at 5 mins, Brix at failure

Note: For nested flap tests, pour 1 L on 10° plate, then pour 1 L on nested 20°/35° plate

TABLE 8: HEATED LEADING EDGE TEST PLAN

Test #	Precipitation Type	Temp (°C)	Precip. Rate ($g/dm^2/h$)	Fluid Brand	Dilution	Test Surface	Measurements
LE-1	Light Freezing Rain	-10	25	Cryotech HV1	100/0	Standard Plate	Brix/thickness/plate temp every 15 mins
LE-2	Light Freezing Rain	-10	25	Cryotech HV1	100/0	Heated Box	Brix/thickness/plate temp every 15 mins
LE-3	Light Freezing Rain	-10	13	Cryotech LV2	100/0	Standard Plate	Brix/thickness/plate temp every 15 mins
LE-4	Light Freezing Rain	-10	13	Cryotech LV2	100/0	Heated Box (100°)	Brix/thickness/plate temp every 15 mins
LE-5	Freezing Drizzle	-10	13	Dow EG106	100/0	Standard Plate	Thickness at 5 mins, Brix at failure
LE-6	Freezing Drizzle	-10	13	Dow EG106	100/0	Heated Box	Thickness at 5 mins, Brix at failure
LE-7*	Freezing Drizzle	-10	5	Kilfrost ABC-S+	100/0	Standard Plate	Thickness at 5 mins, Brix at failure
LE-8*	Freezing Drizzle	-10	5	Kilfrost ABC-S+	100/0	Heated Box	Thickness at 5 mins, Brix at failure

* Optional test, do only if time permitting

Note: For heated box tests, apply fluid, wait 5 minutes, heat box.

OVERALL PROGRAM OF TESTS AT NRC, APRIL 2011

TABLE 9: RUNWAY DEICER TEST PLAN

Test #	Precipitation Type	Temp (°C)	Precip. Rate (g/dm²/h)	Fluid Brand	Dilution	RWD Conc. / Qty*	Comments	Measurements
RWD1	Freezing Drizzle	-3	5	Cryotech HV1	75	N/A		Thickness at 5 mins, Brix at failure
RWD2	Freezing Drizzle	-3	5	Cryotech HV1	75	25%/1.5mL	Apply RWD then ADF	Thickness at 5 mins, Brix at failure
RWD3	Freezing Drizzle	-3	5	Cryotech HV1	75	25%/1.5mL	Apply ADF then RWD	Thickness at 5 mins, Brix at failure
RWD4	Freezing Drizzle	-3	13	Cryotech LV2	100	N/A		Thickness at 5 mins, Brix at failure
RWD5	Freezing Drizzle	-3	13	Cryotech LV2	100	5%/1.5mL	Apply RWD then ADF	Thickness at 5 mins, Brix at failure
RWD6	Freezing Drizzle	-3	13	Cryotech LV2	100	5%/1.5mL	Apply ADF then RWD	Thickness at 5 mins, Brix at failure
RWD7	Freezing Drizzle	-10	5	Cryotech HV1	100	N/A		Thickness at 5 mins, Brix at failure
RWD8	Freezing Drizzle	-10	5	Cryotech HV1	100	25%/1.5mL	Apply RWD then ADF	Thickness at 5 mins, Brix at failure
RWD9	Freezing Drizzle	-10	5	Cryotech HV1	100	25%/1.5mL	Apply ADF then RWD	Thickness at 5 mins, Brix at failure
RWD10	Freezing Drizzle	-10	13	Kilfrost ABC-S+	100	N/A		Thickness at 5 mins, Brix at failure
RWD11	Freezing Drizzle	-10	13	Kilfrost ABC-S+	100	25%/1.5mL	Apply RWD then ADF	Thickness at 5 mins, Brix at failure
RWD12	Freezing Drizzle	-10	13	Kilfrost ABC-S+	100	5%/1.5mL	Apply RWD then ADF	Thickness at 5 mins, Brix at failure
RWD13	Freezing Drizzle	-10	13	Kilfrost ABC-S+	100	25%/1.5mL	Apply ADF then RWD	Thickness at 5 mins, Brix at failure
RWD14	Freezing Drizzle	-10	13	Kilfrost ABC-S+	100	5%/1.5mL	Apply ADF then RWD	Thickness at 5 mins, Brix at failure
RWD15	Light Freezing Rain	-3	13	Clariant Flight	100	N/A		Thickness at 5 mins, Brix at failure
RWD16	Light Freezing Rain	-3	13	Clariant Flight	100	5%/1.5mL	Apply RWD then ADF	Thickness at 5 mins, Brix at failure
RWD17	Light Freezing Rain	-3	13	Clariant Flight	100	5%/1.5mL	Apply ADF then RWD	Thickness at 5 mins, Brix at failure
RWD18	Light Freezing Rain	-3	25	Clariant Launch	100	N/A		Thickness at 5 mins, Brix at failure
RWD19	Light Freezing Rain	-3	25	Clariant Launch	100	25%/1.5mL	Apply RWD then ADF	Thickness at 5 mins, Brix at failure
RWD20	Light Freezing Rain	-3	25	Clariant Launch	100	25%/1.5mL	Apply ADF then RWD	Thickness at 5 mins, Brix at failure
RWD21	Light Freezing Rain	-10	13	Dow Endurance EG106	100	N/A		Thickness at 5 mins, Brix at failure
RWD22	Light Freezing Rain	-10	13	Dow Endurance EG106	100	5%/1.5mL	Apply RWD then ADF	Thickness at 5 mins, Brix at failure
RWD23	Light Freezing Rain	-10	13	Dow Endurance EG106	100	5%/1.5mL	Apply ADF then RWD	Thickness at 5 mins, Brix at failure
RWD24	Light Freezing Rain	-10	25	Kilfrost ABC-S+	75	N/A		Brix/thickness every 15 mins
RWD25	Light Freezing Rain	-10	25	Kilfrost ABC-S+	75	25%/1.5mL	Apply RWD then ADF	Brix/thickness every 15 mins
RWD26	Light Freezing Rain	-10	25	Kilfrost ABC-S+	75	5%/1.5mL	Apply RWD then ADF	Brix/thickness every 15 mins
RWD27	Light Freezing Rain	-10	25	Kilfrost ABC-S+	75	25%/1.5mL	Apply ADF then RWD	Brix/thickness every 15 mins
RWD28	Light Freezing Rain	-10	25	Kilfrost ABC-S+	75	5%/1.5mL	Apply ADF then RWD	Brix/thickness every 15 mins

*Concentrations may be changed during testing, depending on initial results.

OVERALL PROGRAM OF TESTS AT NRC, APRIL 2011

TABLE 10: ICE PELLETS TEST PLAN

Test #	Fluid Type	Fluid Name	Fluid Dilution	Precip. Type	Ambient Temp (°C)	Fluid Temp (°C)	Precip. Rate (g/dm²/h)	Target Allowance Time (min)	Test Surface
IP1	IV	Kilfrost ABC-S+	Neat	IP-	-5	-5	25	50+5	Plate (10°)
IP2	IV	Octagon Max-Flight 04	Neat	IP-	-5	-5	25	50+5	Plate (10°)
IP3	IV	Dow FlightGuard AD-49	Neat	IP-	-5	-5	25	50+5	Plate (10°)
IP4	IV	Kilfrost ABC-S+	Neat	IP-	-5	-5	25	25+5	Plate (35°)
IP5	IV	Kilfrost ABC-S+	Neat	IP	-5	-5	75	25+5	Plate (10°)
IP6	IV	Octagon Max-Flight 04	Neat	IP	-5	-5	75	25+5	Plate (10°)
IP7	IV	Dow FlightGuard AD-49	Neat	IP	-5	-5	75	25+5	Plate (10°)
IP8	IV	Dow AD-49	Neat	IP	-5	-5	75	13+5	Plate (35°)

Notes:
- Tests will be conducted at small end of chamber during Freezing Fog, -3°C conditions
- Tests should be run at least 5 minutes longer than target allowance time
- Measure/record fluid thickness at t=5 minutes, fluid Brix at failure, and adherence if it occurs.

TABLE 11: TASK ASSIGNMENTS BY TEST CONDITION

	FREEZING FOG (-3)	FREEZING FOG (-14,-25)	FREEZING RAIN (-3)	FREEZING RAIN (-10)	FREEZING DRIZZLE (-3)	FREEZING DRIZZLE (-10, 13)	FREEZING DRIZZLE (-10, 5)	COLD SOAK WING (+1)
SB	Rate Mgr	Rate Mgr	Rate Mgr	Rate Mgr	Rate Mgr	Rate Mgr	Rate Mgr	Rate Mgr
YOW	Rate Ast	Rate Ast	Rate Ast	Rate Ast	Rate Ast	Rate Ast	Rate Ast	Rate Ast
JD	HOT Mgr DF Mgr	HOT Mgr DF Mgr	HOT Mgr	HOT Mgr	HOT Mgr	HOT Mgr	HOT Mgr	HOT Mgr
VZ	IP Ast Sprayer Mgr	HOT Ast Sprayer Mgr	HOT Ast Sprayer Mgr	HOT Ast Sprayer Mgr	HOT Ast Sprayer Mgr	HOT Ast Sprayer Mgr	HOT Ast Sprayer Mgr	CS Box Prep Sprayer Mgr
MR	IP Mgr	N/A	DF Mgr HG Mgr TH Mgr RDF Mgr	DF Mgr HG Mgr LE Mgr PH Mgr RDF Mgr	DF Mgr PH Mgr HG Mgr RDF Mgr	DF Mgr HG Mgr LE Mgr PH Mgr RDF Mgr	DF Mgr HG Mgr LE Mgr RDF Mgr	CS Box Mgr
DY	MR Ast	N/A	MR Ast	MR Ast	MR Ast	MR Ast	MR Ast	CS Box Prep
HOT	X	X	X	X	X	X	X	X
Thickness	-	-	X	-	-	-	-	-
Ice Phobic	-	-	-	X	X	X	-	-
Hangar	-	-	X	X	X	X	X	-
Depl. Flaps	X	X	X	X	X	X	X	-
Heated LE	-	-	-	X	-	X	X	-
Runway	-	-	X	X	X	X	X	-
IP	X	-	-	-	-	-	-	-
Sprayer	X	X	X	X	X	X	X	X

*When YOW2 is not needed on specific projects, he will be a second Rate Assistant and Fluid Assistant

TABLE 12: LIST OF FLUIDS

TYPE I															
Fluid Name	**Batch #**	**Fluid Type**	**FFP**	**Brix**	**Litres Required per Project**										
					ET	**TH**	**PH-TH**	**PH-ET**	**PH-AD**	**HG**	**DF**	**HLE**	**RD**	**IP**	**ALL**
Dow UCAR ADF (EG)	unknown	I	-13°C	17.0	-	-	3	3	-	-	-	-	-	-	**6**
Dow UCAR ADF (EG)	unknown	I	-35°C	30.0	-	-	3	-	-	-	-	-	-	-	**3**
Octagon Octaflo EF	WL-102009	I	-20°C	27.0	-	-	-	3	-	-	-	-	-	-	**3**
ALL					-	-	**6**	**6**	-	-	-	-	-	-	**12**

TYPE II/IV														
Fluid Name	**Batch #**	**Fluid Type**	**Fluid Dil.**	**Litres Required per Project**										
				ET	**TH**	**PH-TH**	**PH-ET**	**PH-AD**	**HG**	**DF**	**HLE**	**RD**	**IP**	**ALL**
Cryotech HV1	1.035.1600	IV	100/0	32	2	-	-	-	2	7	2	3	-	**48**
Cryotech HV1	1.035.1600	IV	75/25	28	2	-	-	-	4	4	-	3	-	**41**
Cryotech HV1	1.035.1600	IV	50/50	12	2	-	-	-	2	4	-	-	-	**20**
Cryotech LV2	1.042.1430	IV	100/0	32	2	-	-	-	2	4	2	3	-	**45**
Cryotech LV2	1.042.1430	IV	75/25	28	2	-	-	-	-	-	-	-	-	**30**
Cryotech LV2	1.042.1430	IV	50/50	12	2	-	-	-	-	4	-	-	-	**18**
Kilfrost ABC-S+	P/282/12/10	IV	100/0	-	-	3	3	-	2	12	2	5	3	**30**
Kilfrost ABC-S+	P/282/12/10	IV	75/25	-	-	-	3	-	2	4	-	5	-	**14**
Kilfrost ABC-S+	P/282/12/10	IV	50/50	-	-	-	3	-	-	-	-	-	-	**3**
Clariant Flight	DEG4143041	II	100/0	-	-	-	-	-	-	-	-	3	-	**3**
Clariant Launch	USHA024295	IV	100/0	-	-	-	-	-	2	8	-	3	-	**13**
Dow FlightGuard AD49	UL24	IV	100/0	-	-	-	-	-	-	-	-		3	**3**
Dow Endurance EG106	GMID297182 B5	IV	100/0	-	-	-	3	-	4	12	2	3	-	**24**
Octagon Max-Flight 04	WL122210-4	IV	100/0	-	-	-	-	-	-	-	-		2	**2**
ALL				**144**	**12**	**3**	**12**	**-**	**20**	**59**	**8**	**28**	**8**	**260**

TABLE 13: TYPE I DILUTION TABLES

Octagon Octaflo EF					
FFP (°C)	Test Temp (10°B)	% Glycol	Brix	Glycol for 4 L	Water for 4 L
-9	1	27.5	18.50	1.1	2.9
-13	-3	32.0	21.25	1.3	2.7
-16	-6	36.0	23.50	1.4	2.6
-20	-10	42.0	27.00	1.7	2.3
-35	-25	56.0	34.50	2.2	1.8

Dow UCAR ADF (EG)					
FFP (°C)	Test Temp (10°B)	% Glycol	Brix	Glycol for 4 L	Water for 4 L
-9	1	21.5	13.50	0.9	3.1
-13	-3	26.0	17.00	1.0	3.0
-16	-6	31.0	19.75	1.2	2.8
-20	-10	36.0	22.50	1.4	2.6
-35	-25	49.0	30.00	2.0	2.0

TABLE 14: EQUIPMENT LIST

EQUIPMENT	LOCATION
1L Pour containers (see separate list)	Site
Barrel Opener	Site
Boards for cold-soak test x 13	Site
Brixometer x 3	Site
Buckets for mixing cold-soak fluid*	Site
Clipboards x 10	Site
Close circuit TV camera for rates	Site
Cold-soak box filling stand	Site
Cold-soak boxes (all in good condition)	Site
Collection pans for stands (one per stand)	Site
Electrical Extension Cords x2	Site
Fluids (see Table 12)	Site
Funnels x 4	Site
Gloves - cotton	Site
Gloves - yellow	Site
Hard water chemicals	Site
Inclinometer (yellow level) x 2	Site
Isopropyl x 15	Site
Large digital clock x 2	Site
Marker for Waste x 2	Site
Measuring Cups (various sizes)	Site
Memory Card Reader	Site
Paper Towels (lots)	Site
Plate covers x 16	Site
Plates: 12 w/logging +15 w/o logging	Site
Precipitation Rate Pans x 100	Site
Protective clothing x 6	Site
Rate scales with wiring x 2	Site
Rubber squeegees x 6	Site
Scrapers x 6	Site
Shop Vac + Sump Pump + Tubing	Site
Speed tape	Site
Spreaders: 12-hole x 2	Site
Tape measure (yellow + small)	Site
Temperature probes: immersion x 2	Site
Temperature probes: surface x 2	Site
Test Stand Shims (poker chips)	Site
Test Stands: 2 x 6-position	Site
Test Stands: 9-positions (1,2,3 position stands)	Site
Thermistor Kit + blue USB + black RS232	Site
Thermos x 6 (1 full kit with wood holder)	Site
Thickness Gauges x 4 (both types)	Site
Tote for Waste Fluid	Site
Vise grip (large) for containers	Site
Walkie Talkies x 4	Site
Watmans Paper and conversion charts	Site
Weigh Scale x 2 (sartorius) + wiring	Site
White Billboard for water run-off (large & small)	Site
Yellow Carrying Cases for Pour Containers x 2	Site
Yellow Ice Pic	Site

Cold-soak fluid pump	NRC
Fluid for cold-soak boxes (barrel)	NRC
Rubber Mats	NRC

EQUIPMENT	LOCATION
Ink cartridge for printer	Buy
Nuts to separate plates x 100	Buy
Shelving unit x 1	Buy

Accordian Folder	Office
ARP 5485 and ARP 5945	Office
Chamber Settings	Office
Data Forms printed on Water Phobic Paper	Office
Envelopes (9x12) x box	Office
Hard Drive with Current Project folder	Office
HOT Report + HOT Tables	Office
Mouse for Rate Station	Office
One Temp Logger Laptop (Old Toshiba)	Office
Paper for printer (1 pack)	Office
Pencils (pre-sharpened) + pens + markers	Office
Printer	Office
Rate computer x2	Office
Test Procedures x 2 (1 sided)	Office

SPRAYER DOCUMENTATION PROJECT	LOCATION
MR camera x 1	Site
Camera Suitcase Pack x1	Office

HEATED LE PROJECT	LOCATION
Un-insulated standard LETE box (no logger)	Site
Propane torches with auto trigger (x4)	Buy
Propane refills (x4)	Buy

DEPLOYED FLAPS PROJECT	LOCATION
20° test stand x 2	Site
35° test stand x 2	Site

RUNWAY DEICER PROJECT	LOCATION
RDF Fluid	Site
Spray bottles x2	Site

ICE PHOBIC PROJECT	LOCATION
Ice Phobic Test Plates x2	Site
Adhesion Probe Box	Site

ICE PELLET PROJECT	LOCATION
Ice pellets dispersers x6	Site
Stands for ice pellets dispensing devices x6	Site
Ice Pellet control wires and boxes (all)	Site
IP Styrofoam cont. x20+(10 S/10 L+Extra)	Site
Ice bags	Order
Blenders x6+	Site
Ice pellets sieves	Site
Folding tables	Site
Measuring cups	Site
Wooden Spoons	Site
Rubber Mats	Site

OVERALL PROGRAM OF TESTS AT NRC, APRIL 2011

FIGURE 4: FREEZING PRECIPITATION ENDURANCE TIME DATA FORM

REMEMBER TO SYNCHRONIZE TIME

LOCATION: CEF (Ottawa)	DATE:	RUN NUMBER:	STAND # :

TIME TO FAILURE FOR INDIVIDUAL CROSSHAIRS (real time)

	Plate 1	Plate 2	Plate 3	Plate 4	Plate 5	Plate 6
Time of Fluid Application:						
Initial Plate Temperature (°C) (NEEDS TO BE WITHIN 0.5°C OF AIR TEMP)						
Initial Fluid Temperature (°C) (NEEDS TO BE WITHIN 3°C OF AIR TEMP)						
FLUID NAME/BATCH						
B1 B2 B3						
C1 C2 C3						
D1 D2 D3						
E1 E2 E3						
F1 F2 F3						
TIME TO FIRST PLATE FAILURE WITHIN WORK AREA						
FAILURE CALL (circle)	V. Difficult Difficult. Easy	V. Difficult Difficult. Easy	V. Difficult Difficult. Easy	V. Difficult Difficult. Easy	V. Difficult Difficult. Easy	V. Difficult Difficult. Easy
HRZ. AIR VELOCITY * (circle)	A B C	A B C	A B C	A B C	A B C	A B C

	Plate 7	Plate 8	Plate 9	Plate 10	Plate 11	Plate 12
Time of Fluid Application:						
Initial Plate Temperature (°C) (NEEDS TO BE WITHIN 0.5°C OF AIR TEMP)						
Initial Fluid Temperature (°C) (NEEDS TO BE WITHIN 3°C OF AIR TEMP)						
FLUID NAME/BATCH						
B1 B2 B3						
C1 C2 C3						
D1 D2 D3						
E1 E2 E3						
F1 F2 F3						
TIME TO FIRST PLATE FAILURE WITHIN WORK AREA						
FAILURE CALL (circle)	V. Difficult Difficult. Easy	V. Difficult Difficult. Easy	V. Difficult Difficult. Easy	V. Difficult Difficult. Easy	V. Difficult Difficult. Easy	V. Difficult Difficult. Easy
HRZ. AIR VELOCITY * (circle)	A B C	A B C	A B C	A B C	A B C	A B C

PRECIP (circle): ZF , ZD , ZR-, MOD

AMBIENT TEMPERATURE: ________ °C

COMMENTS: ______________________________

NOTE:
* A: HORIZONTAL AIR VELOCITY ≤ 0.4 m/s
B: 0.4 m/s < HORIZONTAL AIR VELOCITY ≤ 1.0 m/s
C: HORIZONTAL AIR VELOCITY > 1.0 m/s

LEADER / MANAGER: ______________________

FIGURE 5: NRC RATE MANAGEMENT FORM

DATE: ______________________

CONDITION: ______________________ **TECHNICIAN:** ______________________

PAN #	TAB	TIME OUT	1^{st} or 2^{nd} Rate

PAN #	TAB	TIME OUT	1^{st} or 2^{nd} Rate

Retired: 1 2 3 4 5 6 7 8 9 10 11 12

FIGURE 6: FLUID THICKNESS DATA FORM

DATE: ______________ **TEMPERATURE °C (beg.):** ______________ **PERFORMED BY:** ______________

TEST #: _______to_______ **WIND SPEED, kph (beg.):** ______________ **WRITTEN BY:** ______________

STAND: ______________ **LOCATION:** ___CEF (NRC)____

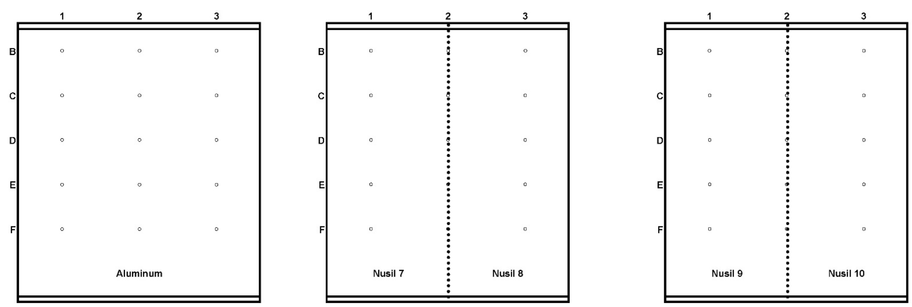
THICKNESS (mil)											
Plate: **U** Run #: Fluid: Application Time:		Plate: **V** Run #: Fluid: Application Time:		Plate: **W** Run #: Fluid: Application Time:		Plate: **X** Run #: Fluid: Application Time:		Plate: **Y** Run #: Fluid: Application Time:		Plate: **Z** Run #: Fluid: Application Time:	
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

FIGURE 7: ICE PHOBIC FLUID THICKNESS DATA FORM

LOCATION: NRC	CONDITION:	DATE:	RUN#:	STAND#:

PLATE #				
SURFACE	Aluminum	Nusil 7 / Nusil 8	Nusil 9 / Nusil 10
FLUID NAME			
TIME OF FLUID APP.			



THICKNESS MEASUREMENTS (mil)

TIME	6" LINE	TIME	6" LINE	6" LINE	TIME	6" LINE	6" LINE

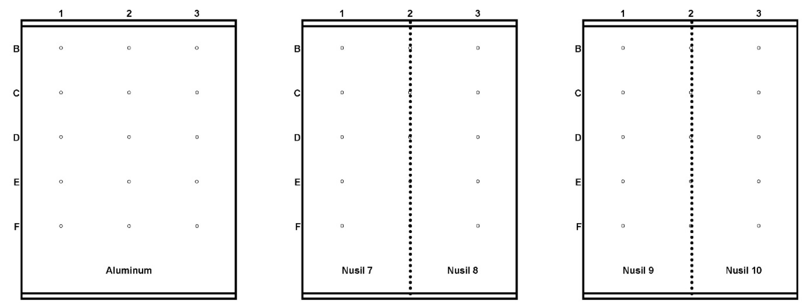
PERFORMED BY: ____________________ WRITTEN BY: ____________________

FIGURE 8: ICE PHOBIC END CONDITION DATA FORM

LOCATION: NRC	CONDITION:	DATE:	RUN#:	STAND#:

PLATE #					
SURFACE	Aluminum	Nusil 7	Nusil 8	Nusil 9	Nusil 10
FLUID NAME					
TIME OF FLUID APPLICATION					
TIME OF FLUID FAILURE					

DESCRIBE ADHESION AND DRAW FAILURE AT TIME OF PLATE 1 FAILURE



BRIX MEASUREMENTS (TIME / BRIX)

5 MIN	/	5 MIN	/	/	5 MIN	/	/
END	/	END	/	/	END	/	/
AT P1 FAIL	/	AT P1 FAIL	/		AT P1 FAIL	/	

THICKNESS MEASUREMENTS (TIME / THICKNESS)

5 MIN	/	5 MIN	/	/	5 MIN	/	/
END	/	END	/	/	END	/	/
AT P1 FAIL	/	AT P1 FAIL	/	/	AT P1 FAIL	/	/

ADDITIONAL COMMENTS

Aluminum	*Nusil 7*	*Nusil 9*
	Nusil 8	*Nusil 10*

check if there are more notes on the other side ☐

PERFORMED BY: ____________ WRITTEN BY: ____________

FIGURE 9: FLUID BRIX / FLUID THICKNESS / PLATE TEMPERATURE DATA FORM

DATE: ______________ **PERFORMED BY:** ________________

RUN #: ______________ **WRITTEN BY:** ________________

STAND: ______________ **LOCATION:** ________________

Plate / BOX:________ Fluid:				Plate/BOX: ________ Fluid:				Plate/BOX: ________ Fluid:				Plate/BOX: ________ Fluid:			
TIME	**Brix**	**Thickness**	**Plate Temp.**	**TIME**	**Brix**	**Thickness**	**Plate Temp.**	**TIME**	**Brix**	**Thickness**	**Plate Temp.**	**TIME**	**Brix**	**Thickness**	**Plate Temp.**

OVERALL PROGRAM OF TESTS AT NRC, APRIL 2011

FIGURE 10: BRIX / THICKNESS DATA FORM

FLUID BRIX/THICKNESS DATA FORM

DATE: ______________ **PERFORMED BY:** __________________

RUN #: ______________ **WRITTEN BY:** __________________

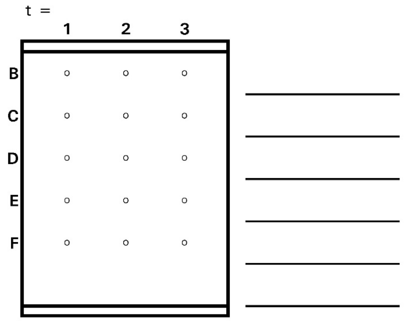
STAND: ______________ **LOCATION:** __________________

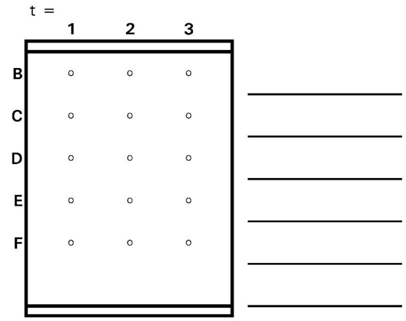
Plate/BOX:			Plate/BOX:			Plate/BOX:			Plate/BOX:		
Fluid:			Fluid:			Fluid:			Fluid:		
TIME	Brix at 15 cm Line	Thick. at 15 cm Line	TIME	Brix at 15 cm Line	Thick. at 15 cm Line	TIME	Brix at 15 cm Line	Thick. at 15 cm Line	TIME	Brix at 15 cm Line	Thick. at 15 cm Line

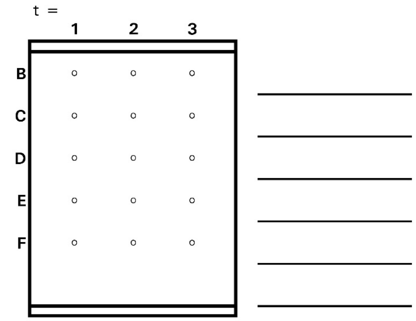
FIGURE 11: ADHERENCE OF FLUID FAILURE DATA FORM

Date: ____________

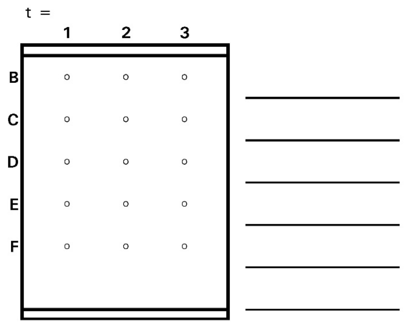
Test #: __________ Fluid / Dilution: ___________ Plate Location: ________

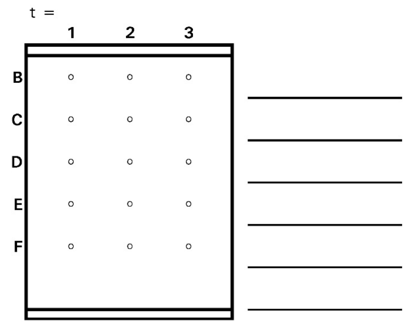






Test #: __________ Fluid / Dilution: ___________ Plate Location: ________





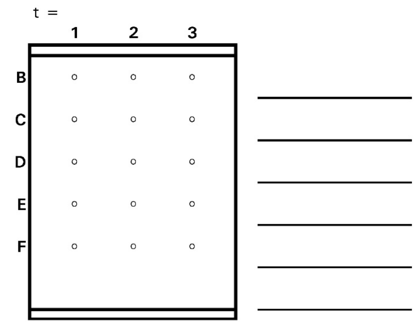


FIGURE 12: POSITION OF ICE PELLET DISPENSER SYSTEM DATA FORM

DATE:______________________ CONDITION:_______________________ TIME:______________________

TYPE OF PRECIPITATION ON PLATE (circle precip. type)

Pos. 1	Pos. 2	Pos. 3	Pos. 4	Pos. 5	Pos. 6
ZR	ZR	ZR	ZR	ZR	ZR
IP	IP	IP	IP	IP	IP
ZR/ IP	ZR/ IP	ZR/ IP	ZR/ IP	ZR/ IP	ZR/ IP

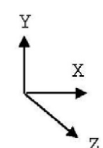
Pos. 7	Pos. 8	Pos. 9	Pos.10	Pos.11	Pos.12
ZR	ZR	ZR	ZR	ZR	ZR
IP	IP	IP	IP	IP	IP
ZR/ IP	ZR/ IP	ZR/ IP	ZR/ IP	ZR/ IP	ZR/ IP

OPERATIONAL TIME LOG OF ICE PELLET DISPENSER

IP DISPENSER ON	IP DISPENSER OFF	IP DISPENSER ON	IP DISPENSER OFF

MARK POSITION OF DISPENSER RELATIVE TO PLATES WITH AN "X" IN SPACE

POSITION[1] OF ICE PELLET DISPENSER



X____________
Y____________
Z____________

(1) Origin is bottom left corner of stand

M:\Projects\PM2169.003 (TC Deicing 10-11)\Procedures\NRC\Final Version 1.0\NRC Procedure - Final Version 1.0.doc
Final Version 1.0, April 11

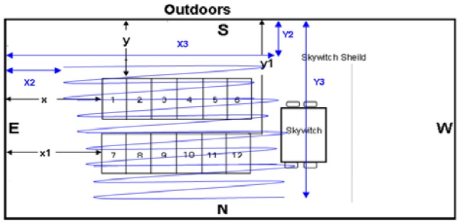
41 of 42

OVERALL PROGRAM OF TESTS AT NRC, APRIL 2011

FIGURE 13: STAND POSITION / SPRAYER CHARACTERISTICS FORM

		STEP 1				STEP 2				STEP 3	STEP 4	
Test	Condition	Final Stand Position				Area of spray zone				Cycle Time	Time that plate is Impacted	
		x	y	x1	y1	x2	y2	x3	y3	sec.	secs	video
1	ZR3H											
2	ZR3L											
3	ZR10H											
4	ZR10L											
5	ZD3H											
6	ZD3L											
7	ZD10H											
8	ZD10L											
9	ZFOG3H											
10	ZFOG3L											
11	ZFOG10H											
12	ZFOG10L											
13	ZFOG14H											
14	ZFOG14L											
15	ZFOG25H											
16	ZFOG25L											
17	CSWH											
18	CSWL											

Outdoors



Step 1: Measure test stand location at end of condition (during rates) ± 2.5 cm

Step 2: Visually inspect where precipitation hits the ground; record area ± 30 cm
↔ X2 measure from east wall (closest)
↔ X3 measure from east wall (furthest)
↕ Y2 measure from south wall (closest)
↕ Y3 measure from south wall (furthest)

Step 3: Measure time the spray pattern takes to complete 1 cycle (because of interlinking of spray pattern the sprayer goes through 2 sweeps) ± 1 sec.

Step 4: Take video of one plate position for one cycle in each condition (suggest using blue towel).

Year: ____________

Performed by: ________________________

Written by: ________________________

OVERALL PROGRAM OF TESTS AT NRC, JULY 2011

CM2169.003 (10-11)

OVERALL PROGRAM OF TESTS AT NRC, JULY 2011

Winter 2010-11

Prepared for

Transportation Development Centre
Transport Canada

Prepared by: Stephanie Bendickson

Reviewed by: John D'Avirro

APS Aviation Inc.

July 15, 2011
Final Version 1.1

OVERALL PROGRAM OF TESTS AT NRC, JULY 2011

Winter 2010-11

1. INTRODUCTION

This document was prepared to bring together several projects that require testing at the National Research Council Climactic Engineering Facility (NRC) in Ottawa. Tests will be carried out from July 19-21, 2011.

The primary objective of the test session is to measure the endurance times of one new Type I fluid. Several other research projects will also be carried out. This document provides the schedule, personnel, fluid, and equipment requirements for each of the projects involved.

A tentative test schedule is included in Figure 1.

2. PROJECTS, PROCEDURES AND OBJECTIVES

The projects that will be carried out at the July 2011 NRC test session are listed in this section. The objectives and procedures for each project 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.

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 I tests and limited Type IV tests, as described below.

- **Type I:** Tests will be conducted with a new non-glycol Type I fluid over the entire range of freezing precipitation conditions encompassed by the Type I HOT table. The fluid will be tested under the fluide code “E2”.

- **Preliminary Type IV:** Tests will be conducted with four experimental Type IV fluids in select test conditions (ZD/10/5, ZD/10/13, ZD/3/13, ZF/3/5, ZR/6/13, ZR/6/25, ZR/10/25). The fluids will be tested under the fluid codes “B1”, “B2”, “K1” and “K2”.

- **Confirmation of -25°C HOTs for LOUT:** Tests will be conducted with a Type IV fluid (fluid code “C1”) at the fluid’s LOUT (-30.5°C) in freezing fog to confirm the validity of -25°C holdover times for use at the LOUT.

The procedure for conducting these tests is given in the document *Test Requirements for Simulated Freezing Precipitation Flat Plate Testing* (1). The test stands should be situated in the cold chamber as per the measurements provided in Figure 2. The cold soak boxes should be prepared using the procedure provided in Attachment 1.

The test plan for these tests is given in Table 1. All tests will be conducted on the main test stand.

2.2 Thickness of New Fluids (Fluid Thickness)

The objective of these tests is to measure the thickness of the Type I non-glycol fluid (fluid code "E2") 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* (2) and can be found in Transport Canada Report TP 13991E, Appendix I.

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.

2.3 Effect of Runway Deicers on Endurance Times (Runway Deicers)

Recent research showed that when thickened aircraft anti-icing fluid came in contact with minimal amounts of runway deicing fluids (formate or acetate based), anti-icing protection provided by the aircraft anti-icing fluid could be diminished. The separation of the thickening agents in the fluid consequently reduced holdover time.

Recent EASA guidance indicates that when using a two-step de/anti-icing process the application of the first step **with water or Type I aircraft anti-icing fluid solution** cleans off the contamination from the runway deicing fluid so that the anti ice protection provided with the second step is not affected by the runway deicing fluids. Testing is required to verify if the first step application is limited to water or Type I, or can be generalized to all applicable de/anti-icing fluids in accordance with current fluid application guidelines.

A limited set of comparative tests will be conducted simulating two-step applications with different first step fluids (both thickened and un-thickened). Due to the close connection between fluid thickness and endurance time, and to limit testing efforts, testing will evaluate fluid thickness during a 30-minute period following the application of the second step. RDF will be applied in 25% concentration by volume (diluted with water) and will be applied at 0.1 g/dm^2

(1.5 mL per plate) on the surface at least 1-hour prior to the start of the test. If large differences in fluid thickness are observed, more extensive comparative endurance time testing may be necessary and will be recommended to validate the results obtained. Therefore this set of tests will be scheduled early in the test session.

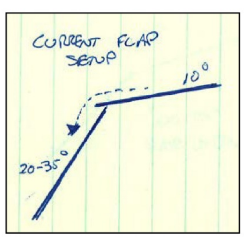
The test plan for Runway Deicer tests is given in Table 3. These tests will be conducted at the small end of the chamber outside of the spray area.

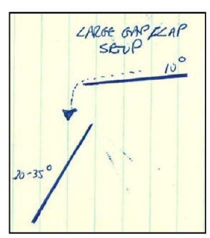
2.4 Endurance Times on Flaps and Slats (Flaps and Slats)

Previous preliminary work conducted in the NRC PIWT and at the NRC CEF on a 2D wing section and flat plates has indicated a potential for early fluid failure on flaps, especially in cases where a disconnect is present in the fluid flow. Although no testing was conducted simulating slats, it was assumed that the scenario would be similar or worst due to the presence of a disconnect in the fluid flow, and steeper angles on the leading edge. Based on the comments from the San Francisco G-12 meeting, additional flat plate testing and potentially full-scale testing was recommended to investigate different flap and slat configurations to validate the results obtained. The following diagram shows the different flap and slat configurations.

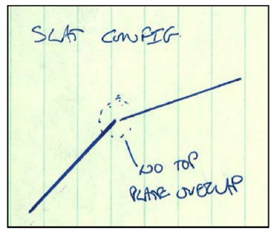
Testing will have three objectives. Other test objectives related to flaps and slats were initially proposed, but will not be investigated during this session. Consideration will be given to including the omitted items in the winter session.

Objective #1 – Nested Flap Configurations with Larger Gaps: Conduct flat plate test using previously used methodology, however simulating larger gaps between the top "feeding" plate and the bottom plate. Consider using fans to simulate wind conditions in the chamber to determine effects on fluid flow. These tests will be conducted on the main test stand.

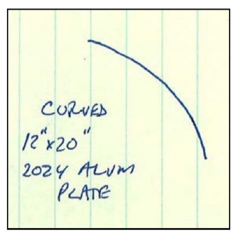




Objective #2 – Slat Configurations to Investigate Fluid Flow: It is assumed that fluid will not flow from the main wing section onto the deployed slat, however limited testing should be conducted to determine the minimum gap possible to provide a flow of fluid onto the simulated slat. A similar setup to the deployed flaps tests will be used. These tests will be conducted at the small end of the chamber outside of the spray area.



Objective #3 – Effect of Slat Curvature on Fluid Endurance Time: Conduct testing with a curved surface, simulating a deployed slat, to determine the effects of fluid flow from a curved surface on fluid endurance times. The endurance time recorded on the curved surface will be compared to a highly sloped flat plate to validate the procedure previously used. These tests will be conducted on the main test stand.



The test plan for the Flaps and Slats tests is given in Table 4. The tests are numbered according to their objective (Objective 1 = FG, Objective 2 = SF, Objective 3 = CLE).

2.5 Documentation of Stand Setup and Sprayer Characteristics (Sprayer)

The objective of this activity is to document the characteristics of the test stand setup and sprayer system at the NRC climate chamber. Initial work was done on this project at the April 2011 NRC test session using still phtography. In each of the 18 precipitation conditions that will be simulated at this test session, each of the following measurements will be taken:

1. Final stand position
2. Area of spray zone

3. Cycle time
4. Time that plate is impacted

Final stand position, area of spray zone and cycle time were measured at the April 2011 test session; these meausurements are being taken this test session to confirm the previous measurements. The time that each plate is impacted will be documented using video recording equipment.

This activity will be done at the end of each condition (when the last plate has failed) by the project manager. Additional guidance is provided on the related data form (see Section 6). No test plan is required for this project.

2.6 Separate Project: Evaluation of Surface Coatings (Surface Coatings)

Tests for a non-TC/FAA funded project will be conducted concurrently with the other tests described in this procedure. The tests, conducted on behalf of a commercial airline, are being conducted at the test seesion to take advantage of cost sharing opportunities. The procedure for these tests is provided in a separate document; the personnel, fluid and equipment requirements have been included in this procedure for planning purposes only.

3. PERSONNEL REQUIREMENTS/RESPONSIBILITIES

The personnel responsibilities are listed below.

1. JD: Project Manager (New Fluid ETs)
2. MR: Project Manager (Runway Deicers, Flaps and Slats, Fluid Thickness, Surface Coatings)
3. SB: Rate Station Manager
4. VZ: Rate Station Assistant (testing), Project Assistant (New Fluid ETs)
5. DY: Rate Station Assistant (calibration), Project Manager (Sprayer), Project Assistant (Runway Deicers, Flaps and Slats, Fluid Thickness, Surface Coatings)

In addition, personnel will be designated responsible for:

- Equipment: DY/MR
- Pre-test Setup: DY/MR
- Data Form Manager: VZ
- Fluid Manager: DY

4. FLUIDS

The required fluids and fluid quantities are shown in Table 5. Type I fluids will be diluted prior to testing using the dilution tables provided in Table 6.

5. EQUIPMENT

Table 7 provides a list of the equipment required.

6. DATA FORMS

The data forms required for each project are listed below.

1. New Fluid ETs:
   - Freezing Precipitation Endurance Time Data Form (Figure 3)
   - Rate Management Form (Figure 4)
2. Fluid Thickness:
   - Fluid Thickness Data Form (Figure 5)
3. Runway Deicers:
   - Fluid Thickness Data Form (Figure 5)
4. Flaps and Slats:
   - Freezing Precipitation Endurance Time Data Form (Figure 3)
   - Fluid Thickness Data Form (Figure 5)
5. Sprayer:
   - Stand Position / Sprayer Characteristics Form (Figure 6)

7. PRE–TEST SET–UP ACTIVITIES

The following activities need to be completed prior to arrival at the NRC:

1. Mark plates and boxes, including composite plates, RDF plates, etc. (MR).
2. Check rate pans: check quantity, check for holes, and check all pans are properly labelled (VZ).
3. Ensure plates and boxes are equipped with operational and verified thermistors (MR).

4. Determine number of loggers required (loggers on stands already) (MR).
5. Prepare PC for logging plate temperatures (MR).
6. Ensure fluids are prepared in advance according to Table 5 (DY).
7. Label squeegees (DY).
8. Prepare labels for pour containers (VZ).
9. Clean and label 1 litre pour containers (DY).
10. Check laptops (2) work for rate station (MR).
11. Rent cube van (PG).
12. Book hotel (PG/VZ).
13. Update and print chamber settings file (DY/VZ).
14. Print data forms and procedures (VZ).
15. Print chamber condition sheets (VZ).

The following items should be purchased prior to arrival at the NRC (DY):

1. Blue towels
2. Spray bottles

8. SAFETY ISSUES

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 MSDS sheets are available for review.
2. Waterproof clothing and gloves are available.
3. Rubber mats must be properly placed in and around the test area and cleaned as necessary.
4. Care should be taken when circulating near the test stand due to slipperiness.
5. First aid kit, water and fire extinguisher are available.
6. All NRC safety guidelines must be followed.

9. REFERENCES

1. Test Requirements For Simulated Freezing Precipitation Flat Plate Testing, Version 1.0, January 15, 2004.

2. 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, JULY 2011

FIGURE 1: TEST SCHEDULE

	Mon Jul 18	Tues Jul 19	Wed Jul 20	Thurs Jul 21	Fri Jul 22
9:00	Packup Drive to YOW	**ZF, -30.5, 2** Type IV=2	**ZR, -6, 25** Type I=4 Type IV=16 (SC)	**ZD, -10, 13** Type I=4 Type IV=16 (SC)	Packup Drive to YUL
9:30					
10:00		**ZF, -30.5, 5** Type IV=2			
10:30					
11:00		Warm to -25	**ZR, -6, 13** Type I=7 Type IV=15 (SC)	**ZR, -10, 13** Type I=4 Type IV=4 (CLE, FG)	
11:30		**ZF, -25, 5** Type I=4			
12:00	Setup at NRC				
12:30		**ZF, -25, 2** Type I=6 (SC)			
13:00			**ZD, -6, 13** Type I=4	**ZR, -10, 25** Type I=6 Type IV=21 (SC, CLE, FG)	
13:30		Warm to -10			
14:00			**ZD, -6, 5** Type I=4		
14:30		**ZF, -10, 2** Type I=4 Small End: SF1-4			
15:00			Warm to -3	**ZD, -10, 5** Type I=7 Type IV=19 (SC, CLE, FG)	
15:30		**ZF, -10, 5** Type I=4	**ZD, -3, 5** Type I=4		
16:00					
16:30		Warm to -6			
17:00		**ZF, -6, 5** Type I=4 Small End: RDF1-8	**ZD, -3, 13** Type I=6 Type IV=25 (SC, CLE, FG)		
17:30					
18:00		**ZF, -6, 2** Type I=4			
18:30				Warm to +1	
19:00		Warm to -3		**CSW, 1, 5** Type I=4	
19:30		**ZF, -3, 2** Type I=4 Small End: SC-TH1-9, TH1-2			
20:00				**CSW, 1, 75** Type I=4	
20:30					
21:00		**ZF, -3, 5** Type I=7 Type IV=4 (SC)			
21:30					
22:00					
22:30					

Projects per Condition

- Type I only (yellow)
- Type I + Type IV (cyan)
- Type IV only (orange)

Legend

CLE = Curved Leading Edge
FG = Flap Gap
SC = Surface Coatings
SF = Slat Flow-off
TH = Thickness

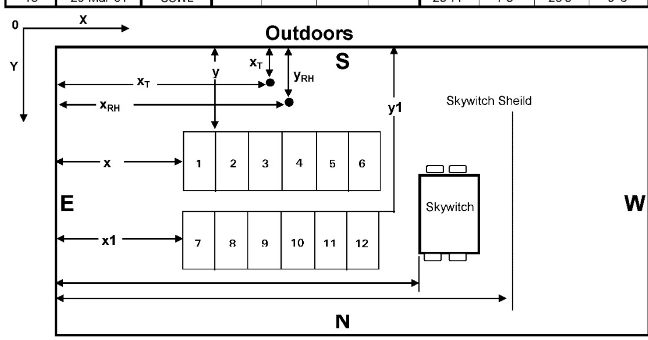
OVERALL PROGRAM OF TESTS AT NRC, JULY 2011

FIGURE 2: TEST STAND LOCATION MEASUREMENTS

LOCATION: CEF (Ottawa) DATE:

CONDITION: ZR3H ZR3L ZR10H ZR10L ZD3H ZD3L ZD10H ZD10L ZF3H ZF3L ZF10H ZF10L ZF14H ZF14L ZF25H ZF25L CSWH CSWL

Test	Date of Final Position	Condition	Sensor Position				Stand Position				Skywitch Position	Skywitch Sheild Position (*)	Nozzle Position (**)	Rate	Height of nozzle over plate	Comments
			X_T	Y_T	X_{RH}	Y_{RH}	x	y	x1	y1						
1	04-Apr-01	ZR3H					24' 2"	7'	22' 7"	9' 10"				Very Good		Top Stand 19' from snow fence
2	04-Apr-01	ZR3L					24' 2"	7'	22' 7"	9' 10"				Very Good		Top Stand 19' from snow fence
3	02/04/2001	ZR10H					24'	6' 9"	24' 5"	9' 6"				Very Good		Top stand is 20 ft. from snow fence
4	02-Apr-01	ZR10L					24'	6' 9"	24' 5"	9' 6"				Very Good		Top stand is 20 ft. from snow fence
5	27-Mar-01	ZD3H					24' 5"	6'6"	22'	10'4"				Very Good		
6	28-Mar-01	ZD3L					25' 3"	7'3"	25' 3"	9' 6"				Good		
7	02-Apr-01	ZD10H					24'	7'11"	25' 3"	9' 6"				Very Good		
8	02-Apr-01	ZD10L					24'	7' 7"	24' 7"	9' 11"				Good		20 ft. from Snow Fence
9	10-Apr-01	ZFog3H					24'	6'6"	21'11"	8'10"	34' 2"from x	40'2" from x	top of plate 11	Good	144"	
10	10-Apr-01	ZFog3L					24'	6'6"	21'11"	8'10"	34' 2"from x	40'2" from x	top of plate 11	Good	144"	
11	10-Apr-01	ZFog10H					24'	6'6"	21'11"	8'10"	34' 2"from x	40'2" from x	top of plate 11	Good	144"	
12	10-Apr-01	ZFog10L					24'	6'6"	21'11"	8'10"	34' 2"from x	40'2" from x	top of plate 11	Good	144"	
13	09-Apr-01	ZFog14H					24'	6'6"	21'11"	8'10"	34' 2"from x	40'2" from x	top of plate 11	Good	144"	
14	09-Apr-01	ZFog14L					24'	6'6"	21'11"	8'10"	34' 2"from x	40'2" from x	top of plate 11	Good	144"	
15	06-Apr-01	ZFog25H					24'	6'6"	21'11"	8'10"	34' 2"from x	40'2" from x	top of plate 11	Good	144"	
16	06-Apr-01	ZFog25L					24'	6'6"	21'11"	8'10"	34' 2"from x	40'2" from x	top of plate 11	Good	144"	
17	29-Mar-01	CSWH					25'3"		25'3"	9' 6"						
18	29-Mar-01	CSWL					23'11"	7'3"	25'3"	9' 6"						



Notes:

* - "From X" refers to the distance from the East wall.
** - The nozzle should be between positions 5 and 11
RH - Relative Humidity Sensor
T - Temperature Sensor

WEIGH SCALE TECHNICIAN: ____________________

LEADER: ____________________

NEW VALUES (IF DIFFERENT)

Test	Date of Final Position	Condition	Sensor Position				Stand Position				Skywitch Position	Skywitch Sheild Position (*)	Nozzle Position (**)	Rate	Height of nozzle over plate	Comments
			X_T	Y_T	X_{RH}	Y_{RH}	x	y	x1	y1						

ATTACHMENT 1: COLD SOAK BOX PREPARATION PROCEDURE

1. Put containers (20 L) of CSW box fluid (propylene 65/35) 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).

OVERALL PROGRAM OF TESTS AT NRC, JULY 2011

TABLE 1: ENDURANCE TIME TEST PLAN

Test #	Precipitation Type	Temp (°C)	Precip. Rate (g/dm²/h)	Fluid Code	Fluid Dilution)	Test Surface	Comments
				Type I Fluid			
1	Freezing Fog	-3	2	E2	10°B (B=24.0)	Al. Plate	
2	Freezing Fog	-3	2	E2	10°B (B=24.0)	Al. Plate	
3	Freezing Fog	-3	2	E2	10°B (B=24.0)	Comp. Plate	
4	Freezing Fog	-3	2	E2	10°B (B=24.0)	Comp. Plate	
5	Freezing Fog	-3	5	E2	10°B (B=24.0)	Al. Plate	
6	Freezing Fog	-3	5	E2	10°B (B=24.0)	Al. Plate	
7	Freezing Fog	-3	5	E2	10°B (B=24.0)	Comp. Plate	
8	Freezing Fog	-3	5	E2	10°B (B=24.0)	Comp. Plate	
9	Freezing Fog	-6	2	E2	10°B (B=27.0)	Al. Plate	
10	Freezing Fog	-6	2	E2	10°B (B=27.0)	Al. Plate	
11	Freezing Fog	-6	2	E2	10°B (B=27.0)	Comp. Plate	
12	Freezing Fog	-6	2	E2	10°B (B=27.0)	Comp. Plate	
13	Freezing Fog	-6	5	E2	10°B (B=27.0)	Al. Plate	
14	Freezing Fog	-6	5	E2	10°B (B=27.0)	Al. Plate	
15	Freezing Fog	-6	5	E2	10°B (B=27.0)	Comp. Plate	
16	Freezing Fog	-6	5	E2	10°B (B=27.0)	Comp. Plate	
17	Freezing Fog	-10	2	E2	10°B (B=30.5)	Al. Plate	
18	Freezing Fog	-10	2	E2	10°B (B=30.5)	Al. Plate	
19	Freezing Fog	-10	2	E2	10°B (B=30.5)	Comp. Plate	
20	Freezing Fog	-10	2	E2	10°B (B=30.5)	Comp. Plate	
21	Freezing Fog	-10	5	E2	10°B (B=30.5)	Al. Plate	
22	Freezing Fog	-10	5	E2	10°B (B=30.5)	Al. Plate	
23	Freezing Fog	-10	5	E2	10°B (B=30.5)	Comp. Plate	
24	Freezing Fog	-10	5	E2	10°B (B=30.5)	Comp. Plate	
25	Freezing Fog	-25	2	E2	10°B (B=37.0)	Al. Plate	
26	Freezing Fog	-25	2	E2	10°B (B=37.0)	Al. Plate	
27	Freezing Fog	-25	2	E2	10°B (B=37.0)	Comp. Plate	
28	Freezing Fog	-25	2	E2	10°B (B=37.0)	Comp. Plate	
29	Freezing Fog	-25	5	E2	10°B (B=37.0)	Al. Plate	
30	Freezing Fog	-25	5	E2	10°B (B=37.0)	Al. Plate	
31	Freezing Fog	-25	5	E2	10°B (B=37.0)	Comp. Plate	
32	Freezing Fog	-25	5	E2	10°B (B=37.0)	Comp. Plate	
33	Light Freezing Rain	-6	13	E2	10°B (B=27.0)	Al. Plate	
34	Light Freezing Rain	-6	13	E2	10°B (B=27.0)	Al. Plate	
35	Light Freezing Rain	-6	13	E2	10°B (B=27.0)	Comp. Plate	
36	Light Freezing Rain	-6	13	E2	10°B (B=27.0)	Comp. Plate	
37	Light Freezing Rain	-6	25	E2	10°B (B=27.0)	Al. Plate	
38	Light Freezing Rain	-6	25	E2	10°B (B=27.0)	Al. Plate	
39	Light Freezing Rain	-6	25	E2	10°B (B=27.0)	Comp. Plate	
40	Light Freezing Rain	-6	25	E2	10°B (B=27.0)	Comp. Plate	
41	Light Freezing Rain	-10	13	E2	10°B (B=30.5)	Al. Plate	
42	Light Freezing Rain	-10	13	E2	10°B (B=30.5)	Al. Plate	
43	Light Freezing Rain	-10	13	E2	10°B (B=30.5)	Comp. Plate	
44	Light Freezing Rain	-10	13	E2	10°B (B=30.5)	Comp. Plate	

TABLE 1: ENDURANCE TIME TEST PLAN – CONT'D

Test #	Precipitation Type	Temp (°C)	Precip. Rate (g/dm²/h)	Fluid Code	Fluid Dilution	Test Surface	Comments
Type I Fluid							
45	Light Freezing Rain	-10	25	E2	10°B (B=30.5)	Al. Plate	
46	Light Freezing Rain	-10	25	E2	10°B (B=30.5)	Al. Plate	
47	Light Freezing Rain	-10	25	E2	10°B (B=30.5)	Comp. Plate	
48	Light Freezing Rain	-10	25	E2	10°B (B=30.5)	Comp. Plate	
49	Freezing Drizzle	-3	5	E2	10°B (B=24.0)	Al. Plate	
50	Freezing Drizzle	-3	5	E2	10°B (B=24.0)	Al. Plate	
51	Freezing Drizzle	-3	5	E2	10°B (B=24.0)	Comp. Plate	
52	Freezing Drizzle	-3	5	E2	10°B (B=24.0)	Comp. Plate	
53	Freezing Drizzle	-3	13	E2	10°B (B=24.0)	Al. Plate	
54	Freezing Drizzle	-3	13	E2	10°B (B=24.0)	Al. Plate	
55	Freezing Drizzle	-3	13	E2	10°B (B=24.0)	Comp. Plate	
56	Freezing Drizzle	-3	13	E2	10°B (B=24.0)	Comp. Plate	
57	Freezing Drizzle	-6	5	E2	10°B (B=27.0)	Al. Plate	
58	Freezing Drizzle	-6	5	E2	10°B (B=27.0)	Al. Plate	
59	Freezing Drizzle	-6	5	E2	10°B (B=27.0)	Comp. Plate	
60	Freezing Drizzle	-6	5	E2	10°B (B=27.0)	Comp. Plate	
61	Freezing Drizzle	-6	13	E2	10°B (B=27.0)	Al. Plate	
62	Freezing Drizzle	-6	13	E2	10°B (B=27.0)	Al. Plate	
63	Freezing Drizzle	-6	13	E2	10°B (B=27.0)	Comp. Plate	
64	Freezing Drizzle	-6	13	E2	10°B (B=27.0)	Comp. Plate	
65	Freezing Drizzle	-10	5	E2	10°B (B=30.5)	Al. Plate	
66	Freezing Drizzle	-10	5	E2	10°B (B=30.5)	Al. Plate	
67	Freezing Drizzle	-10	5	E2	10°B (B=30.5)	Comp. Plate	
68	Freezing Drizzle	-10	5	E2	10°B (B=30.5)	Comp. Plate	
69	Freezing Drizzle	-10	13	E2	10°B (B=30.5)	Al. Plate	
70	Freezing Drizzle	-10	13	E2	10°B (B=30.5)	Al. Plate	
71	Freezing Drizzle	-10	13	E2	10°B (B=30.5)	Comp. Plate	
72	Freezing Drizzle	-10	13	E2	10°B (B=30.5)	Comp. Plate	
73	Cold Soak Box	1	5	E2	10°B (B=19.0)	Al. Box	
74	Cold Soak Box	1	5	E2	10°B (B=19.0)	Al. Box	
75	Cold Soak Box	1	5	E2	10°B (B=19.0)	Comp. Box	
76	Cold Soak Box	1	5	E2	10°B (B=19.0)	Comp. Box	
77	Cold Soak Box	1	75	E2	10°B (B=19.0)	Al. Box	
78	Cold Soak Box	1	75	E2	10°B (B=19.0)	Al. Box	
79	Cold Soak Box	1	75	E2	10°B (B=19.0)	Comp. Box	
80	Cold Soak Box	1	75	E2	10°B (B=19.0)	Comp. Box	

TABLE 1: ENDURANCE TIME TEST PLAN – CONT'D

Test #	Precipitation Type	Temp (°C)	Precip. Rate (g/dm²/h)	Fluid Code	Fluid Dilution	Test Surface	Comments
Type IV Fluid							
81	Freezing Fog	-3	5	K1	50/50	Al. Plate	Priority 1
82	Freezing Fog	-3	5	K2	50/50	Al. Plate	Priority 1
83	Freezing Fog	-3	5	K1	50/50	Al. Plate	Priority 2 (use split plate)
84	Freezing Fog	-3	5	K2	50/50	Al. Plate	Priority 2 (use split plate)
85	Freezing Drizzle	-3	13	B1	100/0	Al. Plate	Priority 1
86	Freezing Drizzle	-3	13	B2	100/0	Al. Plate	Priority 1
87	Freezing Drizzle	-3	13	B1	100/0	Al. Plate	Priority 2 (use split plate)
88	Freezing Drizzle	-3	13	B2	100/0	Al. Plate	Priority 2 (use split plate)
89	Freezing Drizzle	-3	13	K1	100/0	Al. Plate	Priority 1
90	Freezing Drizzle	-3	13	K2	100/0	Al. Plate	Priority 1
91	Freezing Drizzle	-3	13	K1	100/0	Al. Plate	Priority 2 (use split plate)
92	Freezing Drizzle	-3	13	K2	100/0	Al. Plate	Priority 2 (use split plate)
93	Freezing Drizzle	-3	13	K1	75/25	Al. Plate	Priority 1
94	Freezing Drizzle	-3	13	K2	75/25	Al. Plate	Priority 1
95	Freezing Drizzle	-3	13	K1	75/25	Al. Plate	Priority 2 (use split plate)
96	Freezing Drizzle	-3	13	K2	75/25	Al. Plate	Priority 2 (use split plate)
97	Freezing Drizzle	-3	13	K1	50/50	Al. Plate	Priority 1
98	Freezing Drizzle	-3	13	K2	50/50	Al. Plate	Priority 1
99	Freezing Drizzle	-3	13	K1	50/50	Al. Plate	Priority 2 (use split plate)
100	Freezing Drizzle	-3	13	K2	50/50	Al. Plate	Priority 2 (use split plate)
101	Light Freezing Rain	-6	13	B1	100/0	Al. Plate	Priority 1
102	Light Freezing Rain	-6	13	B2	100/0	Al. Plate	Priority 1
103	Light Freezing Rain	-6	13	B1	100/0	Al. Plate	Priority 2 (use split plate)
104	Light Freezing Rain	-6	13	B2	100/0	Al. Plate	Priority 2 (use split plate)
105	Light Freezing Rain	-6	13	K1	100/0	Al. Plate	Priority 1
106	Light Freezing Rain	-6	13	K2	100/0	Al. Plate	Priority 1
107	Light Freezing Rain	-6	13	K1	100/0	Al. Plate	Priority 2 (use split plate)
108	Light Freezing Rain	-6	13	K2	100/0	Al. Plate	Priority 2 (use split plate)
109	Light Freezing Rain	-6	13	K1	75/25	Al. Plate	Priority 1
110	Light Freezing Rain	-6	13	K2	75/25	Al. Plate	Priority 1
111	Light Freezing Rain	-6	13	K1	75/25	Al. Plate	Priority 2 (use split plate)
112	Light Freezing Rain	-6	13	K2	75/25	Al. Plate	Priority 2 (use split plate)
113	Light Freezing Rain	-6	25	B1	100/0	Al. Plate	Priority 1
114	Light Freezing Rain	-6	25	B2	100/0	Al. Plate	Priority 1
115	Light Freezing Rain	-6	25	B1	100/0	Al. Plate	Priority 2 (use split plate)
116	Light Freezing Rain	-6	25	B2	100/0	Al. Plate	Priority 2 (use split plate)
117	Light Freezing Rain	-6	25	K1	100/0	Al. Plate	Priority 1
118	Light Freezing Rain	-6	25	K2	100/0	Al. Plate	Priority 1
119	Light Freezing Rain	-6	25	K1	100/0	Al. Plate	Priority 2 (use split plate)
120	Light Freezing Rain	-6	25	K2	100/0	Al. Plate	Priority 2 (use split plate)
121	Light Freezing Rain	-6	25	K1	75/25	Al. Plate	Priority 1
122	Light Freezing Rain	-6	25	K2	75/25	Al. Plate	Priority 1
123	Light Freezing Rain	-6	25	K1	75/25	Al. Plate	Priority 2 (use split plate)
124	Light Freezing Rain	-6	25	K2	75/25	Al. Plate	Priority 2 (use split plate)

TABLE 1: ENDURANCE TIME TEST PLAN – CONT'D

Test #	Precipitation Type	Temp (°C)	Precip. Rate (g/dm²/h)	Fluid Code	Fluid Dilution	Test Surface	Comments
Type IV Fluid							
125	Freezing Drizzle	-10	5	B1	100/0	Al. Plate	Priority 1
126	Freezing Drizzle	-10	5	B2	100/0	Al. Plate	Priority 1
127	Freezing Drizzle	-10	5	B1	100/0	Al. Plate	Priority 2 (use split plate)
128	Freezing Drizzle	-10	5	B2	100/0	Al. Plate	Priority 2 (use split plate)
129	Freezing Drizzle	-10	5	K1	100/0	Al. Plate	Priority 1
130	Freezing Drizzle	-10	5	K2	100/0	Al. Plate	Priority 1
131	Freezing Drizzle	-10	5	K1	100/0	Al. Plate	Priority 2 (use split plate)
132	Freezing Drizzle	-10	5	K2	100/0	Al. Plate	Priority 2 (use split plate)
133	Freezing Drizzle	-10	5	K1	75/25	Al. Plate	Priority 1
134	Freezing Drizzle	-10	5	K2	75/25	Al. Plate	Priority 1
135	Freezing Drizzle	-10	5	K1	75/25	Al. Plate	Priority 2 (use split plate)
136	Freezing Drizzle	-10	5	K2	75/25	Al. Plate	Priority 2 (use split plate)
137	Freezing Drizzle	-10	13	B1	100/0	Al. Plate	Priority 1
138	Freezing Drizzle	-10	13	B2	100/0	Al. Plate	Priority 1
139	Freezing Drizzle	-10	13	B1	100/0	Al. Plate	Priority 2 (use split plate)
140	Freezing Drizzle	-10	13	B2	100/0	Al. Plate	Priority 2 (use split plate)
141	Freezing Drizzle	-10	13	K1	100/0	Al. Plate	Priority 1
142	Freezing Drizzle	-10	13	K2	100/0	Al. Plate	Priority 1
143	Freezing Drizzle	-10	13	K1	100/0	Al. Plate	Priority 2 (use split plate)
144	Freezing Drizzle	-10	13	K2	100/0	Al. Plate	Priority 2 (use split plate)
145	Freezing Drizzle	-10	13	K1	75/25	Al. Plate	Priority 1
146	Freezing Drizzle	-10	13	K2	75/25	Al. Plate	Priority 1
147	Freezing Drizzle	-10	13	K1	75/25	Al. Plate	Priority 2 (use split plate)
148	Freezing Drizzle	-10	13	K2	75/25	Al. Plate	Priority 2 (use split plate)
149	Light Freezing Rain	-10	25	B1	100/0	Al. Plate	Priority 1
150	Light Freezing Rain	-10	25	B2	100/0	Al. Plate	Priority 1
151	Light Freezing Rain	-10	25	B1	100/0	Al. Plate	Priority 2 (use split plate)
152	Light Freezing Rain	-10	25	B2	100/0	Al. Plate	Priority 2 (use split plate)
153	Light Freezing Rain	-10	25	K1	100/0	Al. Plate	Priority 1
154	Light Freezing Rain	-10	25	K2	100/0	Al. Plate	Priority 1
155	Light Freezing Rain	-10	25	K1	100/0	Al. Plate	Priority 2 (use split plate)
156	Light Freezing Rain	-10	25	K2	100/0	Al. Plate	Priority 2 (use split plate)
157	Light Freezing Rain	-10	25	K1	75/25	Al. Plate	Priority 1
158	Light Freezing Rain	-10	25	K2	75/25	Al. Plate	Priority 1
159	Light Freezing Rain	-10	25	K1	75/25	Al. Plate	Priority 2 (use split plate)
160	Light Freezing Rain	-10	25	K2	75/25	Al. Plate	Priority 2 (use split plate)
-25°C HOTs for LOUT							
161	Freezing Fog	-30.5	5	C1	100/0	Al. Plate	Priority 1
162	Freezing Fog	-30.5	5	C1	100/0	Al. Plate	Priority 2
163	Freezing Fog	-30.5	2	C1	100/0	Al. Plate	Priority 1
164	Freezing Fog	-30.5	2	C1	100/0	Al. Plate	Priority 2

Notes:

- *Type I fluids are not tested in freezing rain at -3ºC as the latent heat of freezing in calm test conditions produces artificially long ETs.*
- *Type IV tests MUST be conducted with each fluid in a miniumum of four (4) conditions.*
- *May need to redo -25°C HOTs for LOUT tests at -25°C if ETs at -30.5°C are different from previously measured -25°C ETs.*

TABLE 2: FLUID THICKNESS TEST PLAN

Test #	Fluid Code	Fluid Dilution	Test Surface	Ambient Air Temperature
TH1	E2	10°B (B=24.0)	Al. Plate	-3°C
TH2	E2	10°B (B=24.0)	Al. Plate	-3°C

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 2 minutes, 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

TABLE 3: RUNWAY DEICER TEST PLAN

Test #	Temp (°C)	First Step Fluid (Dilution)	Second Step Fluid (Dilution)	Test Surface	Comments
RDF1	-6	Octaflo EF (10° B)	ABC-S+ (100/0)	Standard Plate	1st App 0.5L 60°C, wait 3 min, 2nd App 1L OAT, Thick 5, 10, 15, 30 min
RDF2	-6	Octaflo EF (10° B)	ABC-S+ (100/0)	RDF	1st App 0.5L 60°C, wait 3 min, 2nd App 1L OAT, Thick 5, 10, 15, 30 min
RDF3	-6	ABC-S+ (50/50)	ABC-S+ (100/0)	RDF	1st App 0.5L 60°C, wait 3 min, 2nd App 1L OAT, Thick 5, 10, 15, 30 min
RDF4	-6	ABC-S+ (100/0)	ABC-S+ (100/0)	RDF	1st App 0.5L 60°C, wait 3 min, 2nd App 1L OAT, Thick 5, 10, 15, 30 min
RDF5	-6	Dow UCAR ADF (10° B)	Cryotech PGA (100/0)	Standard Plate	1st App 0.5L 60°C, wait 3 min, 2nd App 1L OAT, Thick 5, 10, 15, 30 min
RDF6	-6	Dow UCAR ADF (10° B)	Cryotech PGA (100/0)	RDF	1st App 0.5L 60°C, wait 3 min, 2nd App 1L OAT, Thick 5, 10, 15, 30 min
RDF7	-6	Cryotech PGA (50/50)	Cryotech PGA (100/0)	RDF	1st App 0.5L 60°C, wait 3 min, 2nd App 1L OAT, Thick 5, 10, 15, 30 min
RDF8	-6	Cryotech PGA (100/0)	Cryotech PGA (100/0)	RDF	1st App 0.5L 60°C, wait 3 min, 2nd App 1L OAT, Thick 5, 10, 15, 30 min

Notes:

- All tests to be conducted in dry conditions (no precipitation)
- Consider use of spreader for first step
- For RDF plates, apply 1.5 mL of RDF at 25% concentration one hour prior to test

OVERALL PROGRAM OF TESTS AT NRC, JULY 2011

TABLE 4: FLAPS AND SLATS TEST PLAN

Test #	Precipitation Type	Temp (°C)	Precip. Rate (g/dm²/h)	Fluid Name	Fluid Dilution (%)	Test Surface	Comments
FG1	Light Freezing Rain	-10	25	Cryotech PGA	100/0	Nested 20°	4cm gap. Use top feed plate as 10° baseline for reference.
FG2	Light Freezing Rain	-10	25	Cryotech PGA	100/0	Gapped Nested 20°	4cm gap. Use top feed plate as 10° baseline for reference.
FG3	Light Freezing Rain	-10	13	Dow EG106	100/0	Nested 20°	4cm gap. Use top feed plate as 10° baseline for reference.
FG4	Light Freezing Rain	-10	13	Dow EG106	100/0	Gapped Nested 20°	4cm gap. Use top feed plate as 10° baseline for reference.
FG5	Freezing Drizzle	-10	5	Cryotech PGA	100/0	Nested 35°	4cm gap. Use top feed plate as 10° baseline for reference.
FG6	Freezing Drizzle	-10	5	Cryotech PGA	100/0	Gapped Nested 35°	4cm gap. Use top feed plate as 10° baseline for reference.
FG7	Freezing Drizzle	-3	13	Cryotech PGA	75/25	Nested 20°	4cm gap. Use top feed plate as 10° baseline for reference.
FG8	Freezing Drizzle	-3	13	Cryotech PGA	75/25	Gapped Nested 20°	4cm gap. Use top feed plate as 10° baseline for reference.
SF1	N/A	-3 to -10	N/A	Cryotech PGA	100/0	0 mm Gap	10° top and 27-42°bottom plate. Surfaces must simulate disconnect in slat. Record Visual flow only. Consider using Airfoil.
SF2	N/A	-3 to -10	N/A	Cryotech PGA	100/0	1 mm Gap	10° top and 27-42°bottom plate. Surfaces must simulate disconnect in slat. Record Visual flow only. Consider using Airfoil.
SF3	N/A	-3 to -10	N/A	Cryotech PGA	100/0	1.5-2.0 mm Gap	10° top and 27-42°bottom plate. Surfaces must simulate disconnect in slat. Record Visual flow only. Consider using Airfoil.
SF4	N/A	-3 to -10	N/A	Cryotech PGA	100/0	>2 mm Gap (up to 23.0mm)	10° top and 27-42°bottom plate. Surfaces must simulate disconnect in slat. Record Visual flow only. Consider using Airfoil.
CLE1	Light Freezing Rain	-10	25	Cryotech PGA	100/0	20-35° Flat	Use FG1/2 top plate for baseline.
CLE2	Light Freezing Rain	-10	25	Cryotech PGA	100/0	Curved Plate	Use FG1/2 top plate for baseline. Consider using Airfoil.
CLE3	Light Freezing Rain	-10	13	Dow EG106	100/0	20-35° Flat	Use FG3/4 top plate for baseline
CLE4	Light Freezing Rain	-10	13	Dow EG106	100/0	Curved Plate	Use FG3/4 top plate for baseline. Consider using Airfoil.
CLE5	Freezing Drizzle	-10	5	Cryotech PGA	100/0	20-35° Flat	Use FG5/6 top plate for baseline
CLE6	Freezing Drizzle	-10	5	Cryotech PGA	100/0	Curved Plate	Use FG5/6 top plate for baseline. Consider using Airfoil.
CLE7	Freezing Drizzle	-3	13	Cryotech PGA	75/25	20-35° Flat	Use FG7/8 top plate for baseline
CLE8	Freezing Drizzle	-3	13	Cryotech PGA	75/25	Curved Plate	Use FG7/8 top plate for baseline. Consider using Airfoil.

TABLE 5: LIST OF FLUIDS

TYPE I											
Fluid Name/Code	Batch #	Test Temp	FFP	Brix	Litres Required per Project						Pour Bottles
					ET	TH	SC	RDF	FS	ALL	
E2	52620-76	+1	-9	19.0	8	-	-	-	-	**8**	**8***
E2	52620-76	-3	-13	24.0	16	2	-	-	-	**18**	**8**
E2	52620-76	-6	-16	27.0	24	-	-	-	-	**24**	**8**
E2	52620-76	-10	-20	30.5	24	-	-	-	-	**24**	**8**
E2	52620-76	-25	-35	37.0	8	-	-	-	-	**8**	**8***
Dow UCAR ADF (EG)	Aeromag	-3	-13	17.6	-	-	2	-	-	**2**	**2***
Dow UCAR ADF (EG)	Aeromag	-6	-16	20.1	-	-	-	2	-	**2**	**2***
Dow UCAR ADF (EG)	Aeromag	-10	-20	22.9	-	-	3	-	-	**3**	**3***
Octagon Octaflo EF	WT09	-3	-13	21.25	-	-	8	-	-	**8**	**8***
Octagon Octaflo EF	WT09	50/50		31.5	-	-	2	-	-	**2**	**2***
Octagon Octaflo EF	WT09	-6	-16	23.5	-	-	3	2	-	**5**	**5***
Octagon Octaflo EF	WT09	-10	-20	27.0	-	-	2	-	-	**2**	**2***
Octagon Octaflo EF	WT09	-25	-35	34.5	-	-	2	-	-	**2**	**2***
ALL					**80**	**2**	**22**	**4**	**-**	**108**	**66**

*No other containers needed (for Type Is bring some extra concentrate)

TYPE IV										
Fluid Name/Code	Batch #	Fluid Type	Fluid Dil.	Litres Required per Project						Pour Bottles
				ET	TH	SC	RDF	FS	ALL	
B1	53233-52	IV	100	12	-	-	-	-	**12**	**4**
B2	53233-56	IV	100	12	-	-	-	-	**12**	**4**
K1	2011.07.12.K.A	IV	100	12	-	-	-	-	**12**	**4**
K1	2011.07.12.K.A	IV	75	12	-	-	-	-	**12**	**12***
K1	2011.07.12.K.A	IV	50	4	-	-	-	-	**4**	**4***
K2	2011.07.12.K.B	IV	100	12	-	-	-	-	**12**	**4**
K2	2011.07.12.K.B	IV	75	12	-	-	-	-	**12**	**12***
K2	2011.07.12.K.B	IV	50	4	-	-	-	-	**4**	**4***
C1	2011.07.08.LV2	IV	100	4	-	-	-	-	**4**	**4***
Cryotech PGA	LV2	IV	100	-	-	-	5	12	**17**	**8**
Cryotech PGA	LV2	IV	75	-	-	-	-	4	**4**	**4***
Cryotech PGA	LV2	IV	50	-	-	-	1	-	**1**	**1***
Dow AD-49	4C-24	IV	100	-	-	17	-	-	**17**	**6**
Kilfrost ABC-S+	P/282/12/10	IV	100	-	-	9	5	-	**14**	**5**
Kilfrost ABC-S+	P/282/12/10	IV	50	-	-	-	1	-	**1**	**1***
Dow EG106	WH0601GKDR	IV	100	-	-	-	-	4	**4**	**4***
ALL				**84**	**-**	**26**	**12**	**20**	**142**	**81**

*No other containers needed (for Type IVs consider bringing some extra 100/0)

TABLE 6: TYPE I DILUTION TABLES

Octagon Octaflo EF (PG)					
FFP (°C)	Test Temp (10°B)	% Fluid	Brix	Glycol for 4 L	Water for 4 L
-13	-3	32.0	21.25	1.3	2.7
-16	-6	36.0	23.50	1.4	2.6
-20	-10	42.0	27.00	1.7	2.3
-35	-25	56.0	34.50	2.2	1.8

Dow UCAR ADF (EG)					
FFP (°C)	Test Temp (10°B)	% Fluid	Brix	Glycol for 4 L	Water for 4 L
-13	-3	27.4	17.6	1.1	2.9
-16	-6	31.5	20.1	1.3	2.7
-20	-10	36.3	22.9	1.5	2.5
-35	-25	50.3	30.5	2.0	2.0

E2 (NON-GLYCOL)					
FFP (°C)	Test Temp (10°B)	% Fluid	Brix	Glycol for 4 L	Water for 4 L
-9	+1	28.5	19.00	1.1	2.9
-13	-3	36.7	24.00	1.2	2.8
-16	-6	42.0	27.00	1.3	2.7
-20	-10	48.0	30.50	1.4	2.6
-35	-25	59.5	37.00	1.5	2.5

TABLE 7: EQUIPMENT LIST

HOT and THICKNESS PROJECTS

EQUIPMENT	LOCATION	EQUIPMENT	LOCATION
1L Pour containers (see separate list)	Site	Weigh Scale x 2 (sartorius) + wiring	Site
Barrel Opener	Site	White boards for water run-off	Site
Boards for cold-soak test x13	Site	Yellow Carrying Cases x2	Site
Brixometer x 3	Site	Yellow Ice Pic	Site
Empty 20 L containers for -30C CSW fluid	Site	Cold-soak fluid pump	NRC
Clipboards x 10	Site	Fluid for cold-soak boxes (barrel)	NRC
Close circuit TV camera for rates	Site	Rubber Mats	NRC
Cold-soak box filling stand	Site	Shelving unit x 1	NRC
Cold-soak boxes (all in good condition)	Site	Accordian Folder	Office
Collection pans for stands (one per stand)	Site	ARP 5485 and ARP 5945	Office
Composite Plates x4	Site	Chamber Settings	Office
Composite Boxes x4	Site	Data Forms (on water phobic paper)	Office
Electrical Extension Cords x2	Site	Envelopes (9x12) x box	Office
Fluids (see Table 5)	Site	Hard Drive with Current Project folder	Office
Funnels x 4	Site	Mouse for Rate Station	Office
Gloves - cotton	Site	One Temp Logger Laptop (Old Toshiba)	Office
Gloves - yellow	Site	Paper for printer (1 pack)	Office
Hard water chemicals	Site	Pencils (sharpened) + pens + markers	Office
Hard Water (1x18L)	Site	Printer	Office
Inclinometer (yellow level) x 2	Site	Rate computer x2	Office
Isopropyl x 15	Site	Test Procedures x 2 (1 sided)	Office
Large digital clock x 2	Site		
Marker for Waste x 2	Site		
Measuring Cups (various sizes)	Site		
Memory Card Reader	Site		
Mixing buckets for Type I fluids	Site		
Nuts to separate plates x 100	Site		
Paper Towels (lots)	Site		
Plate covers x 16	Site		
Plates: 12 w/logging +15 w/o logging	Site		
Precipitation Rate Pans x 100	Site		
Protective clothing x 6	Site		
Rate scales with wiring x 2	Site		
Rubber squeegees x 11	Site		
Scrapers x 6	Site		
Shop Vac + Sump Pump + Tubing	Site		
Speed tape	Site		
Spreaders: 12-hole x 2	Site		
Tape measure (yellow + small)	Site		
Temperature probes: immersion x 2	Site		
Temperature probes: surface x 2	Site		
Test Stand Shims (poker chips)	Site		
Test Stands: 2 x 6-position	Site		
Test Stands: 6 positions (for small end)	Site		
Thermistor Kit/blue USB/black RS232/box	Site		
Thermos x 6 (1 full kit with wood holder)	Site		
Thickness Gauges x 4 (both types)	Site		
Tote for Waste Fluid	Site		
Vise grip (large) for containers	Site		
Walkie Talkies x 4	Site		
Watmans Paper and conversion charts	Site		

SPRAYER DOCUMENTATION PROJECT

EQUIPMENT	LOCATION
MR camera x 1 (has video capability)	Site
Camera Suitcase Pack x1	Office

DEPLOYED FLAPS PROJECT

EQUIPMENT	LOCATION
20° and 35° Nested Stands x4	Site
Curved Plate (if available)	?
Thin Aluminum plate (if available)	?
Airfoil	NRC

RUNWAY DEICER PROJECT

EQUIPMENT	LOCATION
Spray bottle for RDF w/spray stoppers x2	Site
Spray bottle for Type I x2	Site/Buy
RDF Fluid	Site
Spreader x2	Site
RDF plates labled x4	Site
Microwave	

SURFACE COATINGS PROJECT

EQUIPMENT	LOCATION
Fluid thickness gauge	Site
Brixometer	Site
3 LogistiClean treated plates	?
White painted aluminum plate	Site
Adhesion probe	Site

FIGURE 3: FREEZING PRECIPITATION ENDURANCE TIME DATA FORM

REMEMBER TO SYNCHRONIZE TIME

LOCATION: CEF (Ottawa) DATE: RUN NUMBER: STAND # :

TIME TO FAILURE FOR INDIVIDUAL CROSSHAIRS (real time)

Time of Fluid Application:

Initial Plate Temperature (°C)
(NEEDS TO BE WITHIN 0.5°C OF AIR TEMP)

Initial Fluid Temperature (°C)
(NEEDS TO BE WITHIN 3°C OF AIR TEMP)

	Plate 1	Plate 2	Plate 3	Plate 4	Plate 5	Plate 6
FLUID NAME/BATCH						
B1 B2 B3						
C1 C2 C3						
D1 D2 D3						
E1 E2 E3						
F1 F2 F3						
TIME TO FIRST PLATE FAILURE WITHIN WORK AREA						
FAILURE CALL (circle)	V. Difficult Difficult. Easy	V. Difficult Difficult. Easy	V. Difficult Difficult. Easy	V. Difficult Difficult. Easy	V. Difficult Difficult. Easy	V. Difficult Difficult. Easy
HRZ. AIR VELOCITY * (circle)	A B C	A B C	A B C	A B C	A B C	A B C

Time of Fluid Application:

Initial Plate Temperature (°C)
(NEEDS TO BE WITHIN 0.5°C OF AIR TEMP)

Initial Fluid Temperature (°C)
(NEEDS TO BE WITHIN 3°C OF AIR TEMP)

	Plate 7	Plate 8	Plate 9	Plate 10	Plate 11	Plate 12
FLUID NAME/BATCH						
B1 B2 B3						
C1 C2 C3						
D1 D2 D3						
E1 E2 E3						
F1 F2 F3						
TIME TO FIRST PLATE FAILURE WITHIN WORK AREA						
FAILURE CALL (circle)	V. Difficult Difficult. Easy	V. Difficult Difficult. Easy	V. Difficult Difficult. Easy	V. Difficult Difficult. Easy	V. Difficult Difficult. Easy	V. Difficult Difficult. Easy
HRZ. AIR VELOCITY * (circle)	A B C	A B C	A B C	A B C	A B C	A B C

PRECIP (circle): ZF , ZD , ZR-, MOD

AMBIENT TEMPERATURE: ________ °C

COMMENTS:

NOTE:
* A: HORIZONTAL AIR VELOCITY ≤ 0.4 m/s
B: 0.4 m/s < HORIZONTAL AIR VELOCITY ≤ 1.0 m/s
C: HORIZONTAL AIR VELOCITY > 1.0 m/s

LEADER / MANAGER: ______________________

FIGURE 4: NRC RATE MANAGEMENT FORM

DATE: ____________________

CONDITION: ____________________ **TECHNICIAN:** ____________________

PAN #	TAB	TIME OUT	1st or 2nd Rate

PAN #	TAB	TIME OUT	1st or 2nd Rate

Retired: 1 2 3 4 5 6 7 8 9 10 11 12

FIGURE 5: FLUID THICKNESS DATA FORM

DATE: ______________ **TEMPERATURE °C (beg.):** ______________ **PERFORMED BY:** ______________

TEST #: _______ to _______ **WIND SPEED, kph (beg.):** ______________ **WRITTEN BY:** ______________

STAND: ______________ **LOCATION:** CEF (NRC)

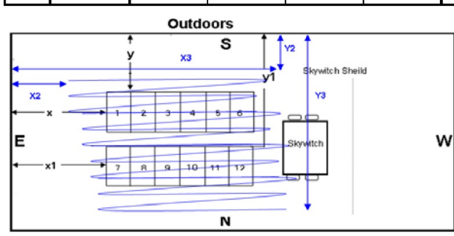
THICKNESS (mil)											
Plate: **U** Run #: Fluid: Application Time:		Plate: **V** Run #: Fluid: Application Time:		Plate: **W** Run #: Fluid: Application Time:		Plate: **X** Run #: Fluid: Application Time:		Plate: **Y** Run #: Fluid: Application Time:		Plate: **Z** Run #: Fluid: Application Time:	
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 2, 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

FIGURE 6: STAND POSITION / SPRAYER CHARACTERISTICS FORM

		STEP 1				STEP 2				STEP 3	STEP 4	
Test	Condition	Final Stand Position				Area of spray zone				Cycle Time	Time that plate is Impacted	
		x	y	x1	y1	x2	y2	x3	y3	sec.	secs	video
1	ZR6H											
2	ZR6L											
3	ZR10H											
4	ZR10L											
5	ZD3H											
6	ZD3L											
7	ZD6H											
8	ZD6L											
9	ZD10H											
10	ZD10L											
11	ZFOG3H											
12	ZFOG3L											
13	ZFOG6H											
14	ZFOG6L											
15	ZFOG10H											
16	ZFOG10L											
17	ZFOG25H											
18	ZFOG25L											
19	CSWH											
20	CSWL											



Step 1: Measure test stand location at end of condition (during rates) ±2.5 cm

Step 2: Visually inspect where precipitation hits the ground; record area ±30 cm
↔ X2 measure from east wall (closest)
↔ X3 measure from east wall (furthest)
↕ Y2 measure from south wall (closest)
↕ Y3 measure from south wall (furthest)

Step 3: Measure time the spray pattern takes to complete 1 cycle (because of interlinking of spray pattern the sprayer goes through 2 sweeps) ±1 sec.

Step 4: Take video of one plate position for one cycle in each condition (suggest using blue towel).

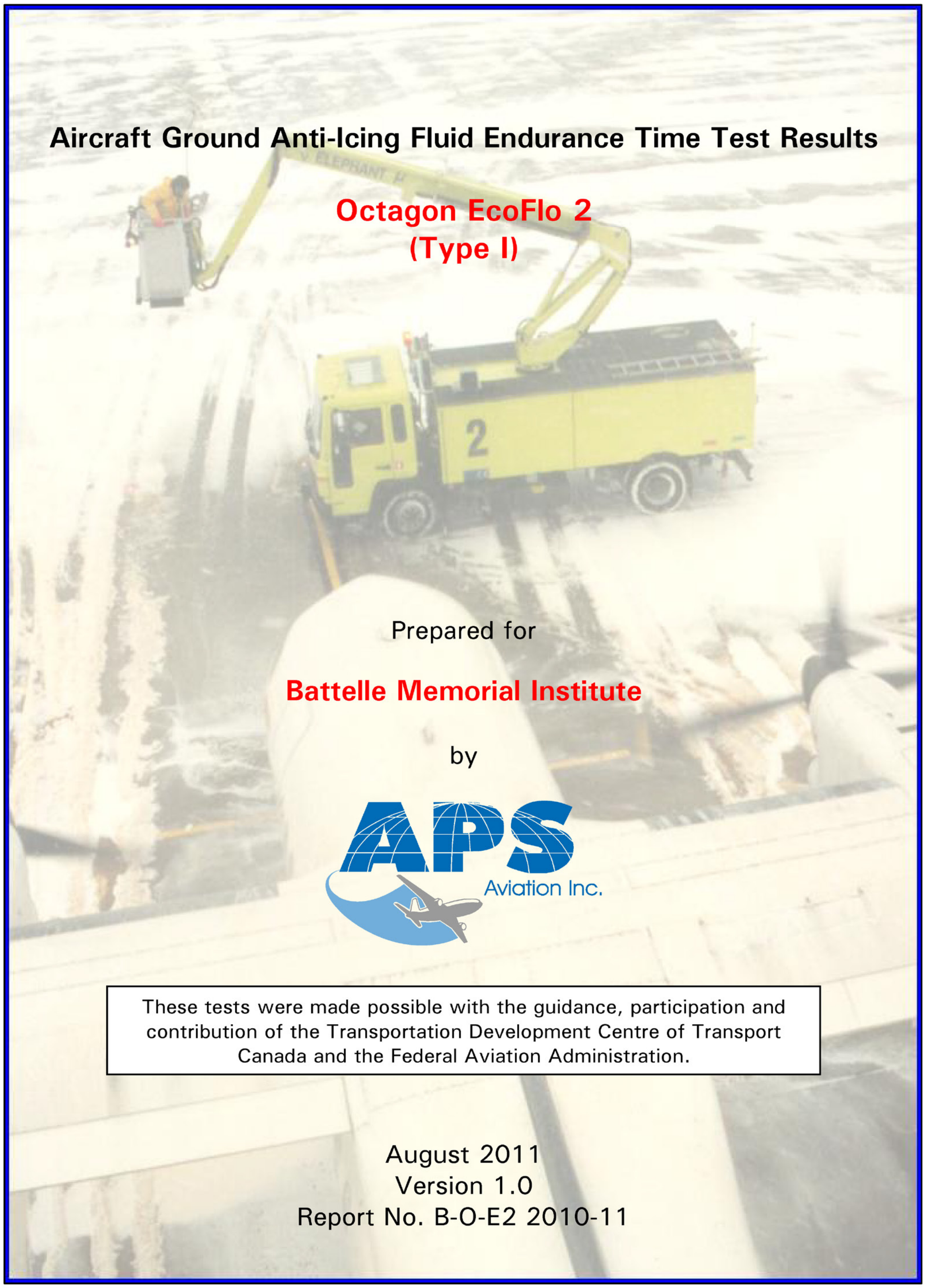
Month/Year: ______________

Performed by: ______________________________

Written by: ______________________________

APPENDIX C

FLUID MANUFACTURER REPORT:
OCTAGON ECOFLO 2 (TYPE I)



Aircraft Ground Anti-Icing Fluid Endurance Time Test Results

Octagon EcoFlo 2
(Type I)

Prepared for

Battelle Memorial Institute

by

APS Aviation Inc.

These tests were made possible with the guidance, participation and contribution of the Transportation Development Centre of Transport Canada and the Federal Aviation Administration.

August 2011
Version 1.0
Report No. B-O-E2 2010-11

Aircraft Ground Anti-Icing Fluid Endurance Time Test Results

Octagon EcoFlo 2
(Type I)

Prepared for

Battelle Memorial Institute

Prepared by: Stephanie Bendickson, Project Analyst — August 4, 2011 (Date)

Reviewed by: John D'Avirro, Program Manager, Eng. — August 4, 2011 (Date)

These tests were made possible with the guidance, participation and contribution of the Transportation Development Centre of Transport Canada and the Federal Aviation Administration.

August 2011
Version 1.0
Report No. B-O-E2 2010-11

ii

FLUID IDENTIFICATION AND CHARACTERISTICS

Manufacturer:	Battelle Memorial Institute	
Fluid Test Name:	E2	
Fluid Commercial Name:	Octagon EcoFlo 2	
Fluid Type / Colour:	Type I / Orange	
Fluid Formulation:	Non-glycol	
Batch #:	52620-76	
Date of Receipt:	July 12, 2011	
Brix (Measured):	Concentrate:	> 50°
LOUT (Stated)	High Speed Test:	-29°C (65/35 dilution)
	Low Speed Test:	not tested
WSET (from AMIL):	50/50:	4.9 minutes

This page intentionally left blank.

iv

SUMMARY

The primary objective of this project was to measure the endurance time performance of Octagon EcoFlo 2 over the entire range of conditions encompassed by the Type I Holdover Time (HOT) tables. This report contains the results of these measurements and was completed with the support of the fluid manufacturer, the Transport Development Centre (TDC) of Transport Canada and the Federal Aviation Administration (FAA).

The HOT test procedure consisted of pouring fluids onto clean aluminum and composite test surfaces inclined at 10°; the onset of failure was recorded as a function of time in simulated freezing fog, freezing drizzle, light freezing rain, and rain on cold soaked wing, and in artificial snow. Endurance time tests were performed at the National Research Council Canada (NRC) Climatic Engineering Facility (CEF) located in Ottawa, Ontario and at the APS Aviation Inc. (APS) test facility located at the Pierre-Elliott-Trudeau International Airport in Montreal, Quebec.

The endurance time results obtained show Octagon EcoFlo 2 has similar or superior endurance times to Type I fluids tested in past years. These results indicate Octagon EcoFlo 2 can be used as a Type I fluid with the current Type I generic HOT guidelines.

At the request of the manufacturer, this fluid was tested in the summer of 2011 to enable its inclusion in the 2011-2012 Transport Canada / FAA holdover time guidelines. Limited testing in natural snow is anticipated in the winter of 2011-12 to verify the results of the indoor testing completed in the summer of 2011. An updated version of this report will be issued upon completion of the natural snow testing.

This page intentionally left blank.

vi

TABLE OF CONTENTS

This page intentionally left blank.

LIST OF FIGURES Page

LIST OF TABLES Page

LIST OF PHOTOS Page

LIST OF FIGURES, TABLES AND PHOTOS

GLOSSARY

APS	APS Aviation Inc.
ARP	Aerospace Recommended Practice
CEF	Climatic Engineering Facility
FAA	Federal Aviation Administration
HOT	Holdover Time
ISO	International Organization for Standardization
LWC	Liquid Water Content
MVD	Median Volume Diameter
MANOBS	Manual of Surface Weather Observations
NCAR	National Center for Atmospheric Research
NRC	National Research Council Canada
SAE	Society of Automotive Engineers, Inc.
TDC	Transportation Development Centre

This page intentionally left blank.

1. INTRODUCTION

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 de/anti-icing fluid holdover time (HOT) tables. 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.

Testing has shown that Type II and Type IV fluid endurance time performance varies considerably by fluid. As a result, endurance time testing is carried out with all Type II and Type IV fluids and fluid-specific HOT tables are developed for each Type II/IV fluid based on the results of the testing.

In contrast, a significant body of previous research and testing has indicated that Type I fluids formulated with glycol perform in a similar manner from an endurance time perspective. As a result, all Type I fluids are used with the Type I generic holdover times (no fluid-specific holdover times are provided) and regulators no longer require endurance time testing be conducted with Type I fluids formulated with propylene glycol, ethylene glycol or diethylene glycol. However, they do require that the endurance time performance of fluids formulated with other glycol bases or with non-glycol bases be measured. This is to ensure the endurance time performance of these fluids is similar to the performance of the Type I fluids that were used to generate the current Type I generic holdover times.

This report provides a detailed account of the endurance time testing APS Aviation Inc. (APS) carried out with **Octagon EcoFlo 2**, a new non-glycol based Type I fluid. It describes the test methodology used, endurance time data collected, and conclusions derived from the results.

This report has been created with the support of the fluid manufacturer, the Transport Development Centre (TDC) of Transport Canada and the Federal Aviation Administration (FAA).

This page intentionally left blank.

2

2. METHODOLOGY

Society of Automotive Engineers (SAE) Aerospace Recommended Practice (ARP) 5945 provides the procedure and requirements for endurance time testing with Type I fluids under natural and simulated conditions. This chapter summarizes some of aspects of the test methodology included in ARP5945, and some aspects which are not included in ARP5945. The chapter includes sections for test sites, equipment, procedures, precipitation rates and ambient temperatures used in Type I endurance time testing, and freezing precipitation droplet sizes. The final subsection describes the analysis methodology used to evaluate Type I endurance time data.

2.1 Test Sites

Natural and artificial snow testing was performed at the APS test site located at the Montréal-Pierre-Elliott-Trudeau International Airport. The location of the test site is shown on the plan view of the airport shown in Figure 2.1. Photos 2.1 and 2.2 show the test site; the site consists of two trailers and three test stand platforms. The APS test site is located near the Meteorological Services of Canada (a division of Environment Canada) automated weather observation station.

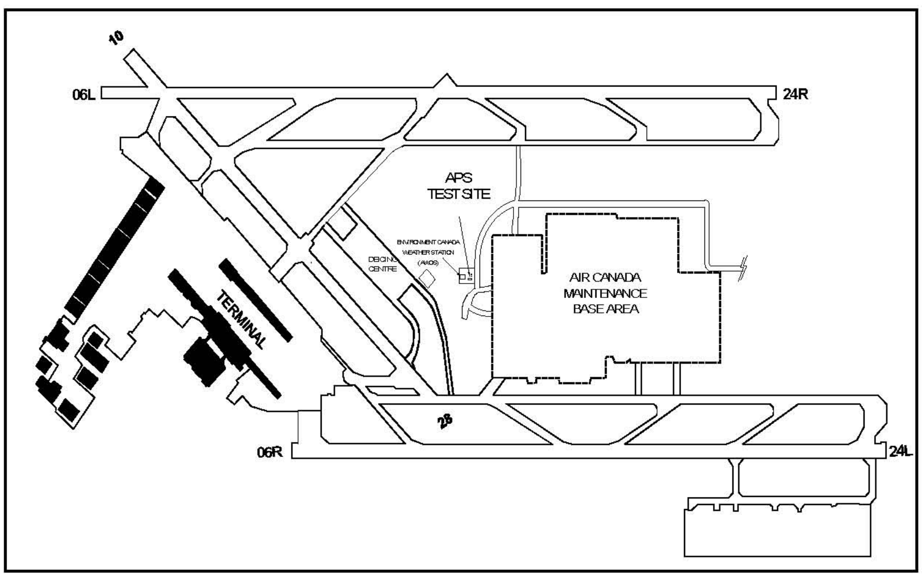


Figure 2.1: APS Test Site at Montréal-Pierre-Elliott-Trudeau International Airport

Tests under conditions of simulated freezing fog, freezing drizzle, light freezing rain and rain on cold soaked wing were conducted indoors at the National Research Council (NRC) Climatic Engineering Facility (CEF), where precipitation is 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.

2.2 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.

2.2.1 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) 9001:2000 standards, and developed internally by APS.

2.2.2 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 ARP5945.

2.2.3 Test Surface Structures

The majority of endurance time testing is carried out on standard flat plates. A schematic of a standard flat plate is provided in Figure 2.2. 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 2.3.4) are achieved. Photo 2.5, taken outdoors at APS test site, shows six test plates mounted on a test stand.

Figure 2.3 shows a schematic of the sealed boxes used for tests simulating a cold soaked wing and in natural snow testing with Type I fluids. The top of the box consists of a flat plate identical to the standard flat plate. A box shaped reservoir is welded to the bottom of the plate. Photo 2.6 shows a picture of a sealed box, which is referred to as a cold-soak box when filled for simulated rain on cold soaked wing tests and a leading edge thermal equivalent box when used empty for testing Type I fluids in natural snow conditions.

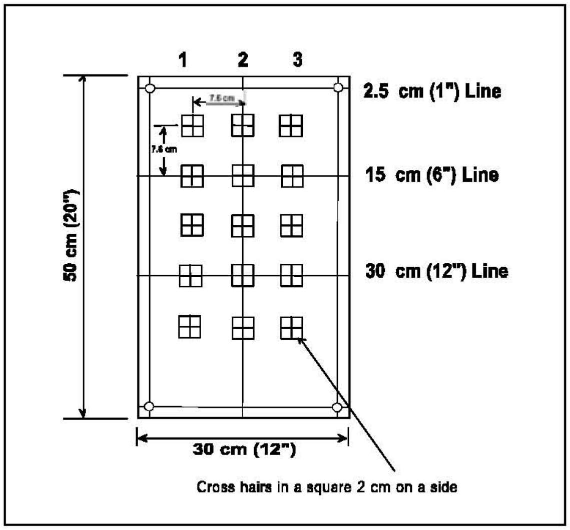


Figure 2.2: Standard Test Plate Schematic

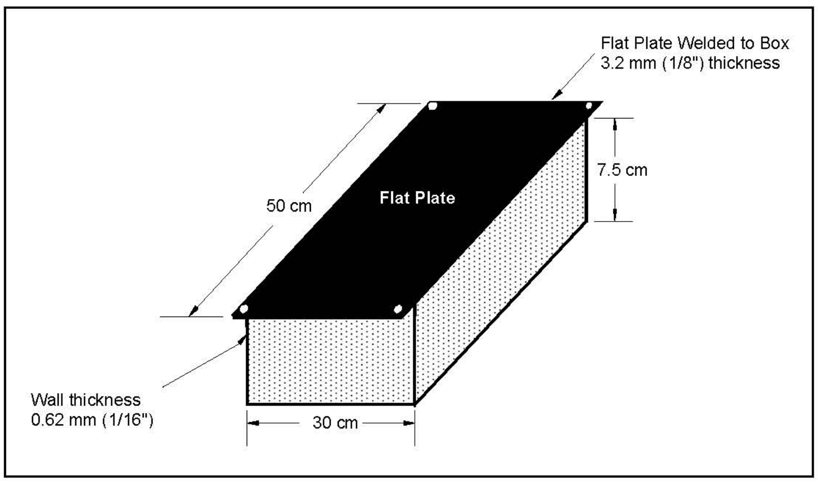


Figure 2.3: Cold Soak Box Schematic

2.2.4 Test Surface Materials

Extensive research has shown holdover times of Type I fluids can be shorter on composite surfaces than on aluminum surfaces. For many years all test surfaces used in endurance time testing were constructed of aluminum. However, since Transport Canada and the FAA implemented new holdover times for composite surfaces in the winter of 2010-11, all new Type I fluids evaluated for endurance time performance are tested on both aluminum and composite surfaces. The details of the test surface materials are as follows:

- Aluminum: Alclad 2024 T3 aluminum, 0.32 cm thick; and
- Composite: Carbon fibre cross weave fabric, 0.32 cm thick.

Previous research has shown this composite material produces endurance time results representative of many composite aircraft materials.

2.2.5 Test Stands

Figure 2.4 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. Photos 2.4 and 2.5 show the test stands set up for indoor and outdoor testing, respectively.

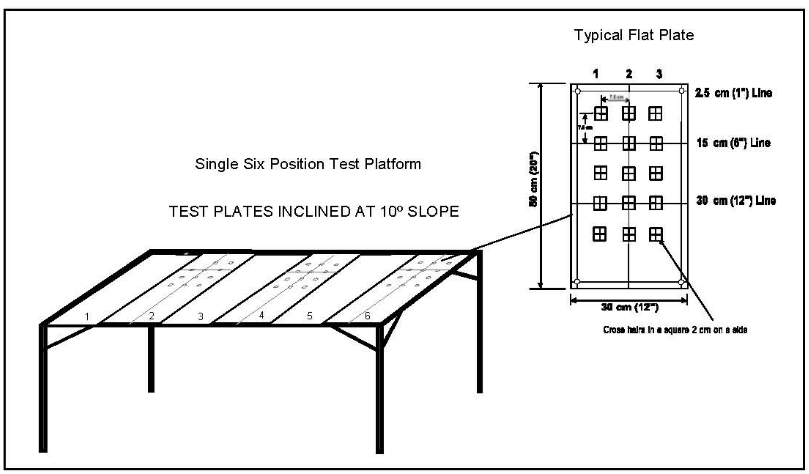


Figure 2.4: Test Stand Setup Schematic

2.2.6 Collection Pans

Figure 2.5 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 2.7 shows the collection pans used for measuring precipitation rates indoors at the NRC.

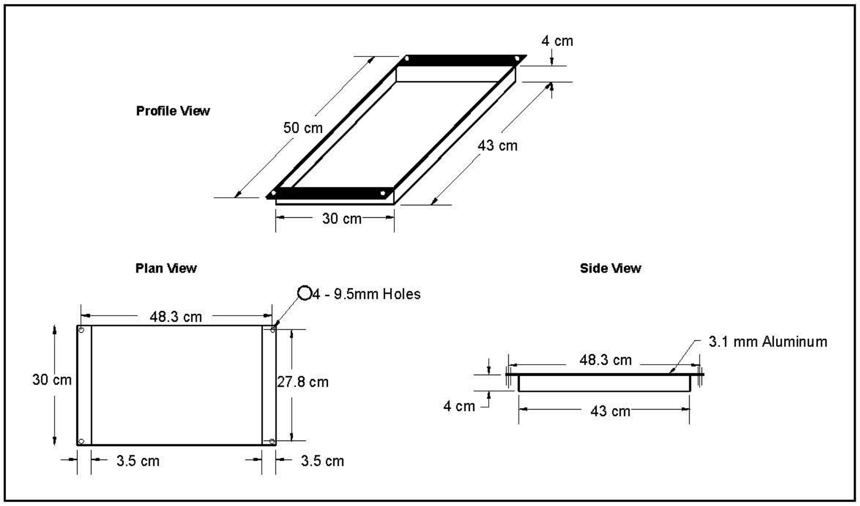


Figure 2.5: Schematic of Outdoor Precipitation Measurement Pan

2.2.7 NRC Sprayer Assembly

NRC developed an improved sprayer assembly, shown in Photos 2.8 and 2.9, 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 2.10.

2.2.8 Refractometer

Freeze points were measured using a hand-held Misco refractometer with a Brix scale (see Photo 2.11)

2.2.9 12-Hole Spreader

A 12-hole spreader was used to apply fluids during natural and artificial snow tests (see Photo 2.12).

2.2.10 Fluids

Testing was carried out using fluid diluted to a freeze point 10°C below the ambient temperature. Information provided by the manufacturer was used to develop the dilution table shown in Table 2.1, which was used to mix the fluid to the appropriate freeze point for each test.

Table 2.1: Octagon EcoFlo 2 Dilution Table

Test Temp. (°C)	FFP (°C)	Fluid %	Brix (°)	Glycol for 4 L	Water for 4 L
+1	-9	28.5	19.0	1.1	2.9
-3	-13	36.7	24.0	1.2	2.8
-6	-16	42.0	27.0	1.3	2.7
-10	-20	48.0	30.5	1.4	2.6
-25	-35	59.5	37.0	1.5	2.5

2.3 Test Procedures

ARP5945 provides the procedure for endurance time testing of Type I fluids under natural precipitation conditions and simulated freezing 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 2.3.4), when a specified degree of freezing occurs. The following subsections provide summaries of the test procedures followed for natural snow, artificial snow and simulated freezing precipitation testing.

2.3.1 Test Protocol – Natural Snow Tests

APS developed a specific procedure for Type I testing in natural snow based on the requirements outlined in ARP5945. Key details of the procedure include:

- Tests are conducted on empty leading edge thermal equivalent boxes (see Subsection 2.2.3);
- Fluid is diluted to a freeze point 10°C below ambient temperature using information provided by the fluid manufacturer (see Table 2.1);
- Fluid is applied at a temperature of 60°C;
- 0.5 L of fluid is applied to the test surface with a 12-hole spreader; and
- For each test with a new Type I fluid, a test with a Type I reference fluid is conducted simultaneously. The reference fluid is a Type I fluid that was used in the determination of the current Type I generic holdover times.

2.3.2 Test Protocol – Artificial Snow Tests

APS developed a specific procedure for testing in artificial snow based on the requirements outlined in ARP5485 (currently ARP5945 does not provide a procedure for artificial snow testing). Key details of the procedure include:

- Tests are conducted on a standard plate with insulated tray (shown in Photo 2.13);
- Fluid is diluted to a freeze point 10°C below ambient temperature using information provided by the fluid manufacturer (see Table 2.1);
- Fluid is applied at a temperature of 60°C;
- 0.5 L of fluid is applied to the test surface with a 12-hole spreader; and
- For each test with a new Type I fluid, a test with a Type I reference fluid is conducted simultaneously. The reference fluid is a Type I fluid that was used in the determination of the current Type I generic holdover times.

2.3.3 Test Protocol – Simulated Precipitation Tests

APS developed a specific procedure for Type I testing in natural snow based on the requirements outlined in ARP5945. Key details of the procedure include:

- Freezing fog, freezing drizzle and light freezing rain tests are conducted on standard flat plates (see Section 2.2.3);
- Cold-soak surface tests are conducted on filled cold-soak boxes (see Section 2.2.3);
- Fluid is diluted to a freeze point 10°C below ambient temperature using information provided by the manufacturer (see Table 2.1);
- Fluid is applied at a temperature of 20°C; and
- 1 L of fluid is hand-poured on the test surface.

2.3.4 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.

2.3.5 Precipitation Rate Measurement Procedures

The procedures for measuring and determining precipitation rates during simulated precipitation and natural precipitation conditions are provided below.

2.3.5.1 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. Prior to the start of the precipitation catch period, the exact time (hh:mm:ss) is recorded. 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 this 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.

2.3.5.2 Natural precipitation conditions

Two rate collection pans per test stand are 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 the each pan are wetted with Type IV anti-icing 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) from the timepiece located near the rate station before leaving the trailer to place the pans on the test stand. The person responsible for collecting precipitation rate data take the time delay necessary to proceed outside from the rate station into consideration.

The pans are positioned in locations 6 and 7 (see Figure 2.4) and are allowed to collect precipitation for 10-minute intervals in normal conditions and 5-minute intervals in periods of high precipitation rates and high winds. 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 has failed.

The rate for any HOT test in natural snow is obtained by computing the time-weighted average of the rates collected in the upper and lower pans over the duration of this particular test.

An example of the rate calculation method for tests in natural snow conditions is displayed in Figure 2.6. Typically, two collections pans are used for each test. The start and end times of the test 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 2.6, 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.

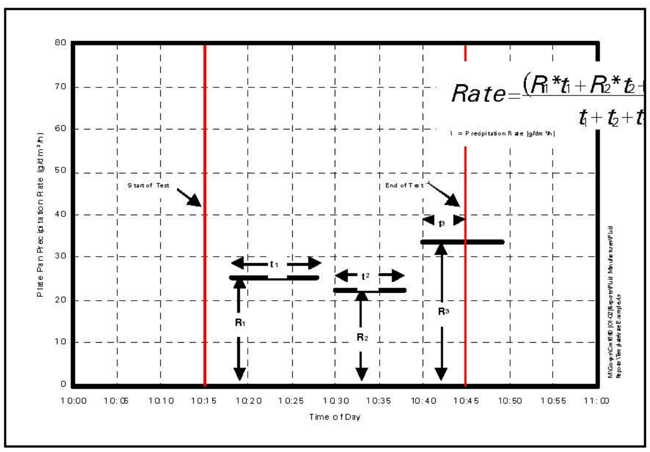


Figure 2.6: Calculation of Outdoor Precipitation Rate

2.4 Precipitation Rate Limits in Type I Endurance Time Testing

Upper and lower precipitation rate limits are an important part of the test methodology for measuring fluid endurance times. Table 2.2 provides the meteorologically accepted definitions of weather phenomenon / precipitation types. It also includes the criteria used to determine precipitation intensity. This table 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).

Table 2.2: Definition of Weather Phenomenon

Weather Phenomenon*	Definition*
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 visibility at the earth's surface to less than 1 km (5/8 mile).
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 (23°F), the crystals are generally agglomerated into snowflakes.
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 the ground or other exposed objects.
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 mm (0.02 in.) or smaller drops which, in contrast to drizzle, are widely separated.
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)	Precipitation of white and opaque grains of ice. These grains are spherical or sometimes conical; their diameter is about 2-5 mm (0.1-0.2 in.). Grains are brittle, easily crushed; they bounce and break on hard ground.
SNOW GRAINS (SG)	Precipitation of very small white and opaque grains of ice. These grains are fairly flat or elongated; their diameter is less than 1 mm (0.04 in.). When the grains hit hard ground, they do not bounce or shatter.
HAIL (GR)	Precipitation of small balls or pieces of ice with a diameter ranging from 5 to > 50 mm (0.2 to 2.0 in.) falling either separately or agglomerated.
ICE PELLETS (PE) Note: Includes Sleet and Small Hail	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.) or less. The pellets of ice usually bounce when hitting hard ground.

Intensity Criteria**

	Snow(SN),Pellets(GS),Grains(SG),Frz Drizzle(FZDZ)		Ice Pellets (PE)
Estimated Intensity	Horizontal Visibility (statute mile)	Liquid Equivalent Snow (S) Intensity***	Definition and Horizontal Visibility
Light (-)	If visibility is: ≥ 5/8 mi (≥ 1.0 km)	Trace to 0.05 in/hr (≤ 1.0 mm or 10.0 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 or 25.0 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 shown that visibility and precipitation intensity are not always directly correlated.

	Drizzle Intensity (FZDZ)
Light(-)	Trace to 0.01 in/hr (0.254 mm 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)
Light (-)	Measured Intensity	Up to 0.10 in/hr (2.5 mm or 25 gr/dm²/hr); Maximum 0.01 inch in 6 minutes
	Estimated Intensity	From scattered drops that, regardless of duration, do not completely wet an exposed surface up to a condition where individual drops are easily seen.
Moderate	Measured Intensity	0.11 in to 0.30 in/hr (7.6 mm or 76 gr/dm²/hr); More than 0.01 to 0.03 inch in 6 minutes
	Estimated Intensity	Individual drops are not clearly identifiable; spray is observable just above pavement and other hard surfaces.
Heavy (+)	Measured Intensity	More than 0.30 in/hr (7.6 mm or 76 gr/dm²/hr); More than 0.03 inch in 6 minutes
	Estimated Intensity	Rain seemingly falls in sheets; individual drops are not identifiable; heavy spray to height of several inches is observed over hard surfaces.

* 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 Proposed Definition for Liquid Equivalent Snowfall Intensity

1) gm/dm² = 0.01 cm = 0.1 mm = 0.0039 in
2) in = 2.54 cm = 25.4 mm = 254 gm/dm²

Compiled by Jeff Cole and Roy Rasmussen of NCAR/RAP June 17, 1997 (Updated for METAR codes)

The precipitation rate limits established for Type I endurance time testing are provided in ARP5945 and represented graphically in Figure 2.7. Subsections 2.4.1 to 2.4.5 provide detailed definitions and explanations of the precipitation types and rate boundaries used in Type I 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 2.2.

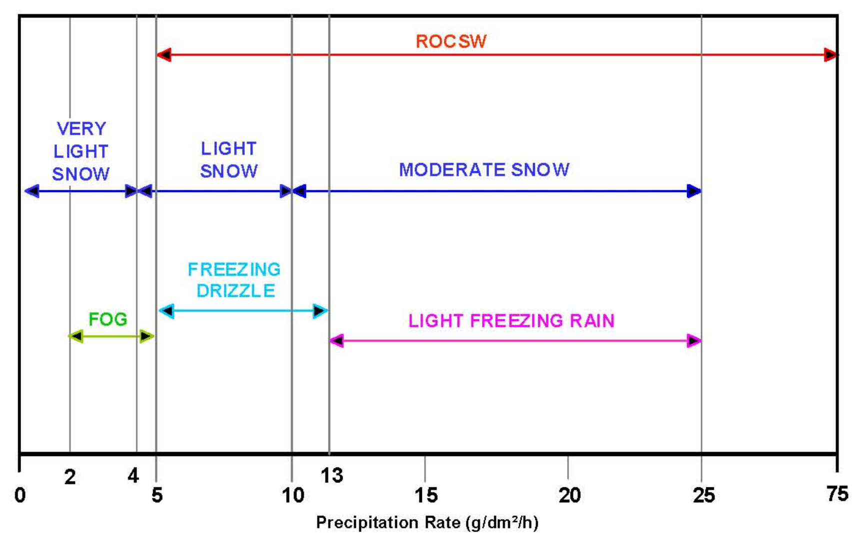


Figure 2.7: Precipitation Rate Limits Used in Endurance Time Testing

2.4.1 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.

2.4.2 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.

2.4.3 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.

2.4.4 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 $g/dm^2/h$).

2.4.5 Snow

The precipitation rate limits used to determine holdover times for Type I fluids in snow are as follows:

a) Very light snow: 4 $g/dm^2/h$;
b) Light snow: 4 and 10 $g/dm^2/h$; and
c) Moderate snow: 10 and 25 $g/dm^2/h$.

Notably, Type II and Type IV holdover times are determined using the precipitation rate limits for moderate snow: 10 and 25 $g/dm^2/h$.

2.5 Ambient Temperatures in Type I Endurance Time Testing

The Type I generic holdover time tables provide holdover times for four temperature ranges:

- -3°C and above
- Below -3 to -6°C
- Below -6 to -10°C
- Below -10°C

In natural snow testing, endurance time testing is carried out under a range of temperatures. In simulated freezing precipitation testing and artificial snow testing, endurance time testing is typically conducted at the lower limit of each temperature band.

- Freezing Fog: -3°C, -6°C, -10°C and -25°C
- Freezing Drizzle: -3°C, -6°C and -10°C
- Light Freezing Rain: -6°C and -10°C (see note below)
- Rain on Cold Soaked Surface: +1°C
- Artificial Snow: -3, -6, -10 and/or -25°C

Note: Testing is not carried out with Type I fluids in light freezing rain at -3°C as the latent heat of freezing in calm test conditions produces artificially long endurance times.

2.6 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 2.3 beside the experimental MVDs for each precipitation condition.

Table 2.3: 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

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 P.E.T. 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
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

2.7 Summary of Freezing Precipitation Test Conditions

The precipitation types/rates, ambient temperatures and droplet sizes for freezing precipitation testing with Type I fluids were described in the previous subsections. In summary, freezing precipitation tests are carried out under each of the 20 weather conditions listed in Table 2.4.

Table 2.4: Summary of Freezing Precipitation Test Conditions (Type I Fluids)

Precipitation Type	Ambient Temperature	Precipitation Rate (Droplet Size)
Freezing Fog	-3°C	2 g/dm²/h (30 µm)
		5 g/dm²/h (30 µm)
	-6°C	2 g/dm²/h (30 µm)
		5 g/dm²/h (30 µm)
	-10°C	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)
Freezing Drizzle	-3°C	5 g/dm²/h (250 µm)
		13 g/dm²/h (350 µm)
	-6°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	-6°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)

2.8 Analysis Methodology

The endurance time performance of Type I fluids is evaluated by comparing the data collected to the performance of historical Type I fluids (i.e. the Type I fluids the generic Type I holdover times are based on). In order for the endurance time performance of a new Type I fluid to be considered acceptable, the endurance time results need to be similar or superior to the historical fluid data.

For simulated freezing precipitation, the new fluid data is plotted on endurance time vs. rate of precipitation charts along with the historic fluid data and a visual examination determines if the new fluid's performance is similar or superior to the historical data.

For snow, the endurance time of each test conducted with a new Type I fluid is compared to the endurance time of the baseline test conducted simultaneously (natural snow) or immediately after (artificial snow) the test with a historical (baseline) Type I fluid. The data set must show that the new fluid has similar or superior endurance times relative to the baseline test.

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

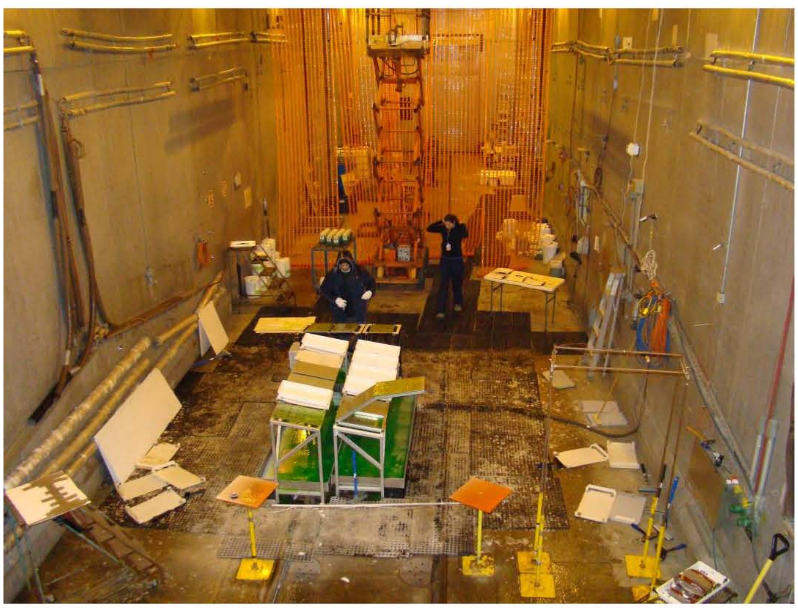


Photo 2.5: Test Plates Mounted on Stand

Photo 2.6: Cold-Soak / Leading Edge Thermal Equivalent Box

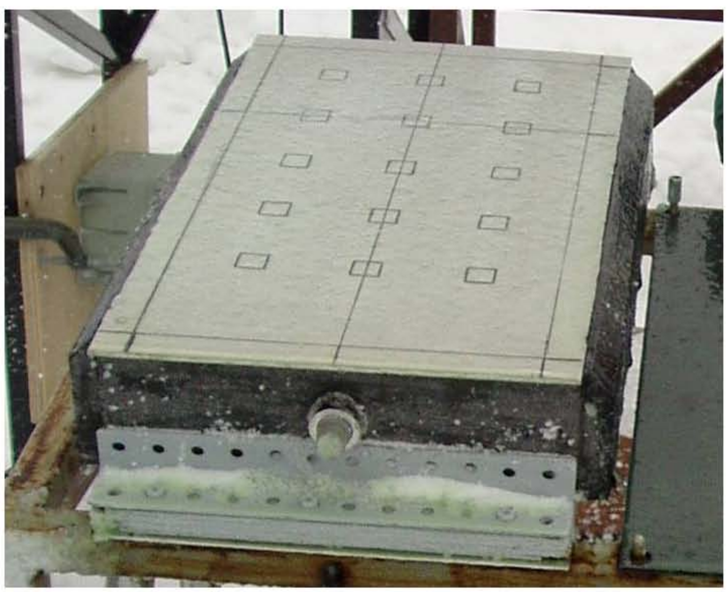


Photo 2.7: Collection Pans Used Indoors at the NRC

Photo 2.8: Sprayer Assembly

Photo 2.9: Sprayer Assembly in Use

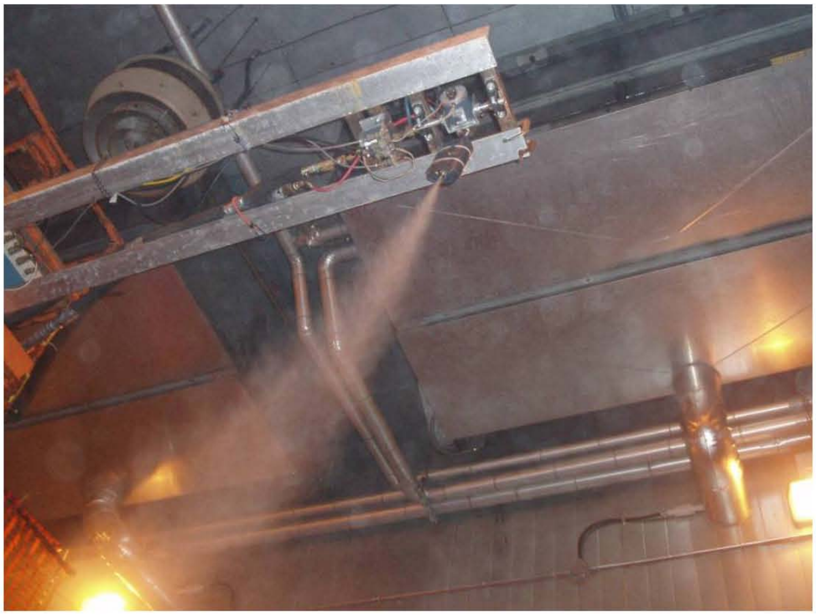


Photo 2.10: Sprayer Nozzle

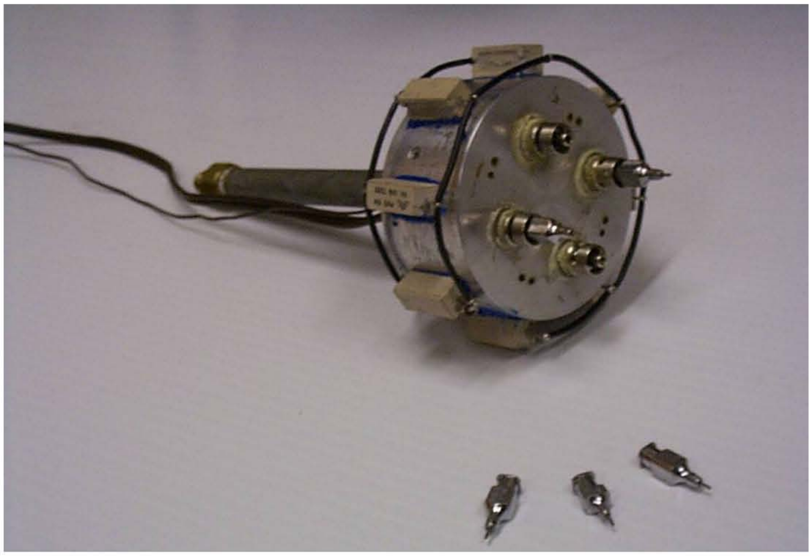


Photo 2.11: Hand Held Brixometer

Photo 2.12: Twelve Hole Spreader Used for Fluid Application

Photo 2.13: Standard Plate Setup for Type I Testing with Artificial Snowmaker

This page intentionally left blank.

3. DESCRIPTION OF DATA

This section provides a summary of the number of tests conducted. Breakdowns are provided for quantity of tests performed by precipitation type, fluid dilution, test surface and test temperature. A list of the tests conducted is provided in Table 3.2 at the end of this section.

3.1 Natural Snow Tests

Natural snow tests will be conducted in the winter of 2011-12. A revised version of this report will be issued upon completion of natural snow testing.

3.2 Artificial Snow Tests

Two tests were conducted with an artificial snowmaker at the APS test site. Both tests were conducted on an aluminum surface at -3°C. For comparison purposes, the tests were repeated with a baseline Type I fluid.

Fluid Dilution	Test Surface	-3°C	-6°C	-10°C	-25°C
10°C Buffer	Aluminum	2	0	0	0

3.3 Freezing Fog Tests

Tests were conducted in freezing fog conditions at the NRC CEF. The breakdown of tests conducted is summarized below by fluid dilution, test surface and test temperature.

Fluid Dilution	Test Surface	-3°C	-6°C	-10°C	-25°C
10°C Buffer	Aluminum	4	6	4	4
10°C Buffer	Composite	4	4	4	4

3.4 Freezing Drizzle Tests

Tests were conducted in freezing drizzle at the NRC CEF. The breakdown of tests conducted is summarized below by fluid dilution, test surface and test temperature.

Fluid Dilution	Test Surface	-3°C	-6°C	-10°C
10°C Buffer	Aluminum	4	4	4
10°C Buffer	Composite	4	4	4

3.5 Light Freezing Rain Tests

Tests were conducted in light freezing rain conditions at the NRC CEF. The breakdown of tests conducted is summarized below by fluid dilution, test surface and test temperature.

Fluid Dilution	Test Surface	-3°C	-6°C	-10°C
10°C Buffer	Aluminum	0*	4	4
10°C Buffer	Composite	0*	4	4

** Type I fluids are not tested in freezing rain at -3°C because the latent heat of freezing in calm test conditions produces artificially long endurance times.*

3.6 Rain on Cold-Soaked Surface Tests

Tests were conducted in rain on cold-soaked surface conditions at the NRC CEF. The breakdown of tests conducted is summarized below by fluid dilution, test surface and test temperature.

Fluid Dilution	Test Surface	+ 1°C
10°C Buffer	Aluminum	4
10°C Buffer	Composite	4

3.7 Fluid Thickness Tests

The purpose of these tests was to measure the film thickness profile of Octagon EcoFlo 2 (mixed to a 10° buffer) under dry conditions. Two tests were performed at an ambient temperature of -3°C.

For each test, one litre of fluid was poured onto a flat plate mounted at 10° to the horizontal. Film thickness measurements were taken at the 15-cm (6") line at pre-selected time intervals over a 30-minute interval. The thickness after 30 minutes was 0.04 mm. The measurements are displayed in Table 3.1.

Table 3.1: Fluid Thickness Measurements

Measurement	Time After Application (mins)	Thickness (mm)	
		Run 1	Run 2
1	2	0.06	0.06
2	5	0.06	0.06
3	15	0.04	0.04
4	30	0.04	0.04

Table 3.2: Summary of Tests Performed

Test No.	Date	Fluid Name	Fluid Dil.*	Icing Intensity (g/dm²/h)	Endurance Time (min)	Test Temp. (°C)	Test Surface	Precipitation Type
1	19-Jul-11	Octagon EcoFlo 2	10°B	2.3	19.3	-3.2	Aluminum	Freezing Fog
2	19-Jul-11	Octagon EcoFlo 2	10°B	1.9	20.1	-3.1	Aluminum	Freezing Fog
3	19-Jul-11	Octagon EcoFlo 2	10°B	2.1	18.8	-3.2	Composite	Freezing Fog
4	19-Jul-11	Octagon EcoFlo 2	10°B	1.7	20.5	-3.1	Composite	Freezing Fog
5	19-Jul-11	Octagon EcoFlo 2	10°B	5.5	12.7	-3.3	Aluminum	Freezing Fog
6	19-Jul-11	Octagon EcoFlo 2	10°B	5.0	12.8	-3.3	Aluminum	Freezing Fog
7	19-Jul-11	Octagon EcoFlo 2	10°B	5.1	11.5	-3.3	Composite	Freezing Fog
8	19-Jul-11	Octagon EcoFlo 2	10°B	4.9	9.7	-3.3	Composite	Freezing Fog
9R	19-Jul-11	Octagon EcoFlo 2	10°B	2.1	14.3	-5.9	Aluminum	Freezing Fog
10	19-Jul-11	Octagon EcoFlo 2	10°B	2.0	16.9	-6.0	Aluminum	Freezing Fog
10R	19-Jul-11	Octagon EcoFlo 2	10°B	1.9	15.8	-5.9	Aluminum	Freezing Fog
11	19-Jul-11	Octagon EcoFlo 2	10°B	1.8	13.4	-6.1	Composite	Freezing Fog
12	19-Jul-11	Octagon EcoFlo 2	10°B	2.1	12.9	-6.1	Composite	Freezing Fog
13	19-Jul-11	Octagon EcoFlo 2	10°B	4.7	7.9	-5.9	Aluminum	Freezing Fog
13R	19-Jul-11	Octagon EcoFlo 2	10°B	4.7	9.7	-6.1	Aluminum	Freezing Fog
14	19-Jul-11	Octagon EcoFlo 2	10°B	4.9	9.7	-5.9	Aluminum	Freezing Fog
15	19-Jul-11	Octagon EcoFlo 2	10°B	4.7	7.7	-5.9	Composite	Freezing Fog
16	19-Jul-11	Octagon EcoFlo 2	10°B	4.7	8.5	-5.9	Composite	Freezing Fog
17	19-Jul-11	Octagon EcoFlo 2	10°B	1.9	13.1	-9.9	Aluminum	Freezing Fog
18R	19-Jul-11	Octagon EcoFlo 2	10°B	2.2	11.7	-10.2	Aluminum	Freezing Fog
19	19-Jul-11	Octagon EcoFlo 2	10°B	2.2	10.5	-9.9	Composite	Freezing Fog
20	19-Jul-11	Octagon EcoFlo 2	10°B	1.8	10.6	-9.9	Composite	Freezing Fog
21	19-Jul-11	Octagon EcoFlo 2	10°B	5.3	8.7	-9.8	Aluminum	Freezing Fog
22	19-Jul-11	Octagon EcoFlo 2	10°B	4.9	9.3	-9.8	Aluminum	Freezing Fog
23	19-Jul-11	Octagon EcoFlo 2	10°B	5.0	7.3	-9.8	Composite	Freezing Fog
24	19-Jul-11	Octagon EcoFlo 2	10°B	4.6	7.0	-9.8	Composite	Freezing Fog
25	19-Jul-11	Octagon EcoFlo 2	10°B	1.9	12.7	-25.0	Aluminum	Freezing Fog
26	19-Jul-11	Octagon EcoFlo 2	10°B	1.7	13.6	-25.0	Aluminum	Freezing Fog
27	19-Jul-11	Octagon EcoFlo 2	10°B	1.9	11.7	-24.9	Composite	Freezing Fog
28	19-Jul-11	Octagon EcoFlo 2	10°B	1.8	12.1	-25.0	Composite	Freezing Fog
29	19-Jul-11	Octagon EcoFlo 2	10°B	5.0	5.2	-24.6	Aluminum	Freezing Fog
30	19-Jul-11	Octagon EcoFlo 2	10°B	5.1	5.6	-24.6	Aluminum	Freezing Fog
31	19-Jul-11	Octagon EcoFlo 2	10°B	4.9	4.3	-24.6	Composite	Freezing Fog
32	19-Jul-11	Octagon EcoFlo 2	10°B	4.6	4.5	-24.6	Composite	Freezing Fog
33	20-Jul-11	Octagon EcoFlo 2	10°B	13.5	8.1	-6.5	Aluminum	Light Freezing Rain
34	20-Jul-11	Octagon EcoFlo 2	10°B	13.4	7.8	-6.5	Aluminum	Light Freezing Rain
35	20-Jul-11	Octagon EcoFlo 2	10°B	13.2	7.3	-6.4	Composite	Light Freezing Rain
36	20-Jul-11	Octagon EcoFlo 2	10°B	13.5	7.3	-6.2	Composite	Light Freezing Rain
37	20-Jul-11	Octagon EcoFlo 2	10°B	25.4	9.1	-5.9	Aluminum	Light Freezing Rain
38	20-Jul-11	Octagon EcoFlo 2	10°B	25.1	9.0	-6.2	Aluminum	Light Freezing Rain
39	20-Jul-11	Octagon EcoFlo 2	10°B	24.9	7.1	-6.3	Composite	Light Freezing Rain
40	20-Jul-11	Octagon EcoFlo 2	10°B	24.7	7.3	-6.0	Composite	Light Freezing Rain
41	21-Jul-11	Octagon EcoFlo 2	10°B	12.5	5.2	-9.4	Aluminum	Light Freezing Rain

Table 3.2 (cont'd): Summary of Tests Performed

Test No.	Date	Fluid Name	Fluid Dil.*	Icing Intensity ($g/dm^2/h$)	Endurance Time (min)	Test Temp. (°C)	Test Surface	Precipitation Type
42	21-Jul-11	Octagon EcoFlo 2	10°B	12.8	5.7	-10.2	Aluminum	Light Freezing Rain
43	21-Jul-11	Octagon EcoFlo 2	10°B	12.8	5.0	-9.4	Composite	Light Freezing Rain
44	21-Jul-11	Octagon EcoFlo 2	10°B	12.5	5.8	-10.0	Composite	Light Freezing Rain
45	21-Jul-11	Octagon EcoFlo 2	10°B	24.5	5.5	-10.2	Aluminum	Light Freezing Rain
46	21-Jul-11	Octagon EcoFlo 2	10°B	25.1	4.5	-10.1	Aluminum	Light Freezing Rain
47	21-Jul-11	Octagon EcoFlo 2	10°B	24.2	4.8	-10.0	Composite	Light Freezing Rain
48	21-Jul-11	Octagon EcoFlo 2	10°B	24.6	5.3	-10.2	Composite	Light Freezing Rain
49	20-Jul-11	Octagon EcoFlo 2	10°B	4.9	14.1	-3.0	Aluminum	Freezing Drizzle
50	20-Jul-11	Octagon EcoFlo 2	10°B	4.7	15.0	-3.0	Aluminum	Freezing Drizzle
51	20-Jul-11	Octagon EcoFlo 2	10°B	4.8	16.7	-3.0	Composite	Freezing Drizzle
52	20-Jul-11	Octagon EcoFlo 2	10°B	4.8	15.5	-3.0	Composite	Freezing Drizzle
53	20-Jul-11	Octagon EcoFlo 2	10°B	12.8	11.7	-3.4	Aluminum	Freezing Drizzle
54	20-Jul-11	Octagon EcoFlo 2	10°B	12.7	12.8	-3.4	Aluminum	Freezing Drizzle
55	20-Jul-11	Octagon EcoFlo 2	10°B	12.7	10.3	-3.4	Composite	Freezing Drizzle
56	20-Jul-11	Octagon EcoFlo 2	10°B	12.8	11.8	-3.4	Composite	Freezing Drizzle
57	20-Jul-11	Octagon EcoFlo 2	10°B	5.1	12.4	-6.5	Aluminum	Freezing Drizzle
58	20-Jul-11	Octagon EcoFlo 2	10°B	4.9	11.6	-6.5	Aluminum	Freezing Drizzle
59	20-Jul-11	Octagon EcoFlo 2	10°B	4.9	11.4	-6.5	Composite	Freezing Drizzle
60	20-Jul-11	Octagon EcoFlo 2	10°B	4.8	10.9	-6.5	Composite	Freezing Drizzle
61	20-Jul-11	Octagon EcoFlo 2	10°B	13.1	5.9	-6.3	Aluminum	Freezing Drizzle
62	20-Jul-11	Octagon EcoFlo 2	10°B	12.9	6.9	-6.2	Aluminum	Freezing Drizzle
63	20-Jul-11	Octagon EcoFlo 2	10°B	12.7	7.3	-6.2	Composite	Freezing Drizzle
64	20-Jul-11	Octagon EcoFlo 2	10°B	12.9	6.8	-6.2	Composite	Freezing Drizzle
65	21-Jul-11	Octagon EcoFlo 2	10°B	5.1	8.5	-10.0	Aluminum	Freezing Drizzle
66	21-Jul-11	Octagon EcoFlo 2	10°B	5.5	9.1	-10.1	Aluminum	Freezing Drizzle
67	21-Jul-11	Octagon EcoFlo 2	10°B	5.2	8.8	-10.0	Composite	Freezing Drizzle
68	21-Jul-11	Octagon EcoFlo 2	10°B	4.8	8.8	-10.3	Composite	Freezing Drizzle
69	21-Jul-11	Octagon EcoFlo 2	10°B	13.7	5.7	-9.0	Aluminum	Freezing Drizzle
70	21-Jul-11	Octagon EcoFlo 2	10°B	13.0	5.8	-9.0	Aluminum	Freezing Drizzle
71	21-Jul-11	Octagon EcoFlo 2	10°B	13.3	6.4	-9.0	Composite	Freezing Drizzle
72	21-Jul-11	Octagon EcoFlo 2	10°B	12.7	4.6	-9.0	Composite	Freezing Drizzle
73	21-Jul-11	Octagon EcoFlo 2	10°B	5.1	5.6	1.6	Aluminum	Cold Soak Box
74R	21-Jul-11	Octagon EcoFlo 2	10°B	4.8	6.3	0.6	Aluminum	Cold Soak Box
75	21-Jul-11	Octagon EcoFlo 2	10°B	4.9	6.4	1.5	Composite	Cold Soak Box
76	21-Jul-11	Octagon EcoFlo 2	10°B	5.2	7.0	0.9	Composite	Cold Soak Box
77	21-Jul-11	Octagon EcoFlo 2	10°B	74.7	1.6	1.1	Aluminum	Cold Soak Box
78	21-Jul-11	Octagon EcoFlo 2	10°B	76.8	1.6	1.2	Aluminum	Cold Soak Box
79	21-Jul-11	Octagon EcoFlo 2	10°B	75.6	1.8	1.2	Composite	Cold Soak Box
80	21-Jul-11	Octagon EcoFlo 2	10°B	75.6	2.4	1.2	Composite	Cold Soak Box
S2	26-Jul-11	Octagon EcoFlo 2	10°B	10.8	10.0	-3.0	Aluminum	Artificial Snow
S2	26-Jul-11	Octagon EcoFlo 2	10°B	5.5	25.0	-3.0	Aluminum	Artificial Snow

** 10°B = Fluid diluted to a freeze point 10°C below test temperature*

This page intentionally left blank.

32

4. RESULTS AND DISCUSSION

The results of endurance time testing with Octagon EcoFlo 2 are presented in this section. To assess the performance of the fluid, the endurance time results are compared to historic Type I fluid endurance times.

4.1 Data

Figures 4.1 to 4.21 present the endurance time data collected with Octagon EcoFlo 2.

Figures 4.1 to 4.20 show the results of testing in simulated freezing precipitation. There is one chart for each freezing precipitation cell in the Type I generic holdover time tables, with the exception of the "-3°C and above" light freezing rain cells (see note in Subsection 2.5). Each chart contains the Octagon EcoFlo 2 endurance times (represented with solid diamonds), the endurance times of other Type I fluids (represented with hollow diamonds) and the current Type I generic holdover times (represented by solid squares).

Figure 4.21 shows the results of testing in artificial snow. The chart shows the endurance times of Octagon EcoFlo 2 along with the endurance times of the Type I reference fluid that was tested immediately following Octagon EcoFlo 2.

4.2 Discussion

The data collected shows the endurance times Octagon EcoFlo 2 are similar or superior to the endurance times of Type I fluids tested in past years and to the current Type I generic holdover times. These results indicate this non-glycol based fluid performs similarly to glycol based Type I fluids from an endurance time perspective and therefore can be used with the generic Type I HOT guidelines.

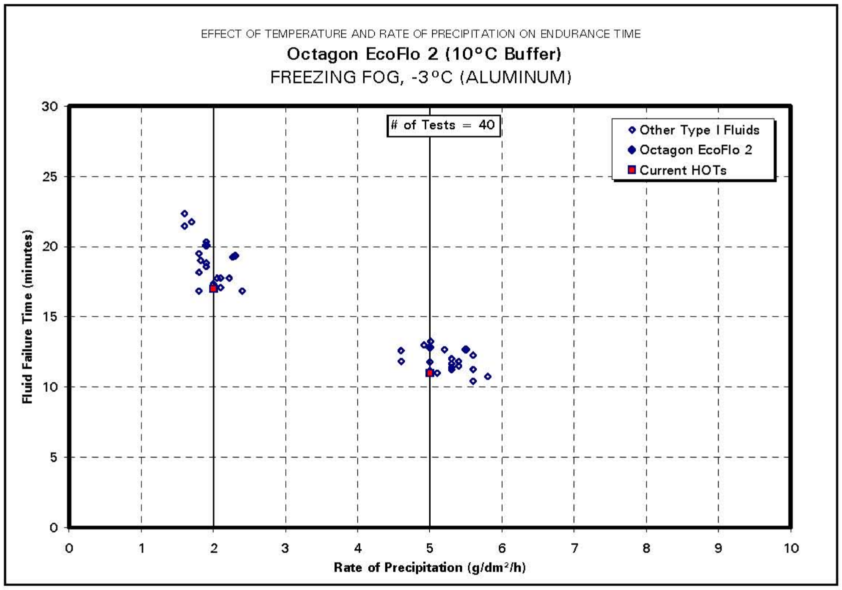


Figure 4.1: Freezing Fog, -3°C and Above, Aluminum Surface

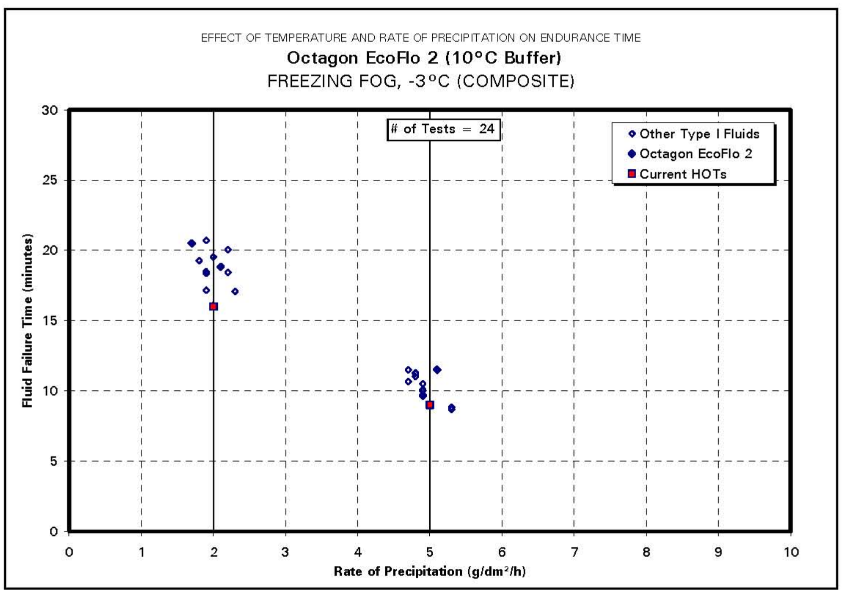


Figure 4.2: Freezing Fog, -3°C and Above, Composite Surface

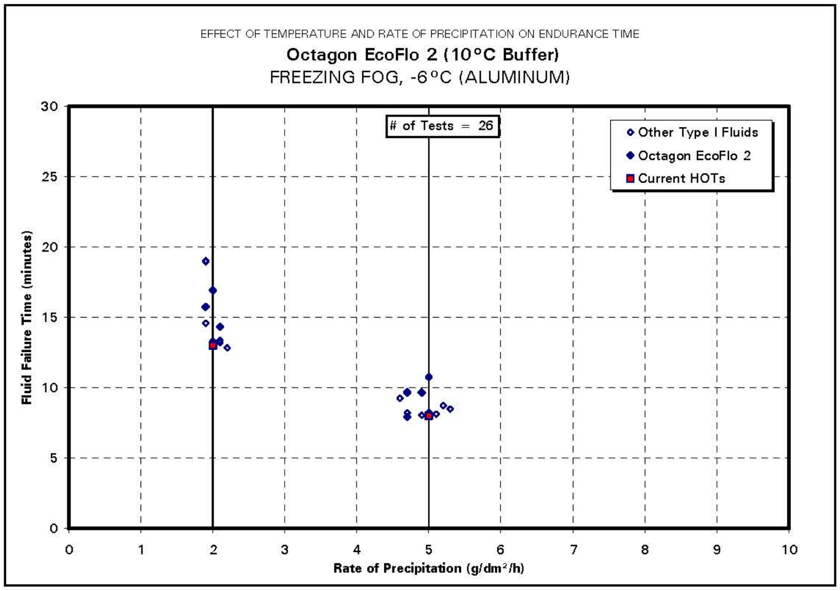


Figure 4.3: Freezing Fog, Below -3 to -6°C, Aluminum Surface

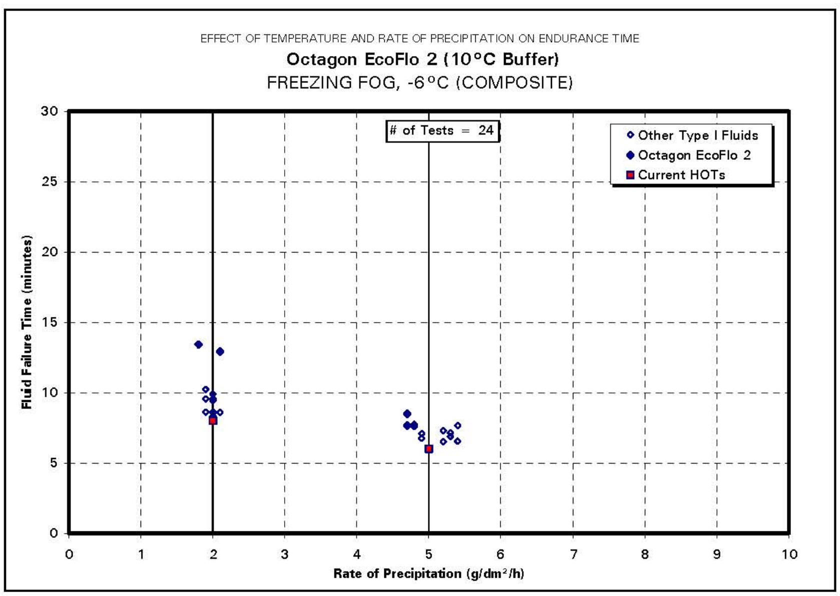


Figure 4.4: Freezing Fog, Below -3 to -6°C, Composite Surface

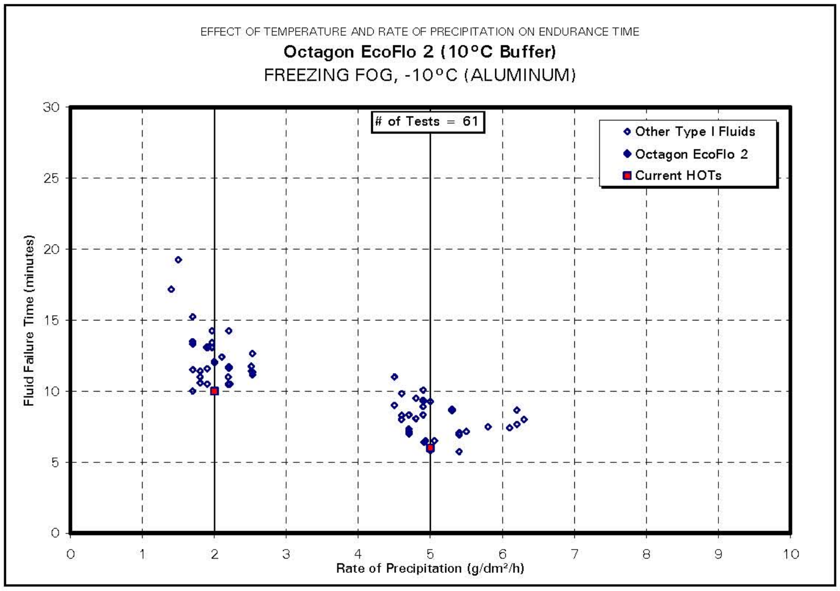


Figure 4.5: Freezing Fog, Below -6 to -10°C, Aluminum Surface

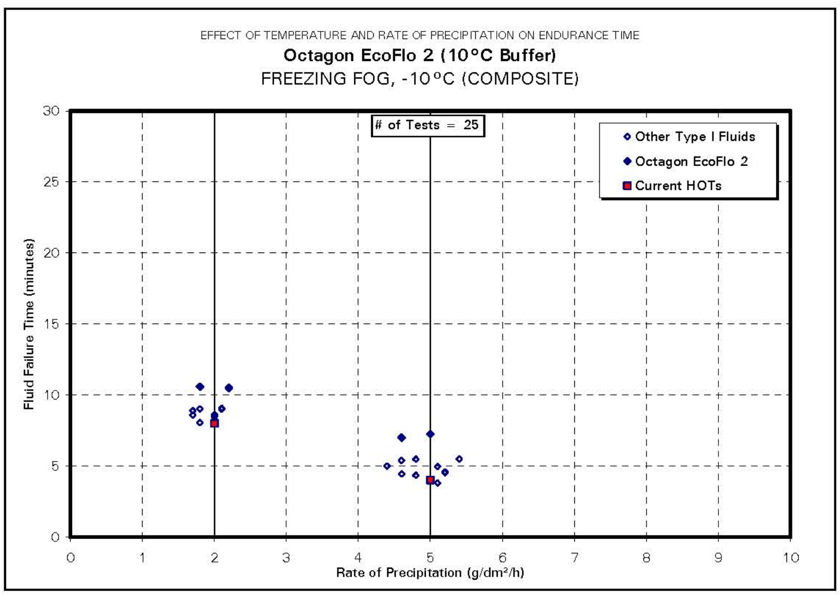


Figure 4.6: Freezing Fog, Below -6 to -10°C, Composite Surface

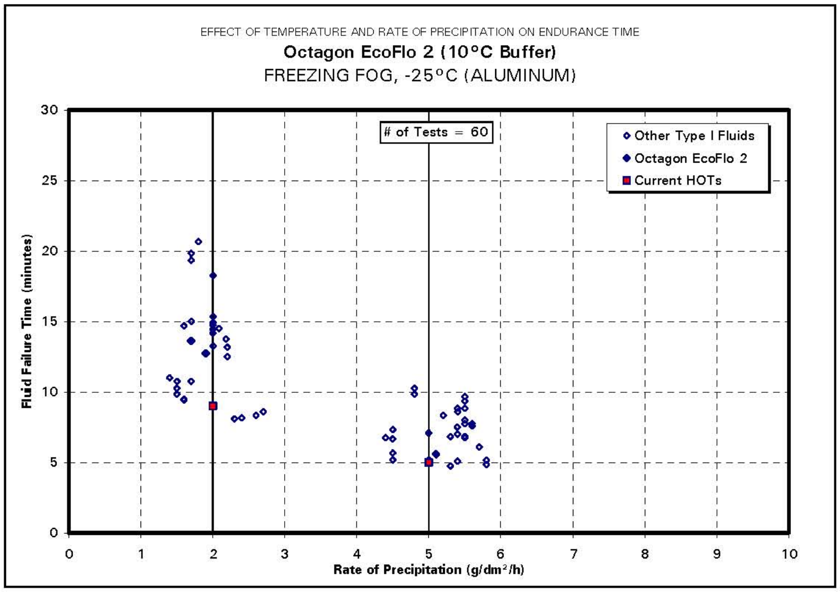


Figure 4.7: Freezing Fog, Below -10°C, Aluminum Surface

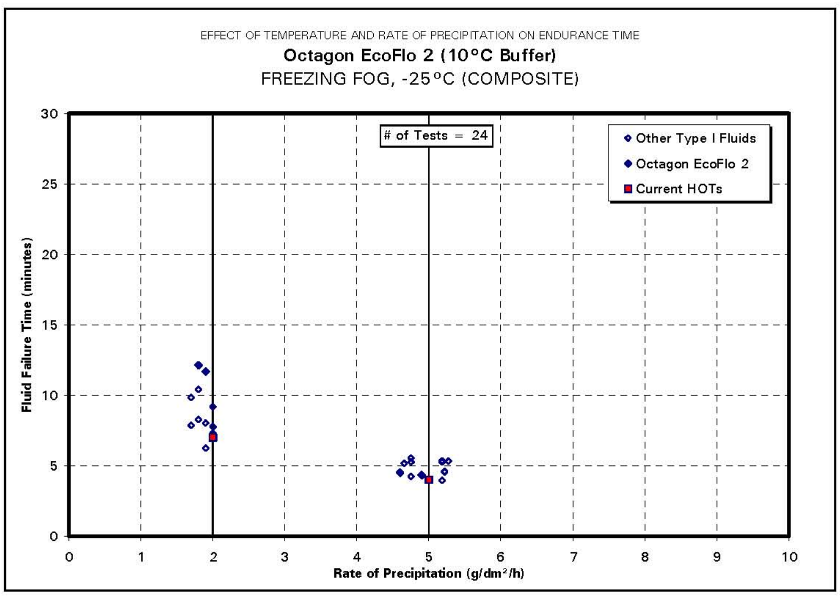


Figure 4.8: Freezing Fog, Below -10°C, Composite Surface

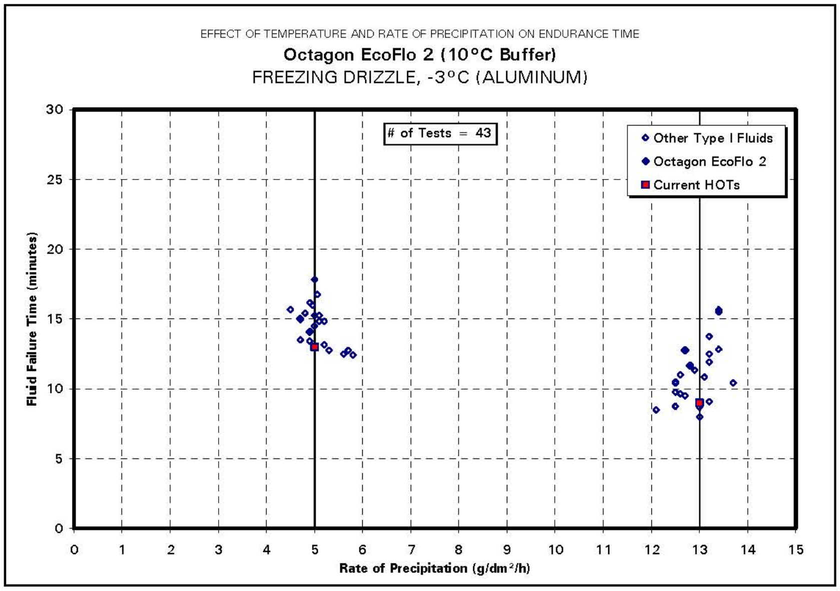


Figure 4.9: Freezing Drizzle, -3°C and Above, Aluminum Surface

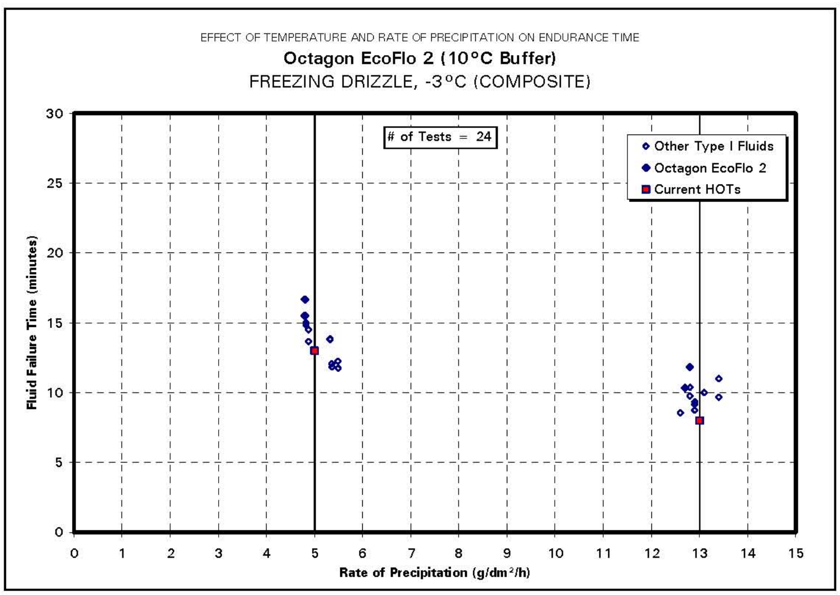


Figure 4.10: Freezing Drizzle, -3°C and Above, Composite Surface

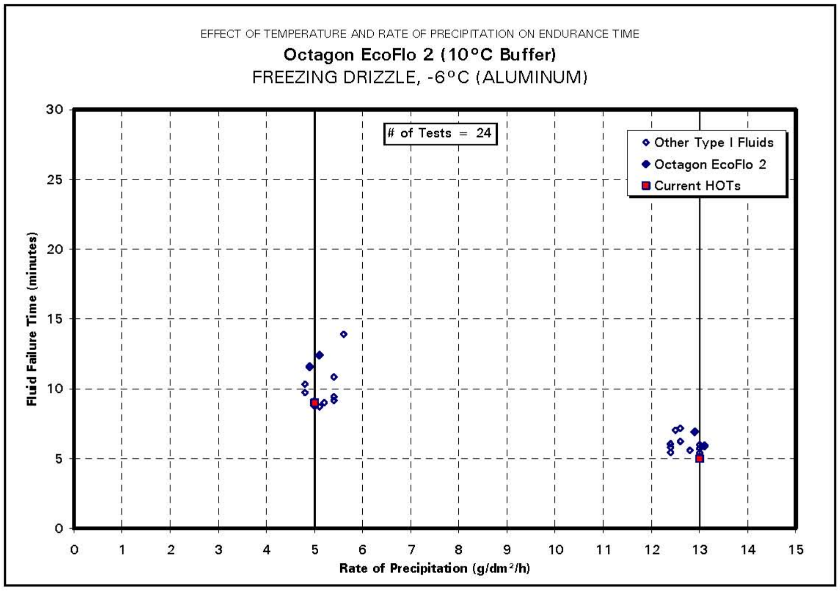


Figure 4.11: Freezing Drizzle, Below -3 to -6°C, Aluminum Surface

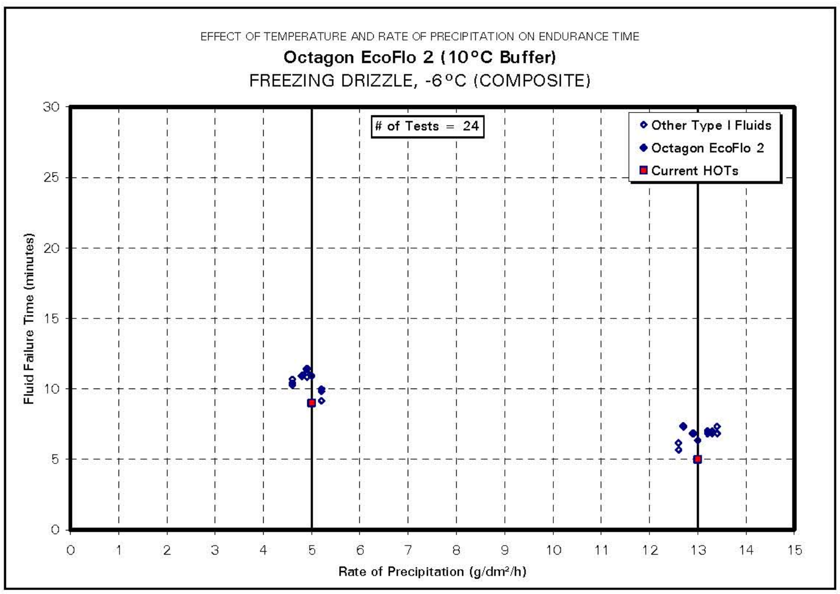


Figure 4.12: Freezing Drizzle, Below -3 to -6°C, Composite Surface

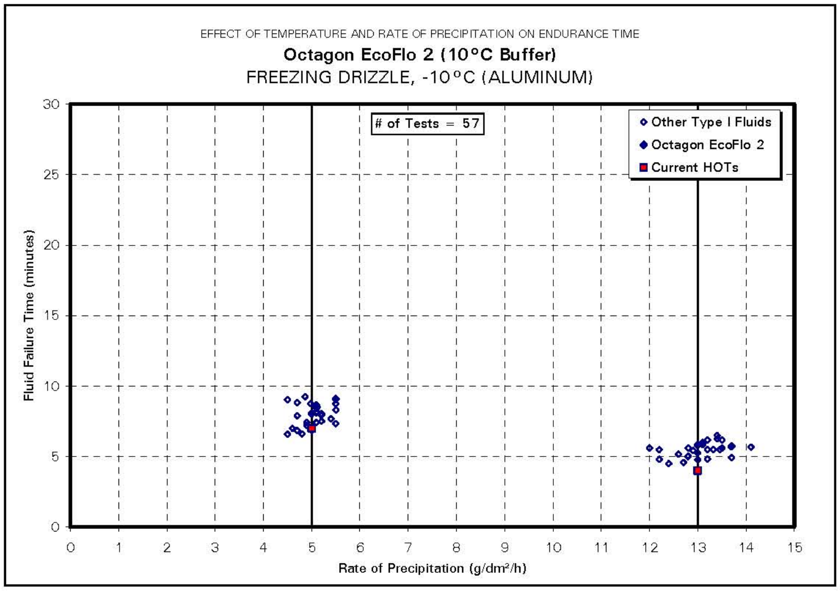


Figure 4.13: Freezing Drizzle, Below -6 to -10°C, Aluminum Surface

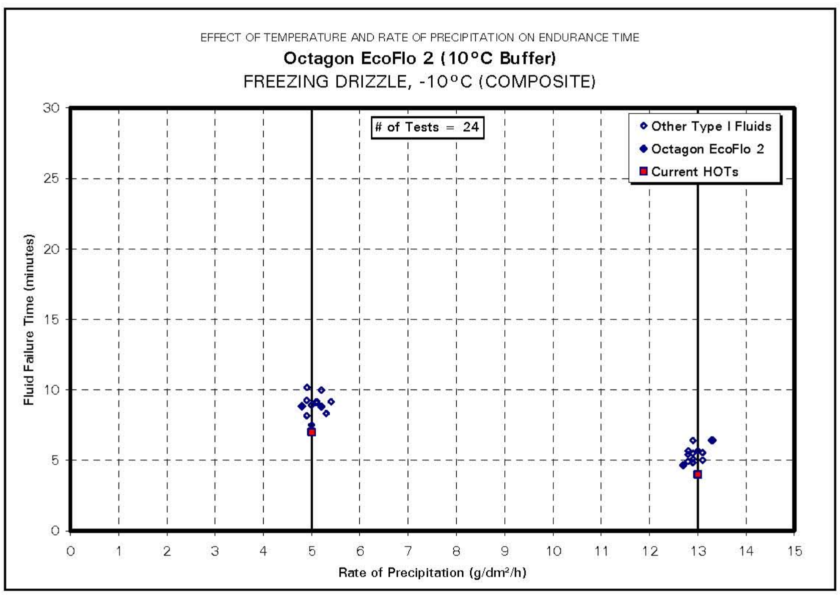


Figure 4.14: Freezing Drizzle, Below -6 to -10°C, Composite Surface

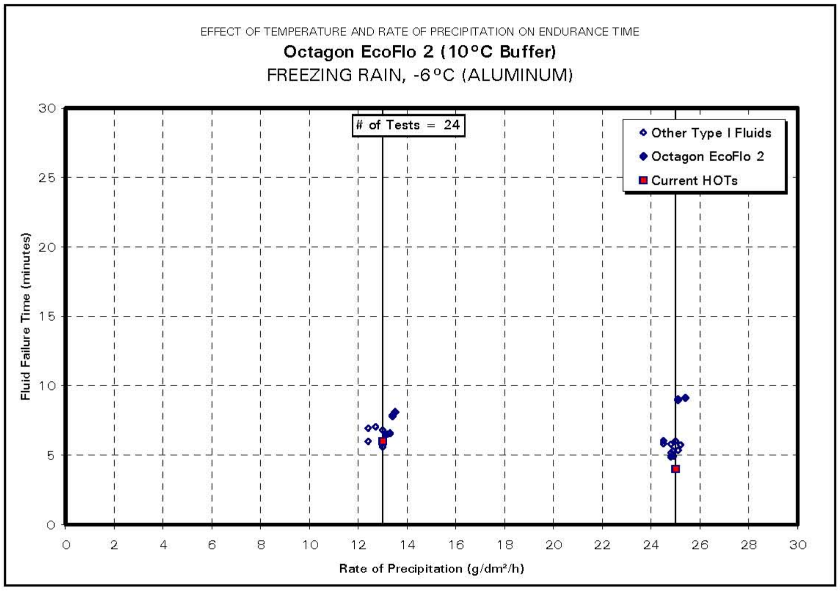


Figure 4.15: Light Freezing Rain, Below -3 to -6°C, Aluminum Surface

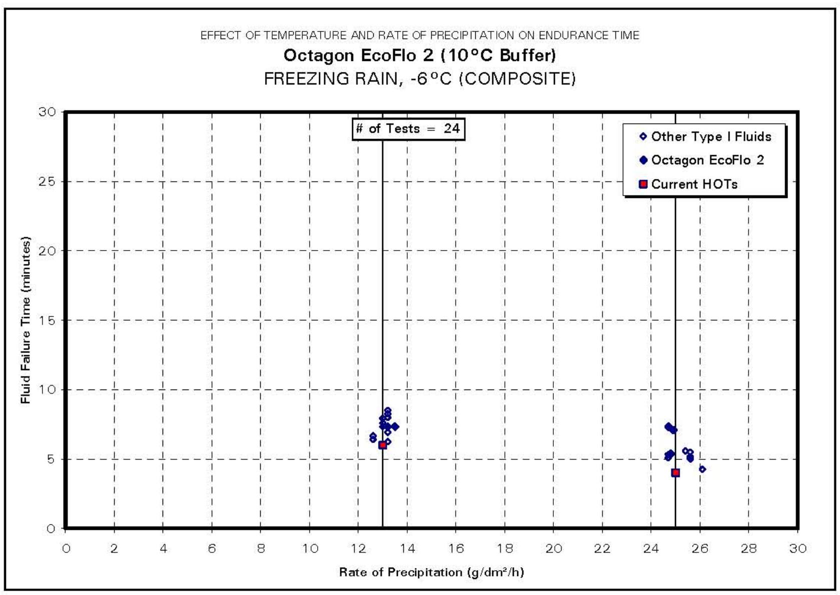


Figure 4.16: Light Freezing Rain, Below -3 to -6°C, Composite Surface

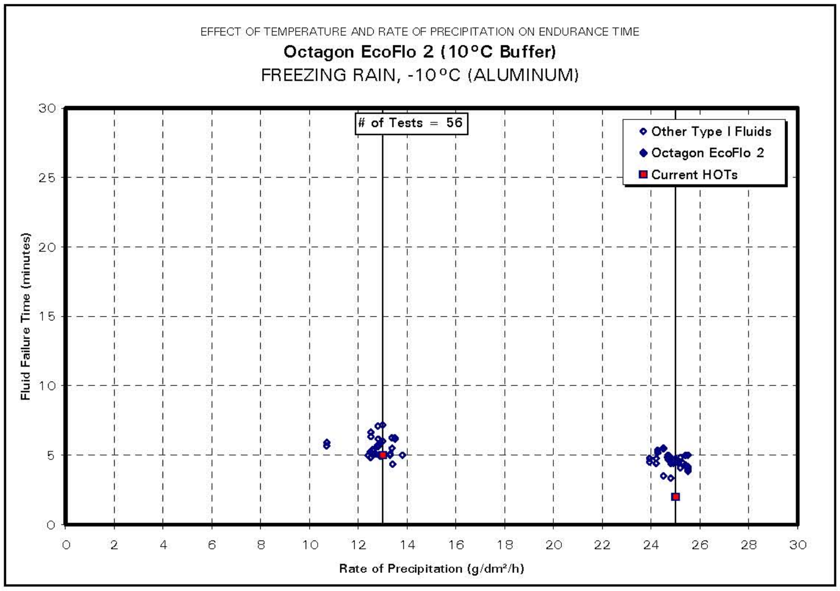


Figure 4.17: Light Freezing Rain, Below -6 to -10°C, Aluminum Surface

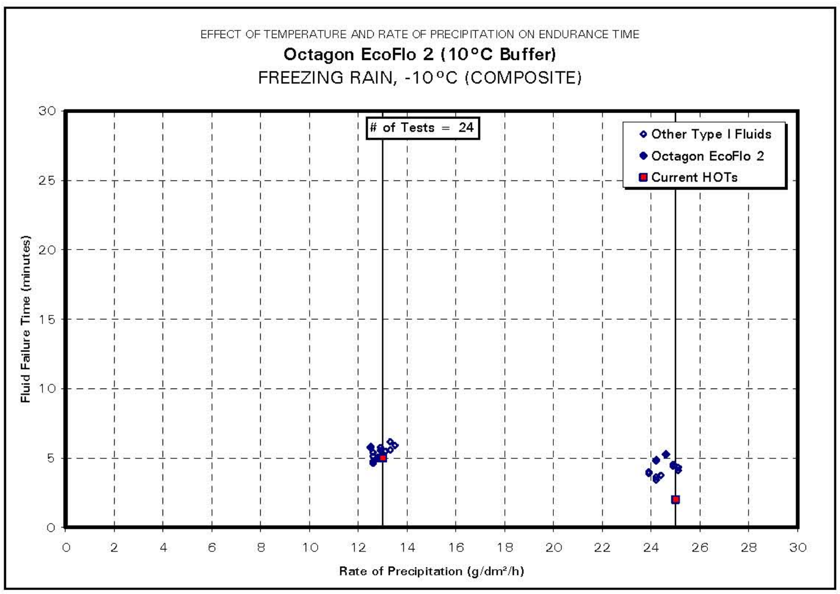


Figure 4.18: Light Freezing Rain, Below -6 to -10°C, Composite Surface

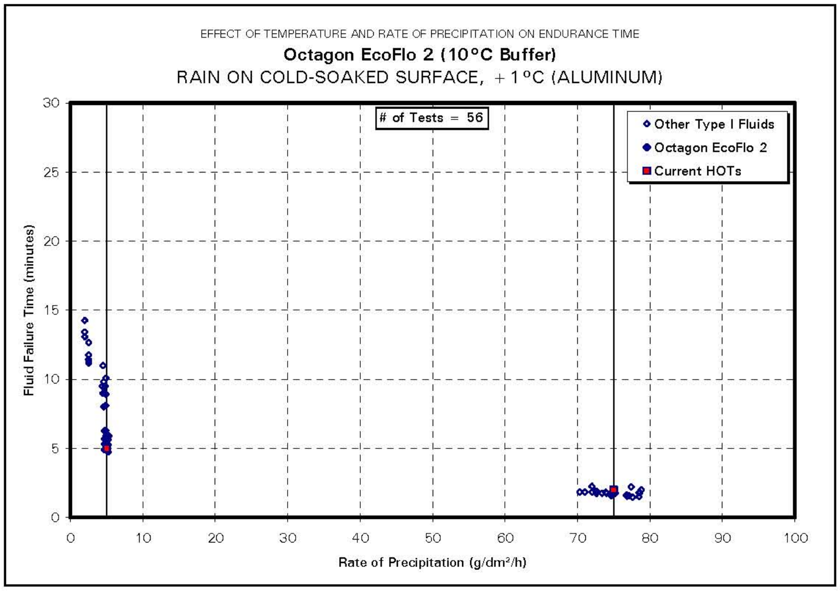


Figure 4.19: Rain on Cold-Soaked Surface, -3°C and Above, Aluminum Surface

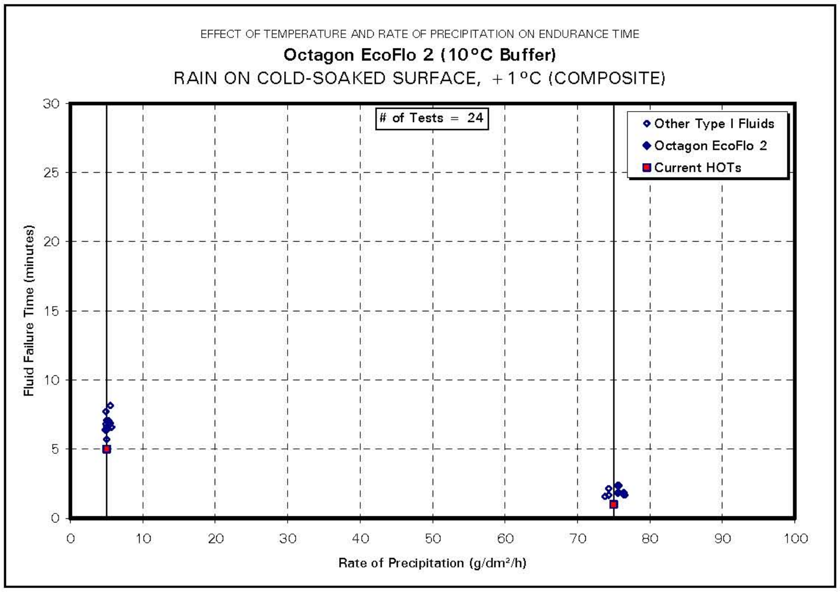


Figure 4.20: Rain on Cold-Soaked Surface, -3°C and Above, Composite Surface

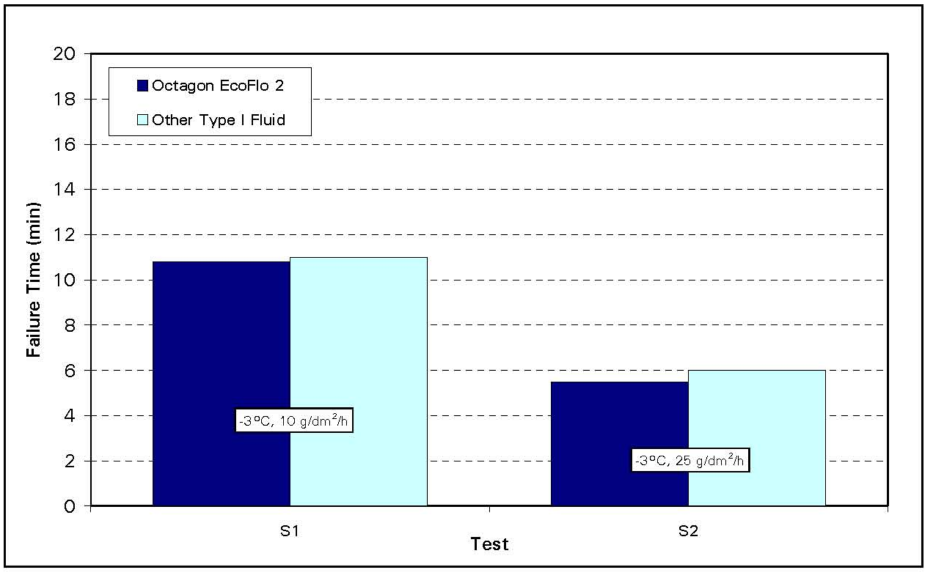
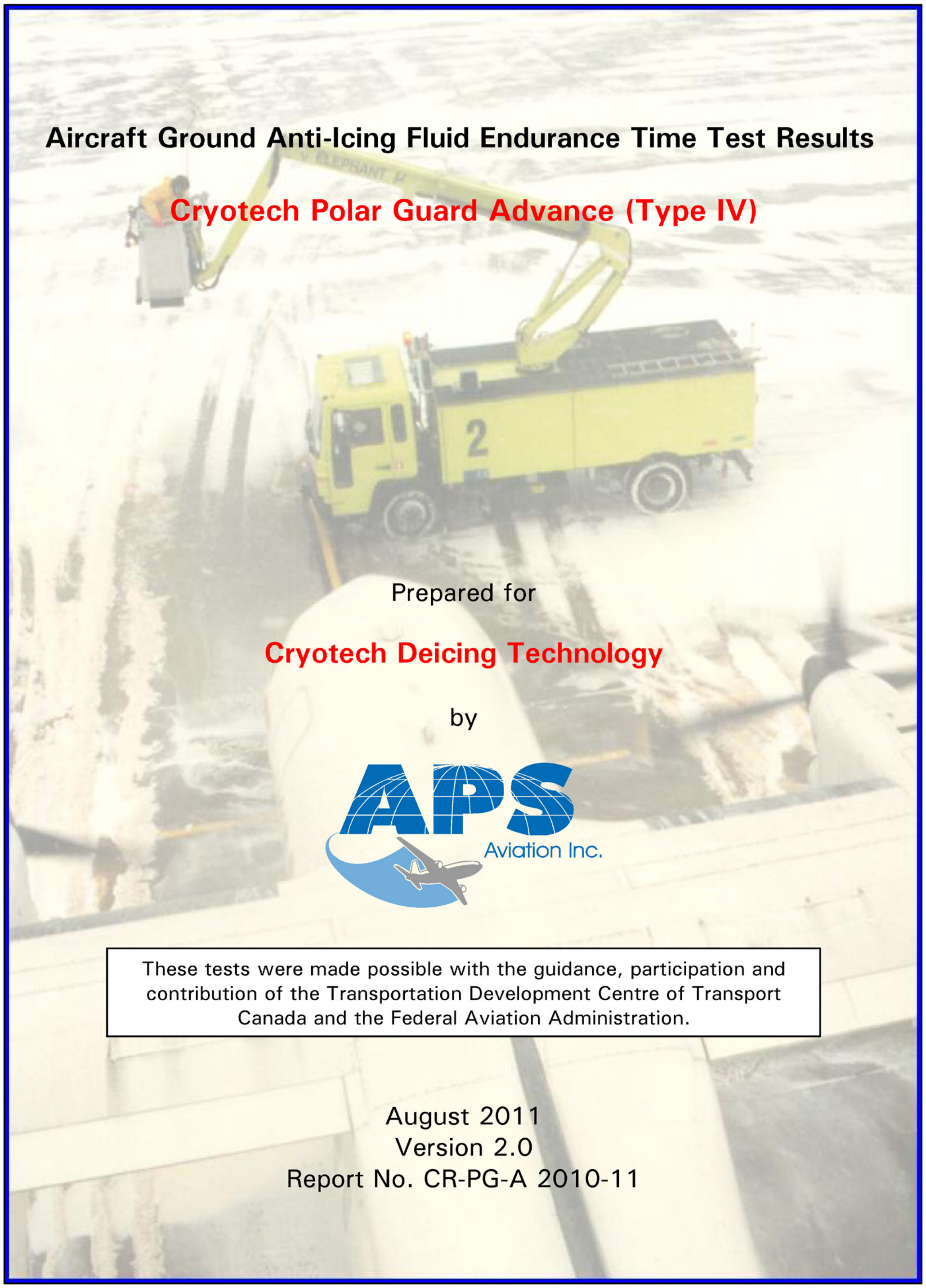


Figure 4.21: Artificial Snow, -3°C and Above, Aluminum Surface

APPENDIX D

FLUID MANUFACTURER REPORT:
CRYOTECH POLAR GUARD ADVANCE (TYPE IV)



Aircraft Ground Anti-Icing Fluid Endurance Time Test Results

Cryotech Polar Guard Advance (Type IV)

Prepared for

Cryotech Deicing Technology

by

APS Aviation Inc.

These tests were made possible with the guidance, participation and contribution of the Transportation Development Centre of Transport Canada and the Federal Aviation Administration.

August 2011
Version 2.0
Report No. CR-PG-A 2010-11

Aircraft Ground Anti-Icing Fluid Endurance Time Test Results

Cryotech Polar Guard Advance (Type IV)

Prepared for

Cryotech Deicing Technology

Prepared by: Stephanie Bendickson, Project Analyst — August 10, 2011 (Date)

Reviewed by: John D'Avirro, Program Manager, Eng. — August 10, 2011 (Date)

These tests were made possible with the guidance, participation and contribution of the Transportation Development Centre of Transport Canada and the Federal Aviation Administration.

August 2011
Version 2.0
Report No. CR-PG-A 2010-11

ii

FLUID IDENTIFICATION AND CHARACTERISTICS

Manufacturer:	Cryotech Deicing Technology		
Fluid Test Name:	LV2		
Fluid Commercial Name:	Polar Guard Advance		
Fluid Type / Colour:	Type IV / Green		
Batch #:	1.042.1430		
Date of Receipt:	February 23, 2011		
Brix (Measured):	Neat fluid:	35.75°	
	75/25 dilution:	28.00°	
	50/50 dilution:	19.75°	
Freeze Point (Stated):	Neat fluid:	-37.6°C	
	75/25 dilution:	-25.0°C	
	50/50 dilution:	-20.5°C	
LOUT (Stated):	Neat fluid:	-30.5°C	
	75/25 dilution:	-18°C	
	50/50 dilution:	-9°C	
Viscosity:	**Mfr Method**[1]	**Stated**	**Measured**
	Neat fluid:	3,800 cP	4,400 cP
	75/25 dilution:	8,840 cP	11,600 cP
	50/50 dilution:	see AIR	see AIR
	AIR9968 Method[2]	**Stated**	**Measured**
	Neat fluid:	4,120 cP	4,050 cP
	75/25 dilution:	9,800 cP	9,750 cP
	50/50 dilution:	80 cP	80 cP
WSET (from AMIL):	Neat fluid:	93 minutes	

[1] Spindle SC4-34/13R, small sample adapter, 10 mL of fluid, 20°C, 0.3 rpm, for 10 minutes 0 seconds
[2] Spindle LV1 with guard leg, 600 mL beaker, 500 mL of fluid, 20°C, 0.3 rpm, for 10 minutes 0 seconds

This page intentionally left blank.

iv

SUMMARY

The primary objective of this project was to measure the endurance time performance of Cryotech Polar Guard Advance 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, the Transport Development Centre (TDC) of Transport Canada (TC) and the Federal Aviation Administration (FAA).

The HOT 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. Natural snow tests were performed at the APS Aviation Inc. (APS) test facility located at the Pierre-Elliott-Trudeau International Airport in Montreal, Quebec. Tests in simulated freezing fog, freezing drizzle, light freezing rain and rain on cold soaked wing were conducted at the National Research Council Canada (NRC) Climatic Engineering Facility (CEF) located in Ottawa, Ontario.

De/anti-icing fluid endurance times were derived from the data using multi-variable regression analysis, resulting in the generation of the fluid-specific HOT values shown below. It is expected this table will be published by regulators for the winter 2011-12 operating season.

Following the submission of Version 1.0 of this report, additional testing was conducted to ensure the endurance times measured at -25°C are valid for use at the fluid's lowest operational use temperature (LOUT). Version 2.0 incorporates the results of the additional testing, which concluded the -25°C holdover times are valid for use at the fluid LOUT.

Cryotech Polar Guard Advance Type IV Fluid Holdover Times

Outside Air Temperature		Type IV Fluid Concentration Neat Fluid/Water (Vol %/Vol %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog	Snow, Snow Grains or Snow Pellets	Freezing Drizzle	Light Freezing Rain	Rain on Cold Soaked Wing	Other
-3 and above	27 and above	100/0	2:50–4:00	1:20–1:50	1:35–2:00	1:15–1:30	0:15–2:00	
		75/25	2:30–4:00	0:45–1:20	1:40–2:00	0:40–1:10	0:09–1:40	
		50/50	0:50–1:25	0:15–0:35	0:20–0:45	0:09–0:20	CAUTION: No holdover time guidelines exist	
below -3 to -14	below 27 to 7	100/0	0:55–2:30	0:55–1:15	0:35–1:35	0:35–0:45		
		75/25	0:40–1:30	0:35–1:00	0:25–1:05	0:35–0:45		
below -14 to -30.5	below 7 to -22.9	100/0	0:25–0:50	0:15–0:30				

This page intentionally left blank.

vi

TABLE OF CONTENTS

This page intentionally left blank.

LIST OF FIGURES Page

LIST OF TABLES Page

LIST OF PHOTOS Page

This page intentionally left blank.

×

GLOSSARY

APS	APS Aviation Inc.
ARP	Aerospace Recommended Practice
CEF	Climatic Engineering Facility
FAA	Federal Aviation Administration
HOT	Holdover Time
ISO	International Organization for Standardization
LOUT	Lowest Operational Use Temperature
LOWV	Lowest On-Wing Viscosity
LWC	Liquid Water Content
MVD	Median Volume Diameter
MANOBS	Manual of Surface Weather Observations
NCAR	National Center for Atmospheric Research
NRC	National Research Council Canada
SAE	Society of Automotive Engineers, Inc.
TC	Transport Canada
TDC	Transportation Development Centre

This page intentionally left blank.

xii

1. INTRODUCTION

This report has been created with the support of the fluid manufacturer, the Transport Development Centre (TDC) of 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 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 Society of Automotive Engineers (SAE) Aerospace Recommended Practice (ARP) ARP5485, 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 all cells of the Type II/IV HOT tables using this protocol and are used to create a fluid-specific HOT table for each Type II/IV fluid tested.

This report provides a detailed account of the endurance time testing conducted by APS Aviation Inc. (APS) with **Cryotech Polar Guard Advance**, a new Type IV fluid. It describes the test methodology used, endurance time data collected, and analysis completed to derive a fluid-specific HOT table for the fluid. This table is expected to be published by regulators for use in the winter 2011-12 operating season.

This page intentionally left blank.

2

2. METHODOLOGY

This chapter describes the methodology used to conduct endurance time tests. It is divided into sections that detail the related weather conditions, test sites, test conditions, test equipment and test procedures; the final subsection describes the analysis methodology used to derive fluid endurance times.

2.1 Meteorological Definitions of Weather Conditions

Table 2.1 provides the meteorologically accepted definitions of weather phenomenon / precipitation types. It also includes the criteria used to determine precipitation intensity. This table 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). Subsections 2.1.1 to 2.1.4 provide more detailed information about the precipitation types encompassed by the fluid-specific HOT guidelines.

Table 2.1: Definition of Weather Phenomenon

Weather Phenomenon*	Definition*
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 visibility at the earth's surface to less than 1 km (5/8 mile).
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 (23°F), the crystals are generally agglomerated into snowflakes.
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 the ground or other exposed objects.
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 mm (0.02 in.) or smaller drops which, in contrast to drizzle, are widely separated.
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)	Precipitation of white and opaque grains of ice. These grains are spherical or sometimes conical; their diameter is about 2-5 mm (0.1-0.2 in.). Grains are brittle, easily crushed; they bounce and break on hard ground.
SNOW GRAINS (SG)	Precipitation of very small white and opaque grains of ice. These grains are fairly flat or elongated; their diameter is less than 1 mm (0.04 in.). When the grains hit hard ground, they do not bounce or shatter.
HAIL (GR)	Precipitation of small balls or pieces of ice with a diameter ranging from 5 to > 50 mm (0.2 to 2.0 in.) falling either separately or agglomerated.
ICE PELLETS (PE) Note: Includes Sleet and Small Hail	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.) or less. The pellets of ice usually bounce when hitting hard ground.

Intensity Criteria**

	Snow(SN),Pellets(GS),Grains(SG),Frz Drizzle(FZDZ)		Ice Pellets (PE)
Estimated Intensity	Horizontal Visibility (statute mile)	Liquid Equivalent Snow (S) Intensity***	Definition and Horizontal Visibility
Light (-)	If visibility is: ≥ 5/8 mi (≥ 1.0 km)	Trace to 0.05 in/hr (≤ 1.0 mm or 10.0 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 or 25.0 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 shown that visibility and precipitation intensity are not always directly correlated.

	Drizzle Intensity (FZDZ)
Light(-)	Trace to 0.01 in/hr (0.254 mm 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)
Light (-)	Measured Intensity	Up to 0.10 in/hr (2.5 mm or 25 gr/dm²/hr); Maximum 0.01 inch in 6 minutes
	Estimated Intensity	From scattered drops that, regardless of duration, do not completely wet an exposed surface up to a condition where individual drops are easily seen.
Moderate	Measured Intensity	0.11 in to 0.30 in/hr (7.6 mm or 76 gr/dm²/hr); More than 0.01 to 0.03 inch in 6 minutes
	Estimated Intensity	Individual drops are not clearly identifiable; spray is observable just above pavement and other hard surfaces.
Heavy (+)	Measured Intensity	More than 0.30 in/hr (7.6 mm or 76 gr/dm²/hr); More than 0.03 inch in 6 minutes
	Estimated Intensity	Rain seemingly falls in sheets; individual drops are not identifiable; heavy spray to height of several inches is observed over hard surfaces.

* 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 Proposed Definition for Liquid Equivalent Snowfall Intensity

1) gm/dm² = 0.01 cm = 0.1 mm = 0.0039 in
2) in = 2.54 cm = 25.4 mm = 254 gm/dm²

Compiled by Jeff Cole and Roy Rasmussen of NCAR/RAP June 17, 1997 (Updated for METAR codes)

Upper and lower precipitation rate limits are an important part of the test methodology for measuring fluid endurance times. The limits established for endurance time testing are not necessarily the same as the meteorological limits described in Table 2.1. The test limits are detailed in Subsection 2.6.2.

2.1.1 Snow

Table 2.1 contains the criteria previously used to estimate snowfall intensity in aircraft ground operations. The criteria uses horizontal visibility to estimate snowfall intensity:

- Light snow, visibility greater than or equal to 1.0 km;
- Moderate snow, visibility 0.5 km to less than 1.0 km; and
- Heavy snow, visibility less than 0.5 km.

As stated in Table 2.1, visibility is only an estimation of snowfall intensity. TC and FAA undertook additional work in the 1990s and early 2000s to better understand the visibility/snowfall intensity relationship. As a result of this work, TC and FAA developed updated visibility vs. snowfall intensity tables, which have been published in their HOT guideline publications since the winter of 2003-04. The tables are based on NCAR field data and theoretical work on classes of snow, and on extensive field data compiled by APS. APS, NCAR, TC and FAA all had input into their formation. The tables categorize snow into four intensities based on visibility, lighting condition and air temperature (wet vs. dry snow). The TC table is shown in Table 2.2; the FAA table is similar.

Table 2.2: Visibility in Snow vs. Snowfall Intensity Chart

Lighting	Temperature Range		Visibility in Snow (Statute Miles)			
	°C	°F	Heavy	Moderate	Light	Very Light
Darkness	-1 and above	30 and above	≤1	>1 to 2½	>2½ to 4	>4
	Below -1	Below 30	≤3/4	>3/4 to 1½	>1½ to 3	>3
Daylight	-1 and above	30 and above	≤½	>½ to 1½	>1½ to 3	>3
	Below -1	Below 30	≤3/8	>3/8 to 7/8	>7/8 to 2	>2

2.1.2 Freezing Drizzle

Freezing drizzle is composed of closely spaced fine water droplets with a diameter less than 0.5 mm (see Table 2.1). Like snow, the intensity of freezing drizzle is estimated through the measurement of horizontal visibility, as follows:

- Light freezing drizzle, visibility greater than or equal to 1.0 km;
- Moderate freezing drizzle, visibility 0.5 km to less than 1.0 km; and
- Heavy freezing drizzle, visibility less than 0.5 km.

2.1.3 Freezing Rain

Freezing rain exists either in the form of drops with diameters greater than 0.5 mm, or smaller drops which, in contrast to drizzle, are widely separated. For each of the three intensities of freezing rain listed in Table 2.1, a visual description is supplied to provide a subjective guideline for the purpose of estimating rain intensity. However, the following definitions apply when an instrument is available to measure the intensity of precipitation:

- Light   Precipitation rate is $\leq$ 25 g/dm²/h;
- Moderate   Precipitation rate is $>$25 g/dm²/h but $\leq$75 g/dm²/h; and
- Heavy   Precipitation rate is $>$75 g/dm²/h.

2.1.4 Freezing Fog

Freezing fog is defined as suspended minute water droplets that freeze upon impact with the ground or exposed objects. Table 2.1 does not provide any indication of intensity or liquid water content (LWC) of the fog other than that the horizontal visibility is reduced to less than 1 km.

2.2 Test Sites

Natural snow testing is performed at the APS test site located at the Montréal-Pierre-Elliott-Trudeau International Airport. The location of the test site is shown on the plan view of the airport shown in Figure 2.1. Photo 2.1 shows the test site trailer and test stands; the site consists of two trailers and three locations for test stands. The APS test site is located near the Meteorological Services of Canada (a division of Environment Canada) automated weather observation station (Photo 2.2).

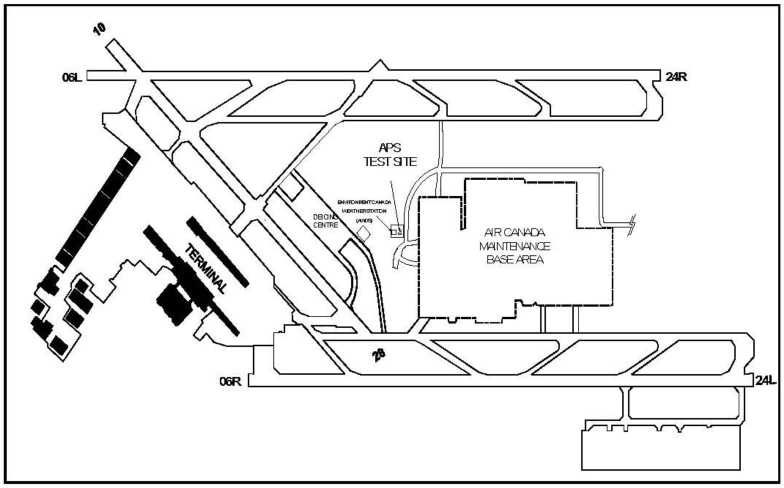


Figure 2.1: APS Test Site at Montréal-Pierre-Elliott-Trudeau International Airport

Tests under conditions of simulated freezing fog, freezing drizzle, light freezing rain and rain on cold soaked wing were conducted indoors at the 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.

2.3 Test Conditions

Subsections 2.3.1 and 2.3.2 provide descriptions of the spray assembly and methods used to produce and calibrate the fine water droplets in simulated precipitation tests at the NRC CEF. Subsection 2.3.3 provides a summary of the categories and characteristics of each precipitation type produced.

2.3.1 Droplet Size and Rate of Precipitation

In the past, significant industry attention has been given to the influence of droplet size on holdover time. To explore this relationship further, experiments were performed to measure droplet sizes produced by different nozzles (gauge of hypodermic needle) at various water and air pressures in the spray delivery unit. Although the gauge of the needles is an important factor in the production of water droplets with appropriate dimensions, the air and water pressure levels in the sprayer system are equally important.

NRC developed an improved sprayer assembly, shown in Photo 2.5, 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 2.6.

Prior to 1995, calibration experiments conducted by the NRC used an optical gauge manufactured by HSS (Biral UK acquired the HSS technology) to verify that the simulation of freezing fog, freezing drizzle, and light freezing rain provided adequate droplet sizes according to ARP5485. Since 1995, APS has used a manual dye-stain technique to carry out droplet size calibration. This technique consists of dusting Whatman #1 filter paper discs with a water-activated, very finely-divided powder form of methylene blue dye. The prepared discs are manually positioned under simulated precipitation for a fixed time to acquire a droplet size pattern. A calibration curve is then used to convert the measured diameter of the droplets on the pattern to the experimental median volume diameter (MVD).

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 P.E.T. Airport
Precipitation:	Natural Light Freezing Rain
Precipitation Rate:	20 $g/dm^2/h$
Calibrated MVD:	1.0 mm

b) *For the indoor test:*

Location:	National Research Council
Precipitation:	Simulated Light Freezing Rain
Precipitation Rate:	25 $g/dm^2/h$
Calibrated MVD:	1.0 mm

The MVD for both natural and simulated light freezing rain was 1 mm.

Figures 2.2 and 2.3 show an example of the distribution of simulated light freezing rain droplets obtained at the NRC.

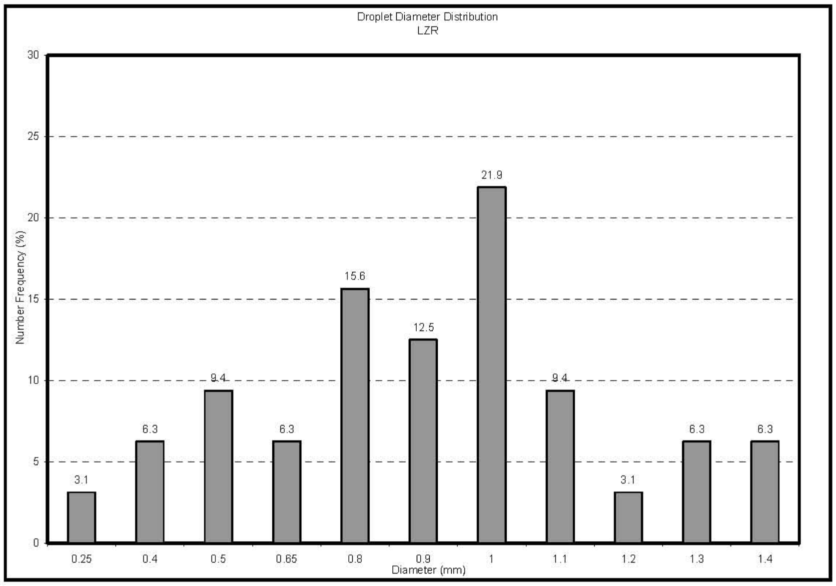


Figure 2.2: Droplet Diameter Distribution, Sample

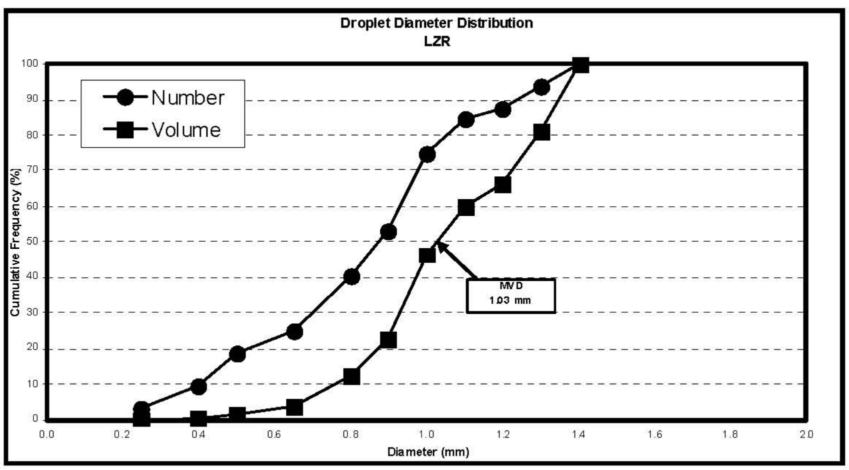


Figure 2.3: Cumulative Frequency of Droplet Diameter, Sample

2.3.2 Median Volume Diameter of Rain Drops

The MVD of a rain droplet was researched and found to be related to the precipitation rate 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 2.3 beside the experimental MVDs for each precipitation condition.

Table 2.3: 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

2.3.3 Characteristics of Precipitation Produced

The following is a point-form summary of the set of test conditions under which data for freezing drizzle, light freezing rain, rain on cold soaked surface, and freezing fog were collected:

1. Freezing Drizzle:

   High precipitation rate: 13 g/dm²/h;

   Droplet median volume diameter: 350 μm; and
   Air temperature: -3 and -10°C.

   Low Precipitation rate: 5 g/dm²/h;

   Droplet median volume diameter: 250 μm; and
   Air temperature: -3 and -10°C.

2. Light Freezing Rain:

   High precipitation rate: 25 g/dm²/h;

   Droplet median volume diameter: 1 000 μm; and
   Air temperature: -3 and -10°C.

   Low precipitation rate: 13 g/dm²/h;

   Droplet median volume diameter: 1 000 μm; and
   Air temperature: -3 and -10°C.

3. Drizzle on Cold-Soaked Surface:

   Precipitation rate: 5 g/dm²/h;
   Droplet median volume diameter: 250 μm; and
   Air temperature: +1°C.

4. Moderate Rain on Cold Soaked Surface:

   Precipitation rate: 75 g/dm²/h;
   Droplet median volume diameter: 1 400 μm; and
   Air temperature: +1°C.

5. Freezing Fog:

   Precipitation rate: 2 and 5 g/dm²/h;
   Droplet median volume diameter: 30 μm; and
   Air temperature: -3°C, -14°C and -25°C.

2.4 Test Equipment

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) 9001:2000 standards, and developed internally by APS.

The general environmental chamber equipment used during tests (including air temperature sensor, data acquisition system, temperature control equipment, etc.) is in accordance with the requirements set out in the ARP5485.

Figure 2.4 shows a schematic of the test platform used for in 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.

Figure 2.4 also 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 were marked with 15 crosshairs used in determining whether end conditions (see Subsection 2.5.2 for definition) were achieved. Photo 2.7, taken outdoors at APS test site, shows six test plates mounted on a stand. For simulated freezing precipitation tests at the NRC, 12 plates were mounted on 2 six-position stands, as shown in Figure 2.4.

Figure 2.5 shows the collection (plate) pan, which is of the same size as a standard flat plate and is used to make precipitation rate measurements during outdoor tests. Photo 2.8 shows the collection pans used for measuring precipitation rates indoors at the NRC.

Sealed boxes (7.5 cm deep) were used for simulating a cold soaked wing (see Figure 2.5). The top of the cold-soak box consists of an aluminium flat plate identical to the standard flat plate. A box shaped reservoir is welded to the bottom of the plate.

Freeze points were measured using a hand-held Misco refractometer with a Brix scale.

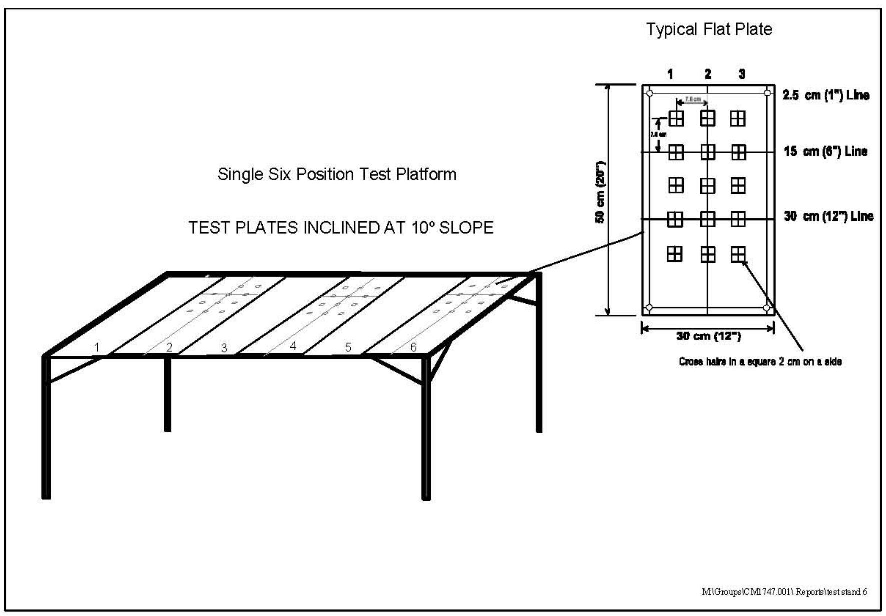


Figure 2.4: Flat Plate Test Set-Up

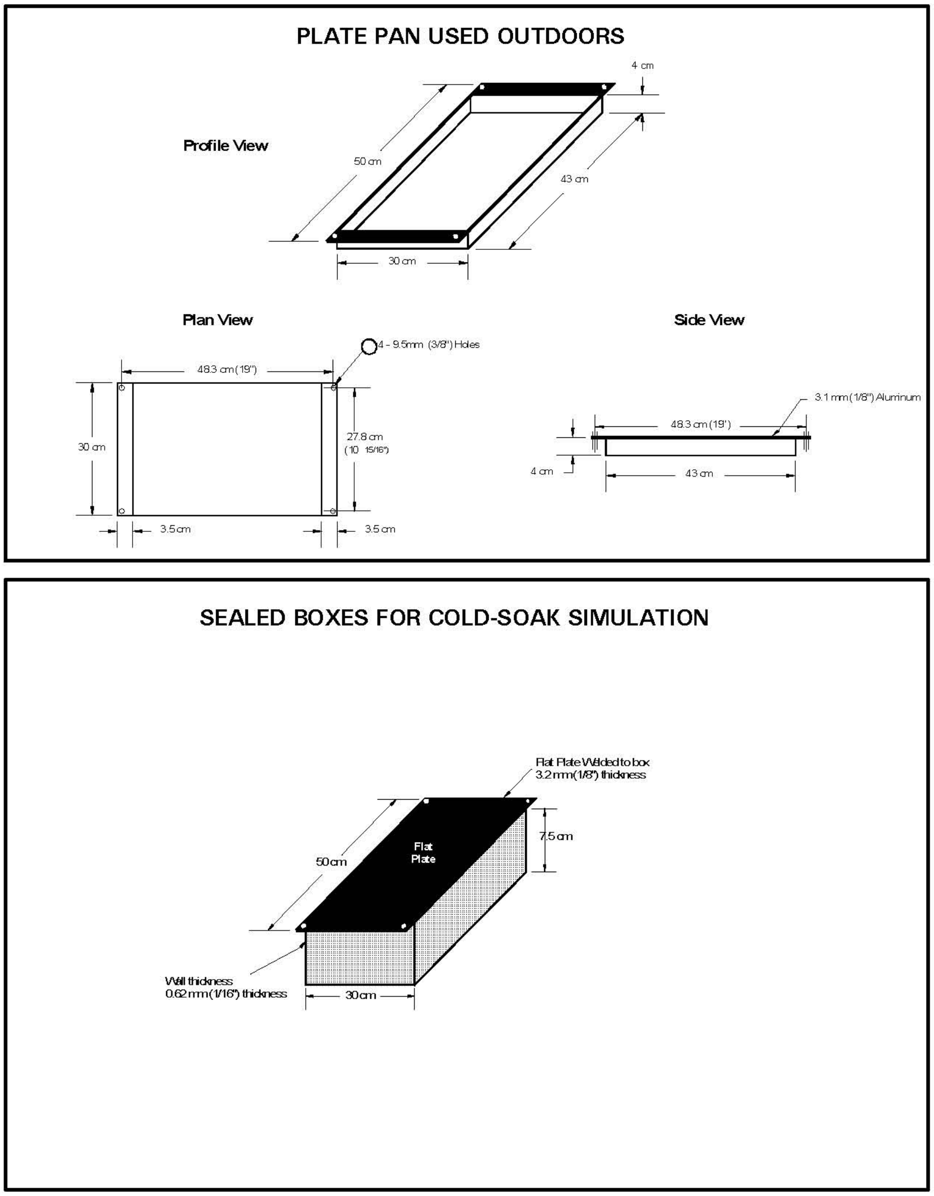


Figure 2.5: Schematics of Plate Pan and Sealed Boxes

2.5 Test Procedures

Tests consisted 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 2.5.2 below).

2.5.1 Test Protocol

A plan containing a detailed description of the test parameters, precipitation measurement methods, testing procedure and test equipment for conducting endurance time tests for Type II, III and IV fluids was developed by APS based on ARP5485. This procedure addresses testing conducted under natural and simulated freezing precipitation conditions, including natural snow and simulated freezing fog, freezing drizzle, light freezing rain and rain on cold soaked wing. Endurance times are evaluated by measuring the minimum exposure time before a specified degree of freezing occurs.

During the conduct of these tests a series of test parameters are recorded, as required by ARP5485 The test parameters are grouped into two categories: generic and specific test parameters. Generic test parameters are recorded once per winter season (or test session, in laboratory testing) and include: test plate material, plate dimensions and surface finish, and ice-catch pan dimensions. Specific test parameters are recorded during each testing session (or weather condition, in laboratory testing) and include: angle of test stand, synchronization of timing devices, plate and ambient temperature profile files, icing intensity, etc. As per ARP5485 requirements, the test surface and ambient temperatures were recorded at a minimum sampling rate of one datum per minute.

2.5.2 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.

2.5.3 Precipitation Rate Procedures

The procedures for measuring and determining precipitation rates during simulated precipitation and natural precipitation conditions are provided below.

2.5.3.1 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. Prior to the start of the precipitation catch period, the exact time (hh:mm:ss) is recorded. 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 this 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.

2.5.3.2 Natural precipitation conditions

Two rate collection pans per test stand are 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 the each pan are wetted with Type IV anti-icing 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) from the timepiece located near the rate station before leaving the trailer to place the pans on the test stand. The person responsible for collecting precipitation rate data take the time delay necessary to proceed outside from the rate station into consideration.

The pans are positioned in locations 6 and 7 (see Figure 2.4) and are allowed to collect precipitation for 10-minute intervals in normal conditions and 5-minute intervals in periods of high precipitation rates and high winds. 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 has failed.

The rate for any HOT test in natural snow is obtained by computing the time-weighted average of the rates collected in the upper and lower pans over the duration of this particular test.

An example of the rate calculation method for tests in natural snow conditions is displayed in Figure 2.6. Typically, two collections pans are used for each test. The start and end times of the test 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 2.6, 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.

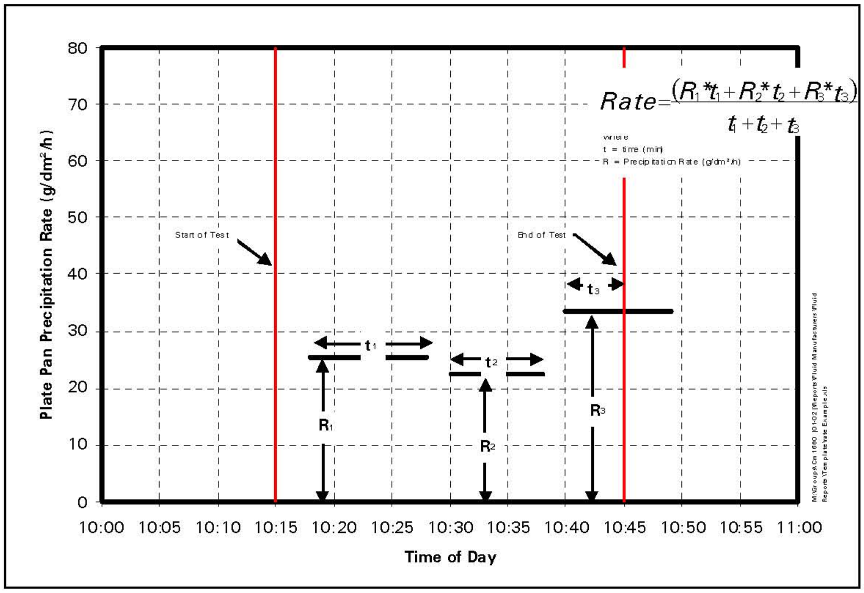


Figure 2.6: Calculation of Outdoor Precipitation Rate

2.6 Analysis Methodology

A multi-variable regression procedure is used to derive fluid-specific holdover times for Type II/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, are detailed in Subsection 2.6.1. 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. Subsection 2.6.2 describes the analysis methodology in more detail.

2.6.1 Precipitation Rate Limits

The precipitation rate limits used in the determination of fluid holdover times are represented graphically in Figure 2.7. Detailed definitions and explanations of the precipitation types and ranges are described in the following subsections. Meteorologically accepted definitions of these conditions were outlined in Table 2.1.

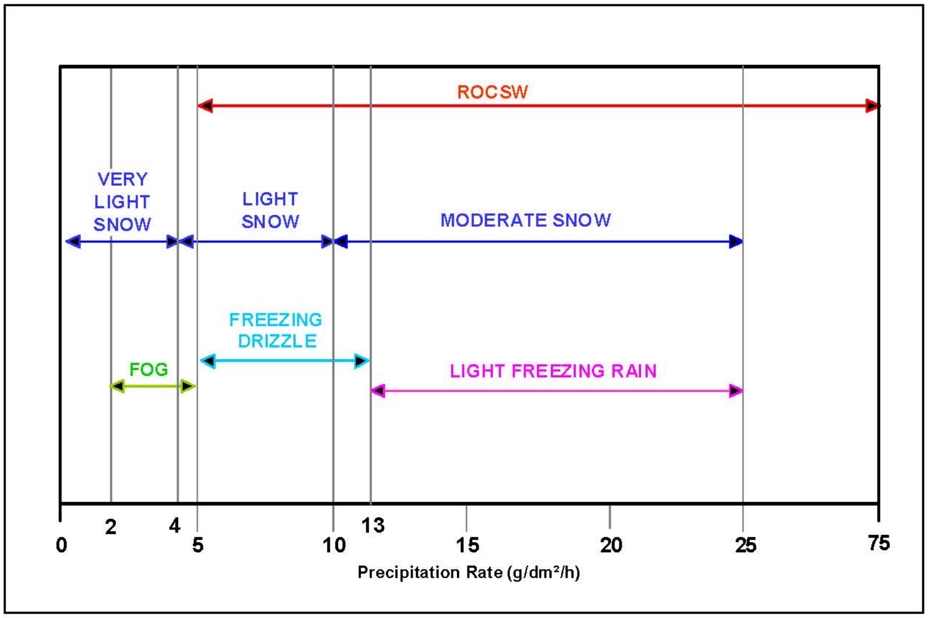


Figure 2.7: Precipitation Rate Boundaries Used for Evaluation of Holdover Times

2.6.1.1 Snow

For Type II and Type IV fluids, the upper and lower limits for the snow column are set at rates of 10 and 25 $g/dm^2/h$, respectively. These limits encompass moderate snow. The upper precipitation rate limit (25 $g/dm^2/h$) corresponds to the onset of heavy snow. Above this rate, HOT table users are referred to the cautionary note indicating that no HOTs exist in these conditions.

2.6.1.2 Freezing drizzle

Freezing drizzle is considered to occur over the range of 0 to 13 $g/dm^2/h$. The precipitation rate limits for endurance time testing in this condition are set at 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. A caution note is included in the HOT tables indicating that if positive identification of freezing drizzle is not possible, the light freezing rain HOT is recommended for use.

2.6.1.3 Light freezing rain

The limits for freezing rain testing are set at 13 and 25 g/dm²/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.

2.6.1.4 Freezing fog

The precipitation rate limits for freezing fog were determined with input from meteorologists from the NRC, 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/m³.

The precipitation rate for fog, referred to as *fog deposition* or simply as *deposition*, is given by the empirical expression,

Deposition = LWC x Wind Velocity x Sin 10° x Collection Efficiency

where the Sin 10° term accounts for the 10° inclination of the test plates into the direction of the wind.
The meteorological circumstances (LWC value and wind speed), and the speed and orientation of the airfoil relative to the wind (stationary or taxiing), contribute to uncertainties in the values that the variables in the equation can assume.

The upper and lower holdover times for freezing fog were set in 1997 at rates of 5 and 2 g/dm²/h, respectively. Discussions at the 1998 SAE G-12 HOT Committee meeting in Vienna indicated 2 g/dm²/h may not be indicative of low rate natural fog. However, 2 g/dm²/h was reaffirmed as the lower precipitation rate limit during a meeting of the Workgroup on Laboratory Methods to Derive HOT Guidelines in Montreal in March 1999.

2.6.1.5 Rain on a cold-soaked surface

The precipitation rate boundaries for rain on cold soaked surface were set at 5 and 75 g/dm²/h. This range encompasses drizzle (5 to 13 g/dm²/h), light rain (13 to 25 g/dm²/h), and moderate rain (25 to 75 g/dm²/h). Heavy rain is encompassed in the HOT tables by the cautionary note indicating that no HOTs exist in these conditions.

2.6.2 Determination of Holdover Times

A multi-variable regression procedure is used to derive fluid holdover times using the precipitation rate limits detailed in Subsection 2.6.1. This analysis is completed on a cell-by-cell basis using the data collected under the weather conditions encompassed by each cell. The Type II and Type IV HOT tables are currently composed of 24 cells; each cell contains a lower and upper time limit for a total of 48 HOT values in each Type II/IV fluid-specific HOT table.

The general form of the regression equation is:

$$t = cR^a$$

where

t	=	Time (minutes)
R	=	Rate of precipitation (g/dm²/h)
a,c	=	coefficients determined from the regression.

However, modifications are made depending on the conditions under which testing is conducted.

2.6.2.1 Simulated freezing precipitation testing

The analysis methodology described in this section is used to derive holdover times from tests conducted in simulated freezing precipitation, including freezing fog, light freezing rain, freezing drizzle and rain on cold soaked surface.

For each related HOT table cell, four tests are conducted at the most restrictive (lowest) temperature in the temperature range for that cell: two tests are conducted at the low precipitation rate limit and two tests are conducted at the high precipitation rate limit, for a total of four tests per cell. The precipitation rate limits were detailed in Subsection 2.6.1.

Tests in freezing fog are conducted at the following temperatures and precipitation rates:

- Temperatures: -3, -14 and -25°C
- Precipitation rates: 2 and 5 g/dm^2/h

Tests in freezing drizzle are conducted at the following temperatures and precipitation rates:

- Temperatures: -3 and -10°C
- Precipitation rates: 5 and 13 g/dm^2/h

Tests in light freezing rain are conducted at the following temperatures and precipitation rates:

- Temperatures: -3 and -10°C
- Precipitation rates: 13 and 25 g/dm^2/h

Tests in rain on cold soaked surface are conducted at the following temperatures and precipitation rates:

- Temperatures: +1°C
- Precipitation rates: 5 and 75 g/dm^2/h

The equation used to treat the data in these categories of precipitation is:

- $t = cR^a$

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 rounding rules (see Subsection 2.6.3).

2.6.2.2 Natural snow testing

As outside air temperature and precipitation rate can not be controlled under natural test conditions, 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.

Best-fit curves are plotted for each cell of the snow column using the most restrictive (lowest) temperature for that cell. Best-fit curves are plotted for neat fluids at -3°C, -14°C and -25°C; for 75/25 fluids at -3°C and -14°C; and for 50/50 fluids at -3°C.

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 is: $t = cR^a(2\text{-}T)^b$.

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. As detailed previously, the precipitation rate limits for the snow column of the Type II/IV HOT tables are 10 and 25 g/dm^2/h.

2.6.3 Rounding and Capping Protocols

Regression-generated holdover times are subject to rounding and capping protocols.

- Rounding Protocol: 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. In cases where the regression-generated holdover times are below 10 minutes, the numbers are rounded down to the nearest whole minute as a precautionary measure. For example, 9.6 minutes is rounded down to 9 minutes.

- Capping Protocol: Holdover time values are capped at 2 hours for all precipitation conditions except freezing fog values, which are capped at 4 hours.

2.6.4 Example

Sample plots of **Log t** versus **Log R** are shown in Figure 2.8. 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 2.9. 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.

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.

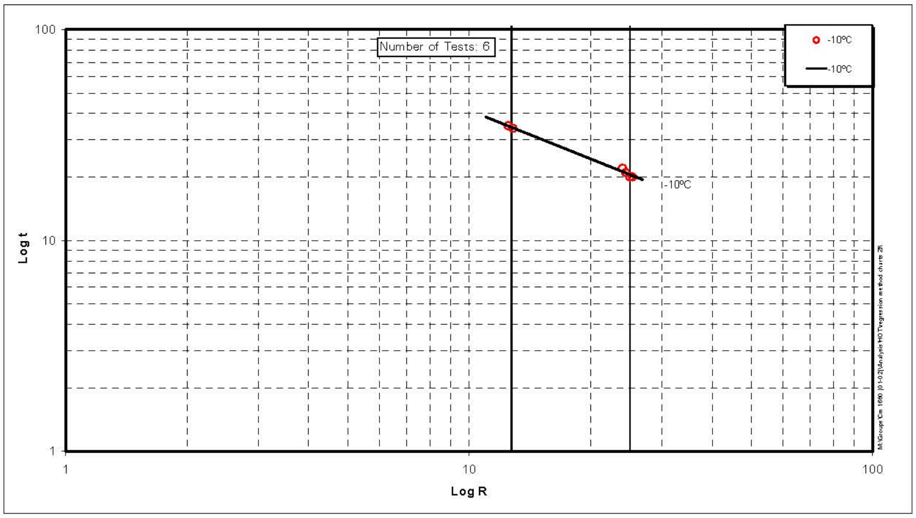


Figure 2.8: Regression Method on Log-Log Chart – Sample Type IV Neat, Freezing Rain

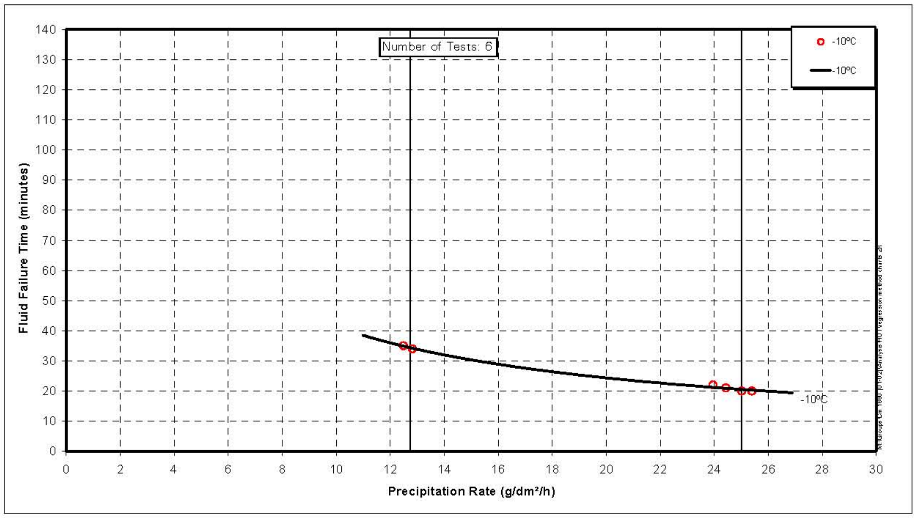


Figure 2.9: Regression Method on Standard Chart – Sample Type IV Neat, Freezing Rain

Photo 2.1: View of Test Site and Associated Equipment

Photo 2.2: Meteorological Services of Canada Weather Observation Station at Montréal-Pierre-Elliott-Trudeau International Airport

Photo 2.3: Outdoor View of NRC Climatic Engineering Facility

Photo 2.4: Inside View of NRC Climatic Engineering Facility

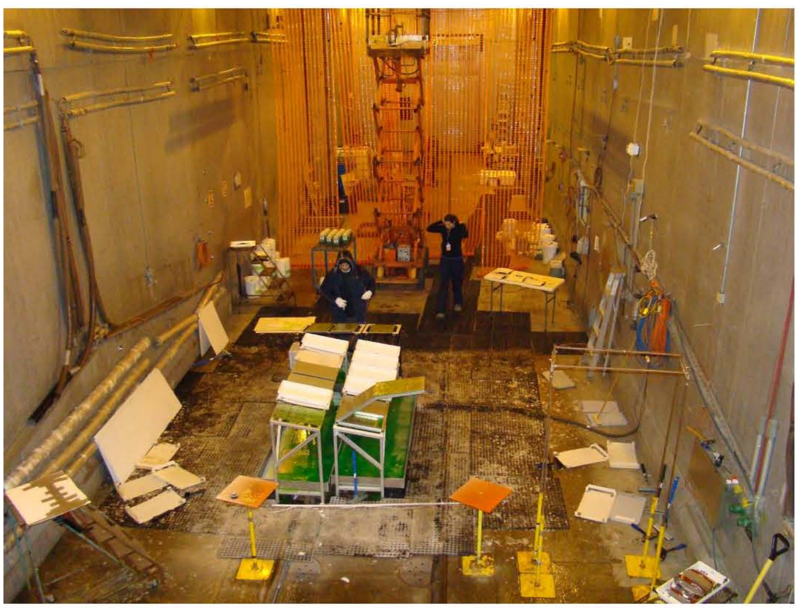


Photo 2.5: Sprayer Assembly

Photo 2.6: Sprayer Nozzle

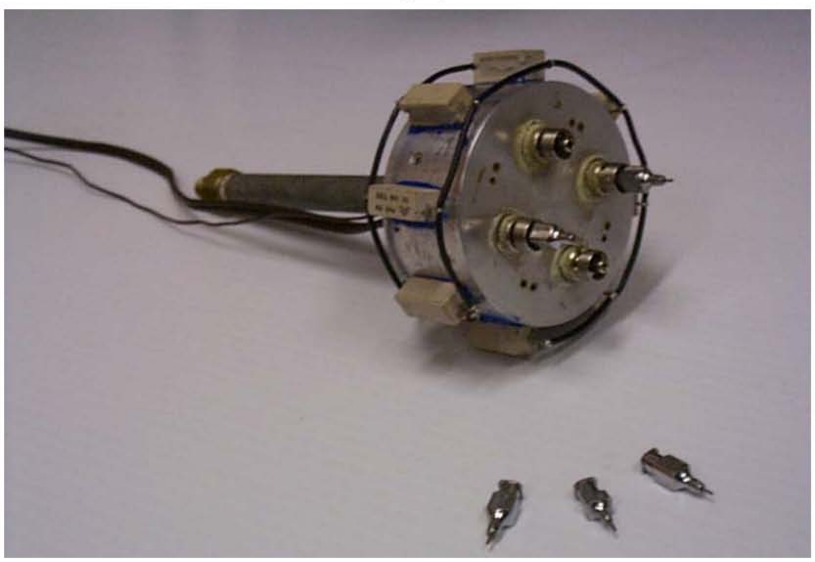


Photo 2.7: Test Plates Mounted on Stand

Photo 2.8: Collection Pans Used Indoors at the NRC

3. DESCRIPTION OF DATA

This section provides a summary of the number of tests conducted in natural snow, simulated light freezing rain, simulated freezing drizzle, simulated freezing fog, and rain on cold soaked wing. Breakdowns are provided for quantity of tests performed by fluid type and temperature.

Lists of tests conducted in natural snow and freezing precipitation are provided in Tables 3.1 and 3.2 at the end of this section.

3.1 Natural Snow Tests

Tests were conducted in natural snow conditions at the APS test site. The breakdown of tests conducted is summarized below by fluid dilution and temperature.

	≥ -3°C	-3 to -14°C	-14 to -25°C	Total
Neat	9	8	0	17
75/25	12	9	0	21
50/50	13	1	0	14
				52

3.2 Freezing Drizzle and Light Freezing Rain Tests

Tests were conducted in freezing drizzle and light freezing rain conditions at the NRC CEF. The breakdown of tests conducted is summarized below by fluid dilution and temperature.

	Freezing Drizzle		Light Freezing Rain	
	-3°C	-10°C	-3°C	-10°C
Neat	4	4	4	4
75/25	4	5	4	4
50/50	4	0	4	0

3.3 Freezing Fog Tests

Tests were conducted in freezing fog conditions at the NRC CEF. The breakdown of tests conducted is summarized below by fluid dilution and temperature.

	-3°C	-14°C	-25°C	-30.5°C
Neat	4	4	4	4
75/25	4	4	0	0
50/50	4	0	0	0

3.4 Rain on Cold-Soaked Surface Tests

Tests were conducted in rain on cold-soaked surface conditions at the NRC CEF with Neat and 75/25 diluted fluids. The breakdown of tests conducted is summarized below by fluid dilution and temperature.

	+1°C
Neat	4
75/25	4
50/50	0

3.5 Fluid Thickness Tests

The purpose of conducting fluid thickness tests was to measure the film thickness profiles of the fluid in all dilutions under dry conditions.

Two tests were performed for each standard dilution (Neat, 75/25 and 50/50). For each test, one litre of fluid was poured onto a flat plate mounted on a test stand inclined at 10° to the horizontal. Film thickness measurements were taken at the 15-cm (6") line at pre-selected time intervals over a 30-minute interval. Tests were conducted at an ambient temperature of -3°C.

The film thickness profiles are displayed in Figure 3.1. The final fluid thicknesses are displayed in Figure 3.2.

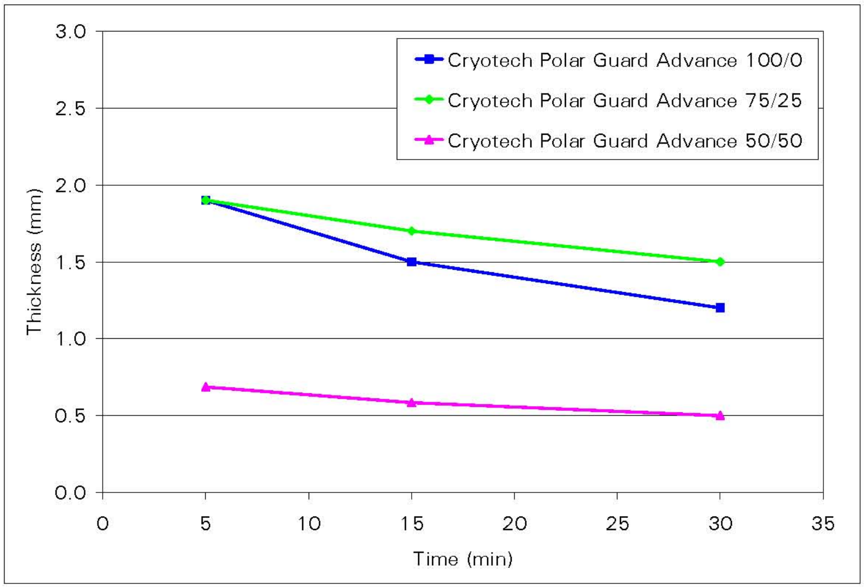


Figure 3.1: Fluid Thickness Profiles of Cryotech Polar Guard Advance

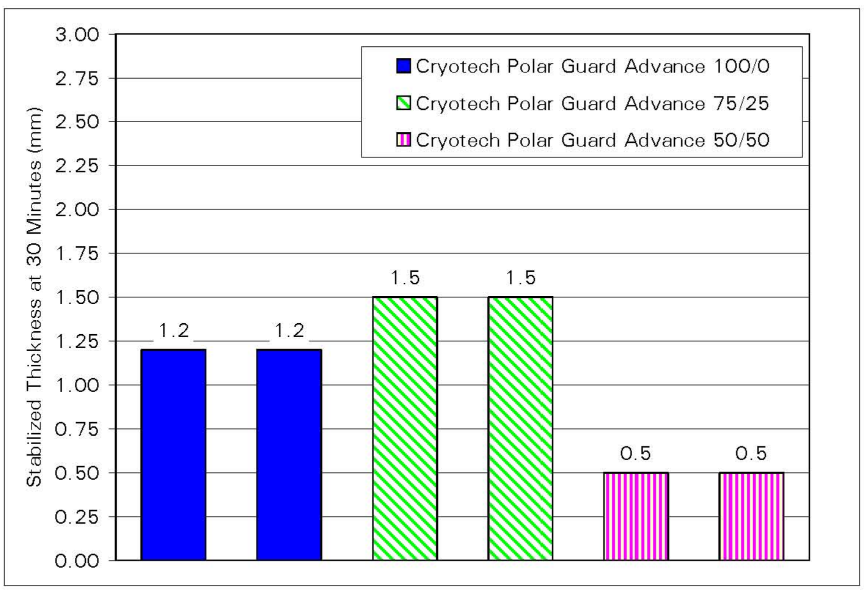


Figure 3.2: Final Fluid Thickness of Cryotech Polar Guard Advance

Table 3.1: Summary of Tests Performed (Snow)

Test No.	Date	Fluid Name	Fluid Dilution	Endurance Time (min)	Icing Intensity (g/dm²/h)	Test Temp. (°C)	Precipitation Type
3	25-Feb-11	Polar Guard Advance	100%	116.7	10.4	-4.0	Natural Snow
4	25-Feb-11	Polar Guard Advance	75%	107.0	10.8	-4.0	Natural Snow
7	25-Feb-11	Polar Guard Advance	75%	111.2	9.8	-3.9	Natural Snow
8	25-Feb-11	Polar Guard Advance	100%	115.8	10.0	-3.9	Natural Snow
12	25-Feb-11	Polar Guard Advance	50%	61.3	4.5	-3.8	Natural Snow
17	25-Feb-11	Polar Guard Advance	100%	148.2	7.7	-3.8	Natural Snow
18	25-Feb-11	Polar Guard Advance	75%	116.4	8.4	-3.8	Natural Snow
27	27-Feb-11	Polar Guard Advance	75%	107.2	3.9	-10.2	Natural Snow
30	27-Feb-11	Polar Guard Advance	100%	108.0	4.2	-10.1	Natural Snow
31	27-Feb-11	Polar Guard Advance	75%	91.1	4.2	-10.1	Natural Snow
34	27-Feb-11	Polar Guard Advance	100%	99.9	4.4	-10.3	Natural Snow
35	27-Feb-11	Polar Guard Advance	75%	88.6	4.4	-10.3	Natural Snow
39	28-Feb-11	Polar Guard Advance	75%	71.5	15.7	0.3	Natural Snow
41	28-Feb-11	Polar Guard Advance	50%	18.8	21.3	0.1	Natural Snow
44	28-Feb-11	Polar Guard Advance	50%	24.3	12.9	0.4	Natural Snow
46	28-Feb-11	Polar Guard Advance	50%	24.7	13.5	0.4	Natural Snow
50	28-Feb-11	Polar Guard Advance	50%	13.3	25.0	0.4	Natural Snow
52	28-Feb-11	Polar Guard Advance	100%	134.3	17.4	0.7	Natural Snow
54	28-Feb-11	Polar Guard Advance	50%	33.1	19.7	0.7	Natural Snow
56	28-Feb-11	Polar Guard Advance	75%	72.7	20.1	0.6	Natural Snow
59	28-Feb-11	Polar Guard Advance	50%	70.0	15.5	0.7	Natural Snow
61	28-Feb-11	Polar Guard Advance	50%	19.0	23.6	0.7	Natural Snow
63	28-Feb-11	Polar Guard Advance	75%	70.9	15.9	0.7	Natural Snow
69	6-Mar-11	Polar Guard Advance	50%	38.0	15.0	-2.3	Natural Snow
71	6-Mar-11	Polar Guard Advance	75%	54.3	14.9	-2.3	Natural Snow
74	6-Mar-11	Polar Guard Advance	100%	96.1	17.2	-2.1	Natural Snow
75	6-Mar-11	Polar Guard Advance	75%	45.4	18.8	-2.1	Natural Snow
77	6-Mar-11	Polar Guard Advance	50%	40.7	10.2	-2.3	Natural Snow
79	6-Mar-11	Polar Guard Advance	50%	32.0	11.8	-2.4	Natural Snow
83	6-Mar-11	Polar Guard Advance	100%	125.5	10.8	-2.4	Natural Snow
84	6-Mar-11	Polar Guard Advance	75%	123.6	10.9	-2.4	Natural Snow
88	6-Mar-11	Polar Guard Advance	50%	36.3	10.9	-2.4	Natural Snow
93	7-Mar-11	Polar Guard Advance	100%	69.6	15.6	-7.9	Natural Snow
96	7-Mar-11	Polar Guard Advance	100%	84.0	16.3	-7.9	Natural Snow
97	7-Mar-11	Polar Guard Advance	75%	38.0	17.3	-7.7	Natural Snow
101	7-Mar-11	Polar Guard Advance	100%	82.3	6.9	-7.1	Natural Snow
102	7-Mar-11	Polar Guard Advance	75%	51.7	12.7	-7.1	Natural Snow
105	7-Mar-11	Polar Guard Advance	75%	45.4	16.2	-8.0	Natural Snow
106	6-Mar-11	Polar Guard Advance	75%	102.5	10.9	-2.3	Natural Snow

Table 3.1 (cont'd): Summary of Tests Performed (Snow)

Test No.	Date	Fluid Name	Fluid Dilution	Endurance Time (min)	Icing Intensity (g/dm²/h)	Test Temp. (°C)	Precipitation Type
109	10-Mar-11	Polar Guard Advance	100%	123.0	11.5	-0.8	Natural Snow
111	10-Mar-11	Polar Guard Advance	100%	90.2	18.7	-0.8	Natural Snow
112	10-Mar-11	Polar Guard Advance	50%	38.0	11.5	-0.8	Natural Snow
113	10-Mar-11	Polar Guard Advance	75%	56.3	14.9	-0.8	Natural Snow
116	10-Mar-11	Polar Guard Advance	100%	128.5	9.2	-1.2	Natural Snow
117	10-Mar-11	Polar Guard Advance	75%	92.0	8.5	-1.2	Natural Snow
120	10-Mar-11	Polar Guard Advance	100%	98.8	18.1	-0.8	Natural Snow
123	10-Mar-11	Polar Guard Advance	75%	117.7	6.2	-0.6	Natural Snow
126	10-Mar-11	Polar Guard Advance	100%	145.9	7.9	-0.6	Natural Snow
127	10-Mar-11	Polar Guard Advance	75%	72.8	19.1	-0.8	Natural Snow
129	10-Mar-11	Polar Guard Advance	100%	161.5	8.9	-0.2	Natural Snow
131	10-Mar-11	Polar Guard Advance	50%	28.6	18.3	0.4	Natural Snow
133	10-Mar-11	Polar Guard Advance	75%	69.6	19.6	-0.8	Natural Snow

Table 3.2: Summary of Tests Performed (Freezing Precipitation)

Test No.	Date	Fluid Name	Fluid Dilution	Endurance Time (min)	Icing Intensity (g/dm²/h)	Test Temp. (°C)	Precipitation Type
3	12-Apr-11	Polar Guard Advance	100	> 4 hrs	1.9	-3.4	Freezing Fog
4	12-Apr-11	Polar Guard Advance	100	> 4 hrs	1.9	-3.4	Freezing Fog
7	12-Apr-11	Polar Guard Advance	75	> 4 hrs	1.7	-3.4	Freezing Fog
8	12-Apr-11	Polar Guard Advance	75	> 4 hrs	1.8	-3.4	Freezing Fog
11	12-Apr-11	Polar Guard Advance	50	104.0	1.7	-3.3	Freezing Fog
12	12-Apr-11	Polar Guard Advance	50	84.5	1.8	-3.2	Freezing Fog
15	12-Apr-11	Polar Guard Advance	100	172.6	4.8	-3.2	Freezing Fog
16	12-Apr-11	Polar Guard Advance	100	167.5	5.1	-3.2	Freezing Fog
19	12-Apr-11	Polar Guard Advance	75	155.5	4.7	-3.2	Freezing Fog
20	12-Apr-11	Polar Guard Advance	75	153.5	4.9	-3.2	Freezing Fog
23	12-Apr-11	Polar Guard Advance	50	46.5	5.3	-3.2	Freezing Fog
24	12-Apr-11	Polar Guard Advance	50	49.3	5.0	-3.2	Freezing Fog
27	11-Apr-11	Polar Guard Advance	100	154.9	1.9	-14.1	Freezing Fog
28	11-Apr-11	Polar Guard Advance	100	153.7	2.0	-14.1	Freezing Fog
31	11-Apr-11	Polar Guard Advance	75	90.4	2.1	-14.3	Freezing Fog
32	11-Apr-11	Polar Guard Advance	75	90.0	2.0	-14.3	Freezing Fog
35	11-Apr-11	Polar Guard Advance	100	53.3	5.3	-13.9	Freezing Fog
36	11-Apr-11	Polar Guard Advance	100	51.9	4.9	-13.9	Freezing Fog
39	11-Apr-11	Polar Guard Advance	75	40.3	4.8	-14.0	Freezing Fog
40	11-Apr-11	Polar Guard Advance	75	39.5	4.6	-14.0	Freezing Fog
43	11-Apr-11	Polar Guard Advance	100	50.5	2.1	-25.1	Freezing Fog
44	11-Apr-11	Polar Guard Advance	100	48.2	2.2	-25.1	Freezing Fog
47	11-Apr-11	Polar Guard Advance	100	27.2	5.1	-25.1	Freezing Fog
48	11-Apr-11	Polar Guard Advance	100	26.5	5.2	-25.1	Freezing Fog
51	7-Apr-11	Polar Guard Advance	100	86.8	13.0	-3.2	Light Freezing Rain
52	7-Apr-11	Polar Guard Advance	100	89.7	13.0	-3.2	Light Freezing Rain
55	7-Apr-11	Polar Guard Advance	75	74.2	12.9	-3.2	Light Freezing Rain
56	7-Apr-11	Polar Guard Advance	75	65.0	13.1	-3.3	Light Freezing Rain
59	7-Apr-11	Polar Guard Advance	50	18.3	13.0	-3.3	Light Freezing Rain
60	7-Apr-11	Polar Guard Advance	50	17.8	13.0	-3.3	Light Freezing Rain
63	7-Apr-11	Polar Guard Advance	100	76.2	24.5	-3.2	Light Freezing Rain
64	7-Apr-11	Polar Guard Advance	100	71.6	24.7	-3.2	Light Freezing Rain
67	7-Apr-11	Polar Guard Advance	75	38.8	24.4	-3.1	Light Freezing Rain
68	7-Apr-11	Polar Guard Advance	75	40.6	24.4	-3.1	Light Freezing Rain
71	7-Apr-11	Polar Guard Advance	50	10.0	24.4	-3.2	Light Freezing Rain
72	7-Apr-11	Polar Guard Advance	50	9.3	24.4	-3.2	Light Freezing Rain
75	6-Apr-11	Polar Guard Advance	100	43.1	12.9	-10.0	Light Freezing Rain
76	6-Apr-11	Polar Guard Advance	100	45.9	13.0	-10.0	Light Freezing Rain

Table 3.2 (cont'd): Summary of Tests Performed (Freezing Precipitation)

Test No.	Date	Fluid Name	Fluid Dilution	Endurance Time (min)	Icing Intensity (g/dm²/h)	Test Temp. (°C)	Precipitation Type
79	6-Apr-11	Polar Guard Advance	75	45.3	12.6	-10.0	Light Freezing Rain
80	6-Apr-11	Polar Guard Advance	75	44.1	12.9	-10.0	Light Freezing Rain
83	6-Apr-11	Polar Guard Advance	100	34.7	24.6	-10.1	Light Freezing Rain
84	6-Apr-11	Polar Guard Advance	100	34.5	24.8	-10.1	Light Freezing Rain
87	6-Apr-11	Polar Guard Advance	75	34.0	24.5	-10.1	Light Freezing Rain
88	6-Apr-11	Polar Guard Advance	75	37.0	24.2	-10.2	Light Freezing Rain
91	8-Apr-11	Polar Guard Advance	100	> 2 hrs	5.2	-3.2	Freezing Drizzle
92	8-Apr-11	Polar Guard Advance	100	> 2 hrs	4.9	-3.2	Freezing Drizzle
95	8-Apr-11	Polar Guard Advance	75	> 2 hrs	4.8	-3.2	Freezing Drizzle
96	8-Apr-11	Polar Guard Advance	75	> 2 hrs	4.8	-3.2	Freezing Drizzle
99	8-Apr-11	Polar Guard Advance	50	46.7	4.8	-3.2	Freezing Drizzle
100	8-Apr-11	Polar Guard Advance	50	43.2	5.4	-3.2	Freezing Drizzle
103	7-Apr-11	Polar Guard Advance	100	106.0	13.5	-3.4	Freezing Drizzle
104	7-Apr-11	Polar Guard Advance	100	87.5	13.3	-3.3	Freezing Drizzle
107	7-Apr-11	Polar Guard Advance	75	100.7	13.2	-3.4	Freezing Drizzle
108	7-Apr-11	Polar Guard Advance	75	103.3	13.0	-3.4	Freezing Drizzle
111	7-Apr-11	Polar Guard Advance	50	19.2	13.3	-3.2	Freezing Drizzle
112	7-Apr-11	Polar Guard Advance	50	18.1	13.5	-3.2	Freezing Drizzle
115	6-Apr-11	Polar Guard Advance	100	100.6	4.6	-10.3	Freezing Drizzle
116	6-Apr-11	Polar Guard Advance	100	106.3	4.7	-10.3	Freezing Drizzle
119	6-Apr-11	Polar Guard Advance	75	68.0	5.0	-10.4	Freezing Drizzle
120	6-Apr-11	Polar Guard Advance	75	62.6	5.0	-10.4	Freezing Drizzle
123	6-Apr-11	Polar Guard Advance	100	37.3	13.3	-10.1	Freezing Drizzle
124	6-Apr-11	Polar Guard Advance	100	32.7	13.1	-10.1	Freezing Drizzle
127R	6-Apr-11	Polar Guard Advance	75	25.0	13.5	-10.2	Freezing Drizzle
127S	6-Apr-11	Polar Guard Advance	75	28.2	12.8	-10.2	Freezing Drizzle
127T	6-Apr-11	Polar Guard Advance	75	28.3	13.2	-10.2	Freezing Drizzle
131	8-Apr-11	Polar Guard Advance	100	119.2	5.4	0.8	Cold-Soaked Surface
132	8-Apr-11	Polar Guard Advance	100	> 2 hrs	5.1	0.8	Cold-Soaked Surface
135	8-Apr-11	Polar Guard Advance	75	94.6	5.4	0.8	Cold-Soaked Surface
136	8-Apr-11	Polar Guard Advance	75	103.1	5.0	0.7	Cold-Soaked Surface
139	8-Apr-11	Polar Guard Advance	100	13.6	76.4	1.4	Cold-Soaked Surface
140	8-Apr-11	Polar Guard Advance	100	15.5	75.6	1.4	Cold-Soaked Surface
143	8-Apr-11	Polar Guard Advance	75	9.0	74.2	1.3	Cold-Soaked Surface
144	8-Apr-11	Polar Guard Advance	75	10.0	74.7	1.2	Cold-Soaked Surface
161	19-Jul-11	Polar Guard Advance	100	23.5	5.2	-30.2	Freezing Fog
162	19-Jul-11	Polar Guard Advance	100	23.7	5.0	-30.2	Freezing Fog
163	19-Jul-11	Polar Guard Advance	100	45.5	1.9	-30.1	Freezing Fog
164	19-Jul-11	Polar Guard Advance	100	45.5	2.0	-30.1	Freezing Fog

This page intentionally left blank.

34

4. RESULTS AND DISCUSSION

The methods used to evaluate the test data were reviewed in Subsection 2.6. The holdover times and data used to generate the holdover times are presented in this section.

4.1 Data

Figures 4.1 to 4.14 present the data collected in natural snow, 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.

Figure 4.15 presents supplemental data collected in freezing fog at the fluid's lowest operational use temperature (LOUT). Comparative data at -25°C is included, as are the results of similar comparative tests conducted with other Type II/IV fluids. Further discussion is provided in Subsection 4.3.

Table 4.1 illustrates the outputs from the multi-variable regression analyses performed on the natural snow, freezing fog, freezing drizzle, freezing rain and cold soak data. These outputs were used to derive the fluid-specific holdover time values used in the fluid-specific HOT table (see Subsection 4.2).

4.2 Holdover Time Table

A fluid-specific HOT table for Cryotech Polar Guard Advance is shown in Table 4.2 at the end of this section. As Cryotech intends to commercialize this fluid, the table will be published in the 2011-12 FAA and TC HOT guidelines. Commercialization of this fluid will not affect the generic Type IV holdover times.

4.2.1 Holdover Times in Snow, Below -14°C to LOUT

Very little endurance time data has been collected in natural snow at temperatures below -14°C. In the winter of 2003-04, testing was conducted with artificial snowmakers to collect additional snow data below -14°C. As a result of this testing, the current propylene Type II and Type IV fluids were given generic values in the "Below -14 to LOUT" snow cell. Because no natural snow tests were conducted below -14°C with Cryotech Polar Guard Advance, generic values have been used in the "Below -14°C to LOUT" snow cell.

4.2.2 Holdover Times in Frost

In May 2009, a decision was made by TC and the FAA 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 fluid-specific HOT table for Cryotech Polar Guard Advance.

4.2.3 Fluid Viscosity

The viscosity of the fluid samples used in this testing were measured using both the AIR 9968 method and the manufacturer's designated method. The APS measured viscosities appear at the front of this document and will also be published in the HOT Guidelines as the lowest on-wing viscosity (LOWV) 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 superior to the published LOWV.

4.3 Supplemental Testing: Validity of Holdover Times at LOUT

In the winter of 2008-09, a decision was made to change the lower limit of the lowest temperature band in the Type II and Type IV fluid-specific HOT tables from -25°C to fluid LOUT. This decision was based on research conducted with a number of Type II and Type IV fluids which showed fluids have similar endurance times at -25°C and -28.5°C (the average LOUT for propylene-glycol based Type II/IV fluids). As described in Subsection 4.2.1, generic holdover times are used in the -25°C snow cell and therefore only freezing fog testing was required to substantiate this change.

The LOUT of Cryotech Polar Guard Advance is -30.5°C, lower than most other fluids and notably lower than the temperature at which the previous LOUT research was conducted (-28.5°C). As a result, testing was required to determine if holdover times derived from testing at -25°C are valid for use at -30.5°C. As the LOUT value was determined after the original endurance time testing was completed, this testing was conducted at a supplemental test session in July 2011.

Figure 4.15 shows the results of the supplemental testing. It shows the endurance times measured at -25°C and -30.5°C are similar: the differences are approximately 10%, which is within experimental error and similar to the results seen previously. It was concluded from this research that the holdover times derived for Cryotech Polar Guard Advance at -25°C are valid for use down to the temperature of the fluid LOUT of -30.5°C.

4.4 Discussion

Cryotech has indicated it will commercialize Polar Guard Advance; therefore, the HOT table created for this fluid, as well as the LOWV and LOUT information, will be published in the 2011-12 FAA and TC HOT guidelines.

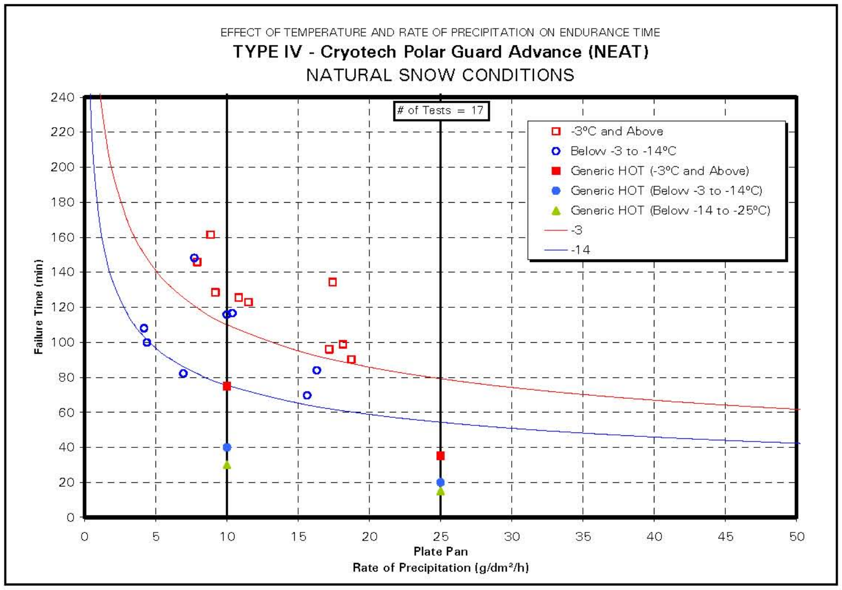


Figure 4.1: Type IV Neat – Natural Snow

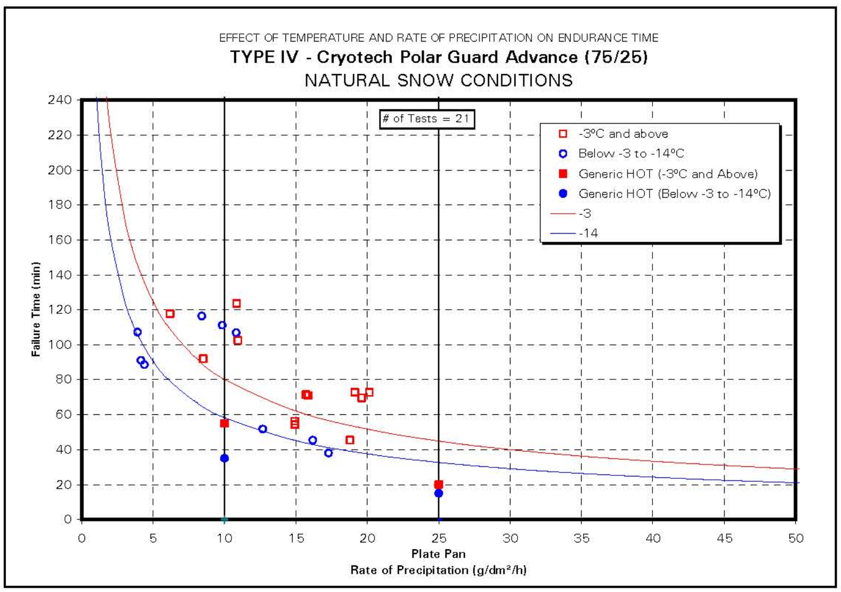


Figure 4.2: Type IV 75/25 – Natural Snow

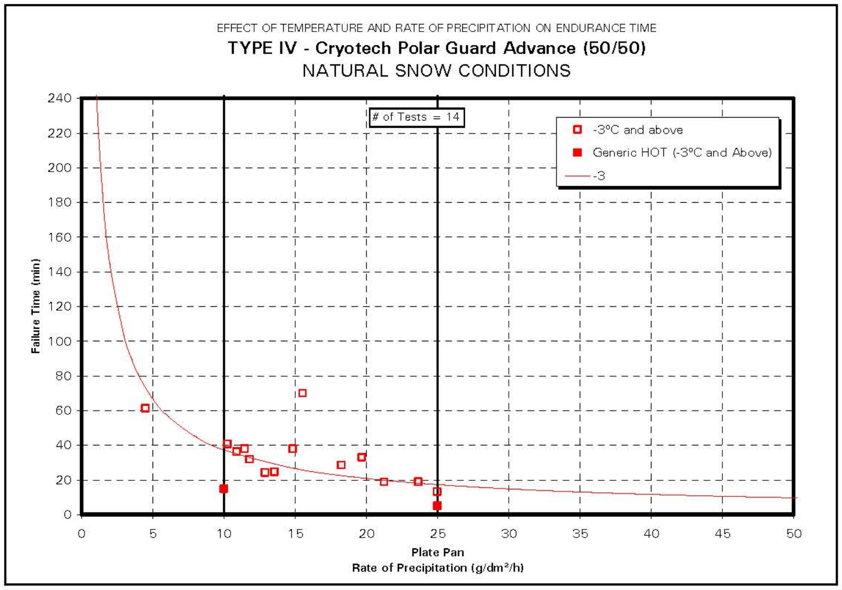


Figure 4.3: Type IV 50/50 – Natural Snow

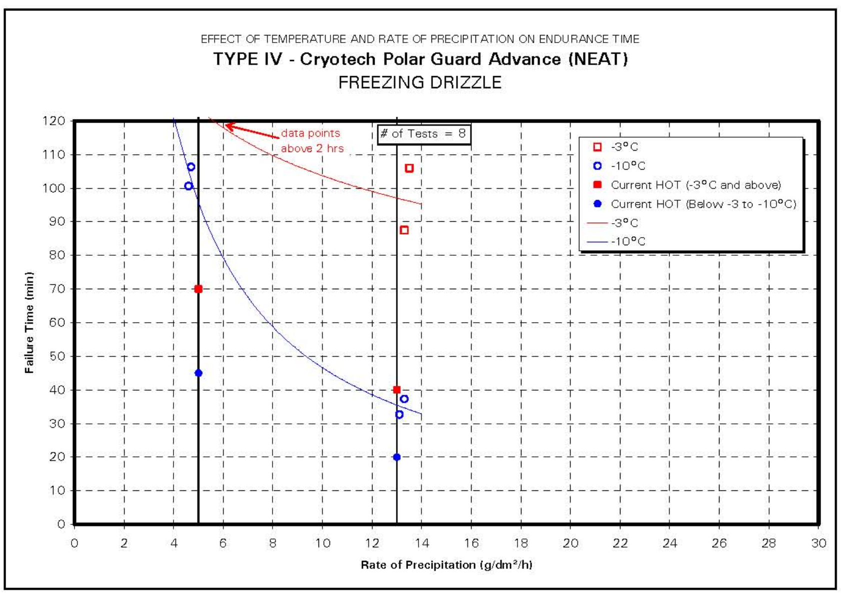


Figure 4.4: Type IV Neat – Freezing Drizzle

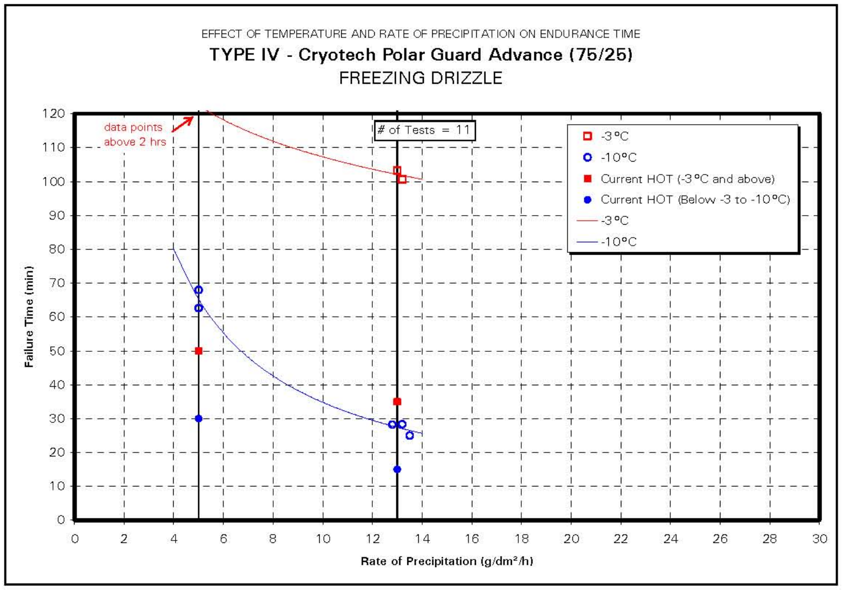


Figure 4.5: Type IV 75/25 – Freezing Drizzle

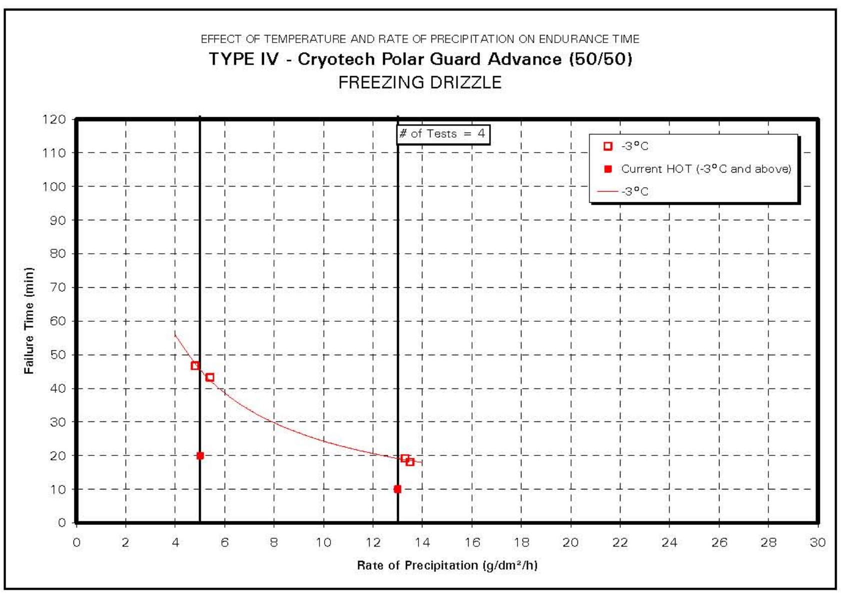


Figure 4.6: Type IV 50/50 – Freezing Drizzle

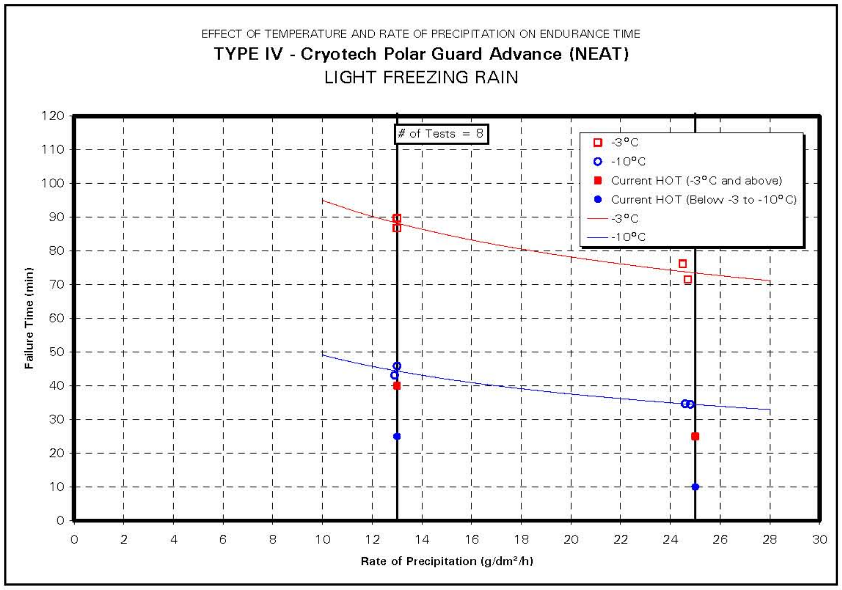


Figure 4.7: Type IV Neat – Light Freezing Rain

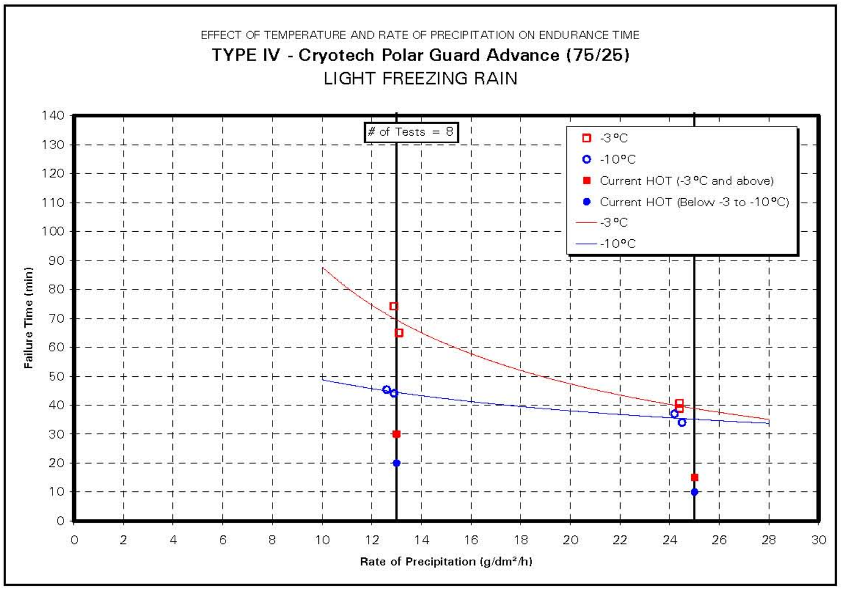


Figure 4.8: Type IV 75/25 – Light Freezing Rain

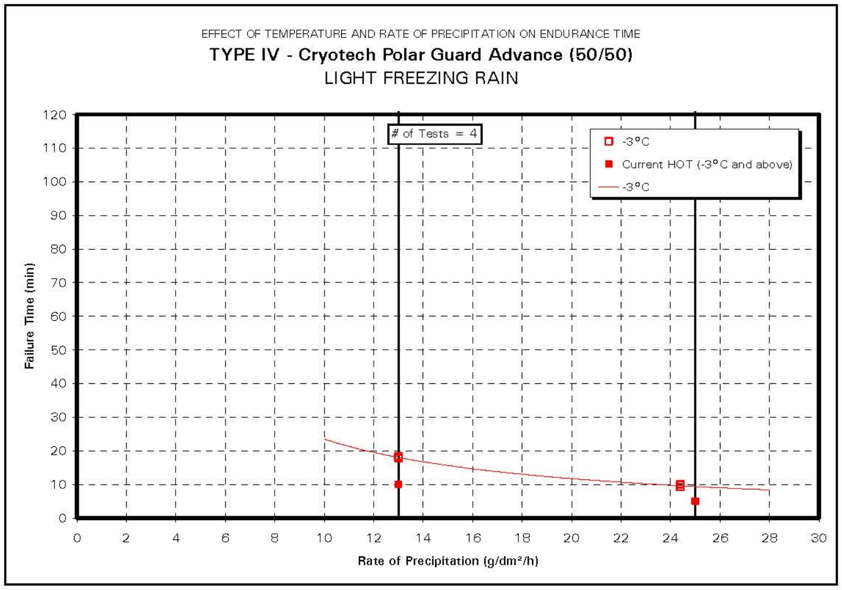


Figure 4.9: Type IV 50/50 – Light Freezing Rain

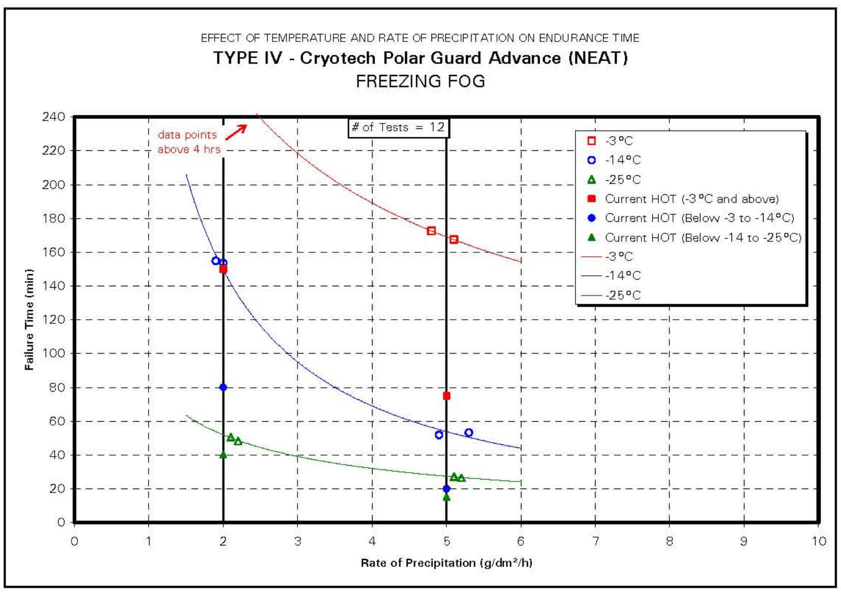


Figure 4.10: Type IV Neat – Freezing Fog

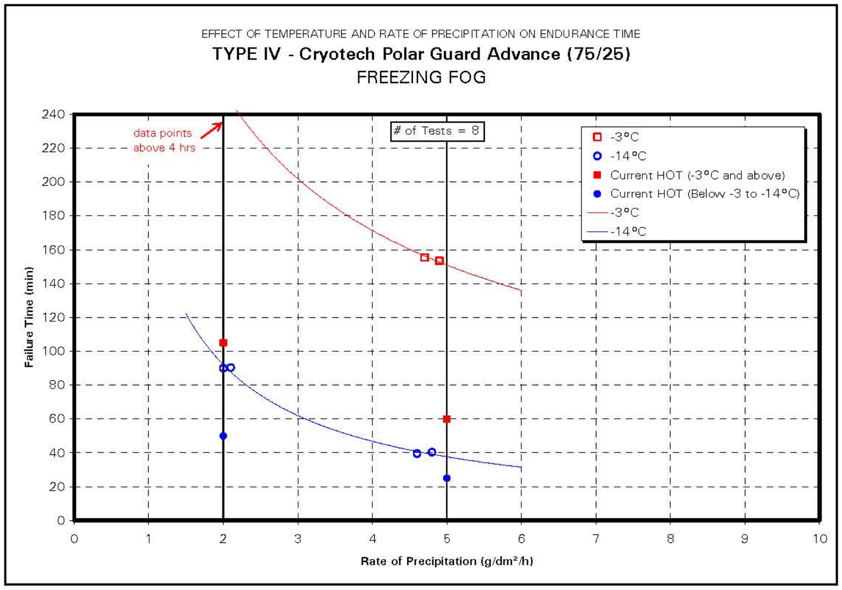


Figure 4.11: Type IV 75/25 – Freezing Fog

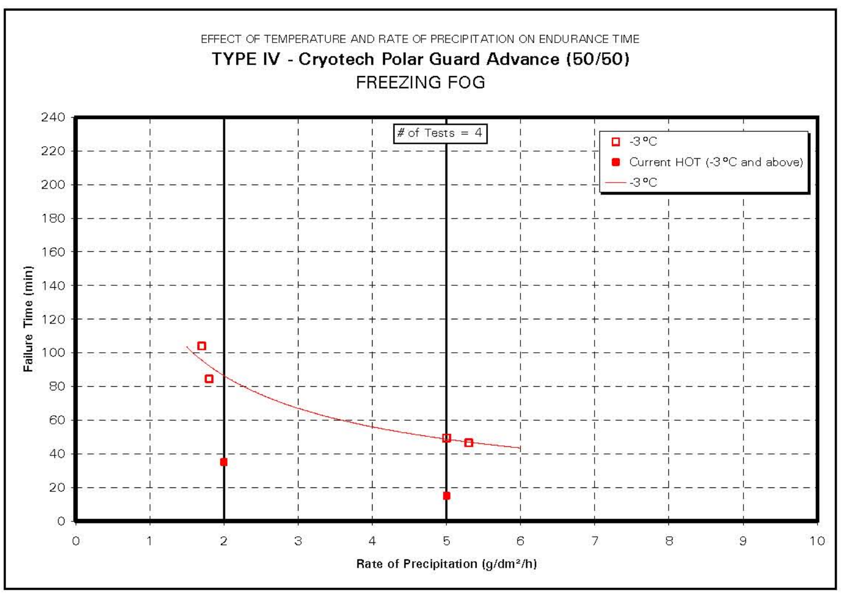


Figure 4.12: Type IV 50/50 – Freezing Fog

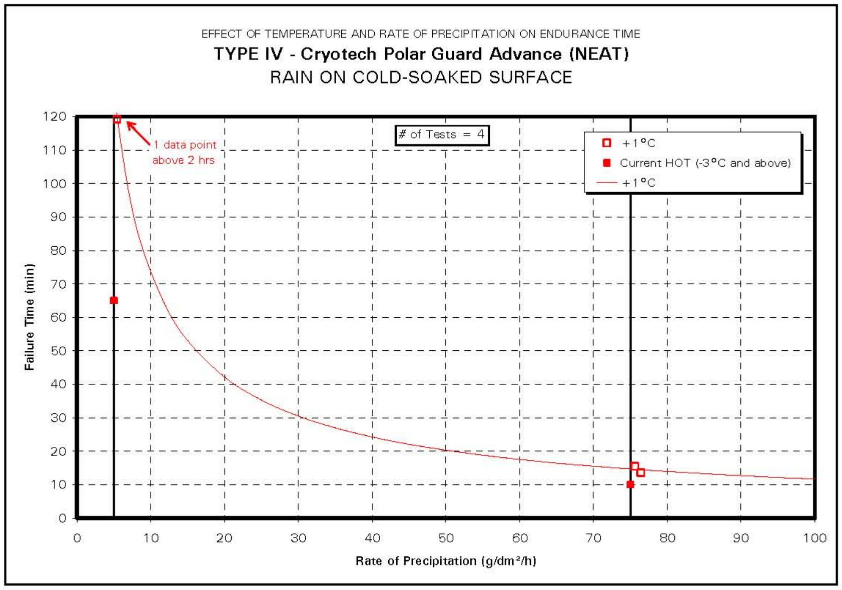


Figure 4.13: Type IV Neat – Rain on Cold-Soaked Surface

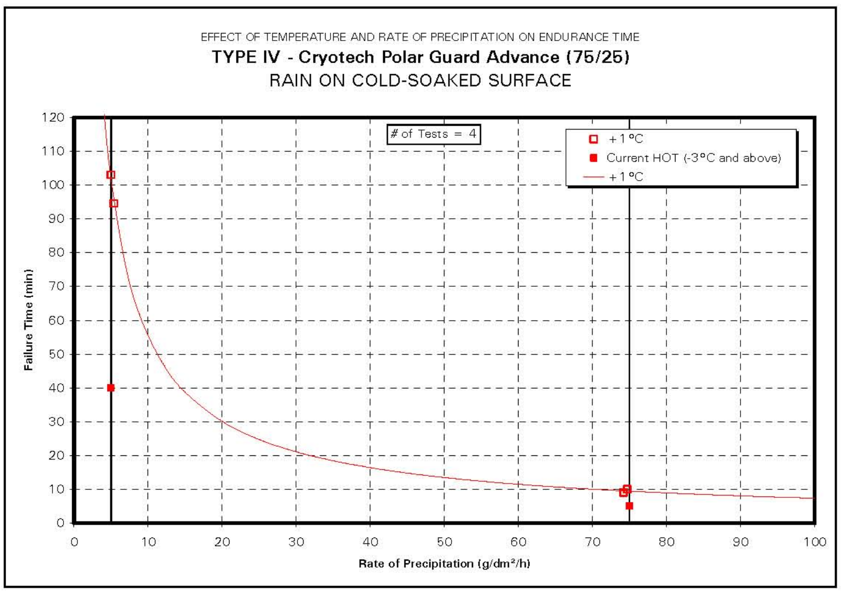


Figure 4.14: Type IV 75/25 – Rain on Cold-Soaked Surface

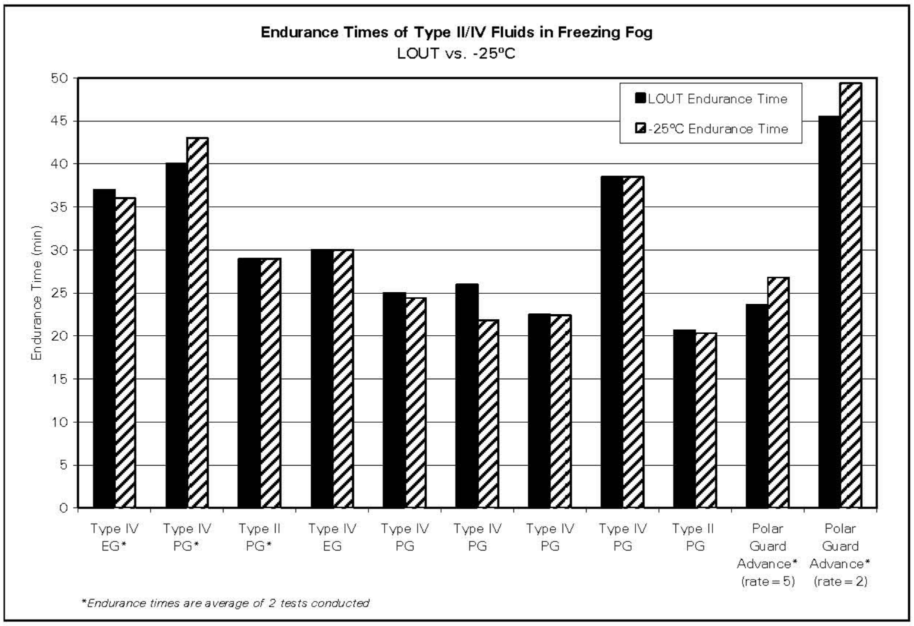


Figure 4.15: Type IV 100 – Comparison of -25°C and LOUT Endurance Times

Table 4.1: Regression Equation Coefficient Summary for Cryotech Polar Guard Advance

Natural Snow Conditions

Fluid	Dil	R^2	Intercept (I)	Coeff. Rate (A)	Coeff. Tem (B)	Total Pts.
Cryotech Polar Guard Advance	Neat	73%	2.6278	-0.3591	-0.3246	17
Cryotech Polar Guard Advance	75%	59%	2.7318	-0.6352	-0.2744	21
Cryotech Polar Guard Advance	50%	49%	2.5102	-0.8406	-0.1391	14

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 Advance	Neat	-3°C	100%	2.5794	-0.5025	4
Cryotech Polar Guard Advance	75%	-3°C	100%	2.5776	-0.5705	4
Cryotech Polar Guard Advance	50%	-3°C	97%	2.1254	-0.6271	4
Cryotech Polar Guard Advance	Neat	-14°C	99%	2.5101	-1.1145	4
Cryotech Polar Guard Advance	75%	-14°C	100%	2.2594	-0.9785	4
Cryotech Polar Guard Advance	Neat	-25°C	100%	1.9253	-0.6979	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 Advance	Neat	-3°C	76%	2.2682	-0.2524	4
Cryotech Polar Guard Advance	75%	-3°C	99%	2.2204	-0.1898	4
Cryotech Polar Guard Advance	50%	-3°C	100%	2.2943	-0.9086	4
Cryotech Polar Guard Advance	Neat	-10°C	99%	2.7077	-1.0390	4
Cryotech Polar Guard Advance	75%	-10°C	99%	2.4495	-0.9076	5

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 Advance	Neat	-3°C	93%	2.2584	-0.2806	4
Cryotech Polar Guard Advance	75%	-3°C	97%	2.8328	-0.8896	4
Cryotech Polar Guard Advance	50%	-3°C	99%	2.3695	-0.9996	4
Cryotech Polar Guard Advance	Neat	-10°C	97%	2.0801	-0.3886	4
Cryotech Polar Guard Advance	75%	-10°C	94%	2.0483	-0.3597	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 Advance	Neat	+1°C	100%	2.6661	-0.7999	4
Cryotech Polar Guard Advance	75%	+1°C	100%	2.6248	-0.8807	4

General Equation $t = 10^I R^A$

Table 4.2: Fluid Specific Holdover Time Guidelines – Cryotech Polar Guard Advance

TABLE 4-CR-PG-A

CRYOTECH TYPE IV FLUID HOLDOVER GUIDELINES FOR WINTER 2011-2012[1]
POLAR GUARD ADVANCE

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

Outside Air Temperature[2]		Type IV Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog	Snow, Snow Grains or Snow Pellets[3]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 and above	27 and above	100/0	2:50 – 4:00	1:20 – 1:50	1:35 – 2:00	1:15 – 1:30	0:15 – 2:00	
		75/25	2:30 – 4:00	0:45 – 1:20	1:40 – 2:00	0:40 – 1:10	0:09 – 1:40	
		50/50	0:50 – 1:25	0:15 – 0:35	0:20 – 0:45	0:09 – 0:20		CAUTION: No holdover time guidelines exist
below -3 to -14	below 27 to 7	100/0	0:55 – 2:30	0:55 – 1:15	0:35 – 1:35[7]	0:35 – 0:45[7]		
		75/25	0:40 – 1:30	0:35 – 1:00	0:25 – 1:05	0:35 – 0:45		
below -14 to -30.5	below 7 to -22.9	100/0	0:25 – 0:50	0:15 – 0:30				

NOTES

1 These holdover times are derived from tests of this fluid having a viscosity as listed in Table 9.
2 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I when Type IV fluid cannot be used.
3 Use light freezing rain holdover times in conditions of light snow mixed with light rain.
4 Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, and hail.
7 These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.

CAUTIONS

- **The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable holdover time 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.**
- **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.**

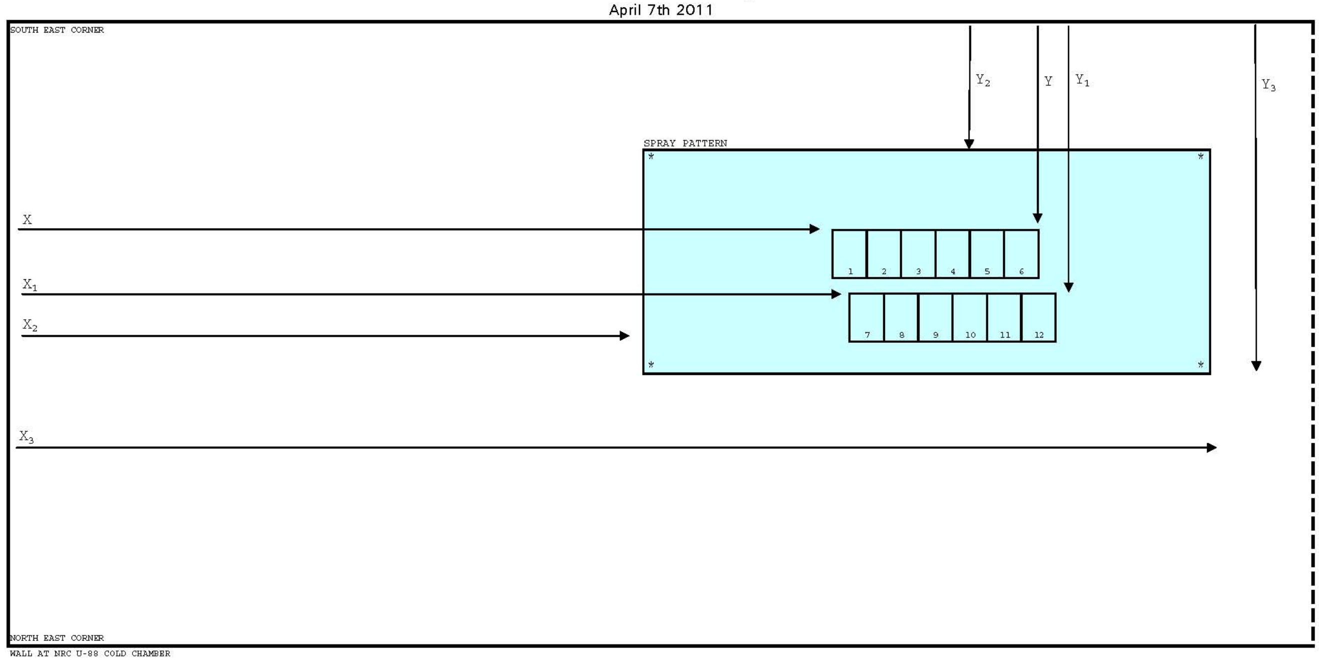
This page intentionally left blank.

APPENDIX E

FREEZING PRECIPITATION STAND SETUP AND SPRAYER CHARACTERISTICS DATA

FREEZING RAIN -3, 25 g/dm^2/h

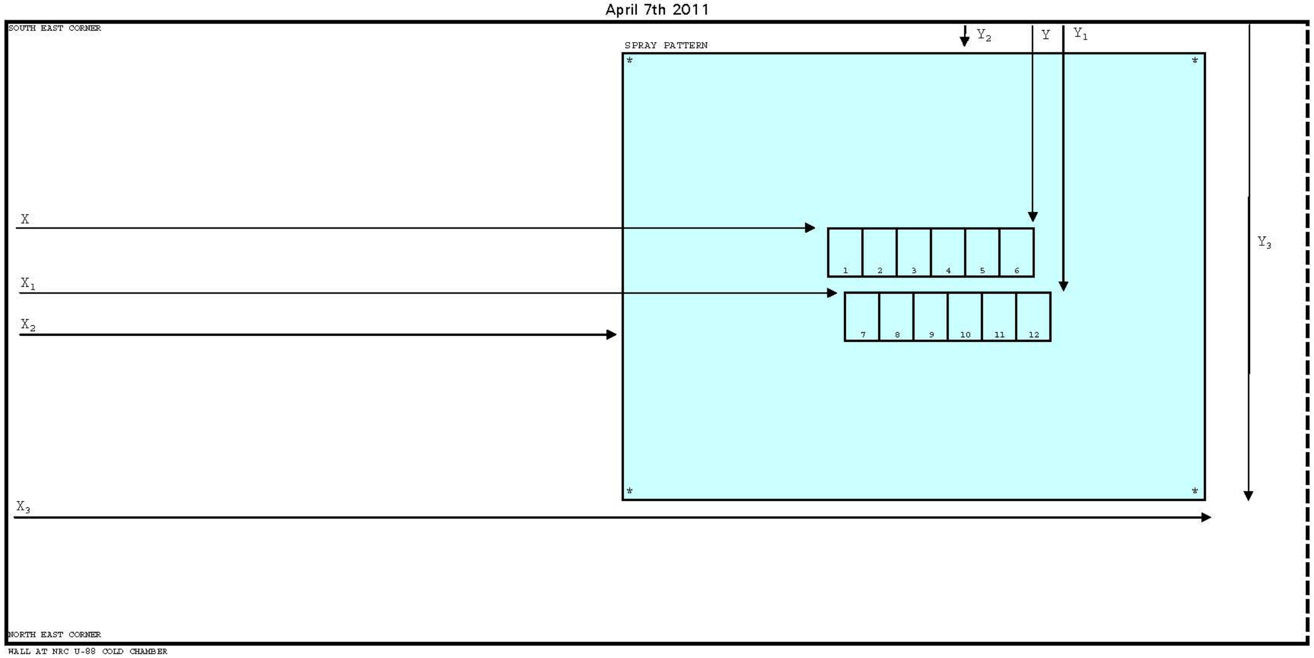
April 7th 2011



FINAL STAND POSITION		AREA OF SPRAY ZONE		
				CYCLE TIME = 26 SECONDS
X	24'2"	X2	19'	
Y	6'6"	Y2	4"6"	IMPACT TIME ON PLATE = 3 SECONDS (EST)
X1	24'8"	X3	35'	
Y1	8'11"	Y3	11'6"	DETAILED VIDEO OF PLATE = NO

FREEZING RAIN -3, 13 g/dm^2/h

April 7th 2011



FINAL STAND POSITION		AREA OF SPRAY ZONE	
X	24'2"	X2	18'
Y	6'6"	Y2	1'
X1	24'8"	X3	35'
Y1	8'11"	Y3	15'

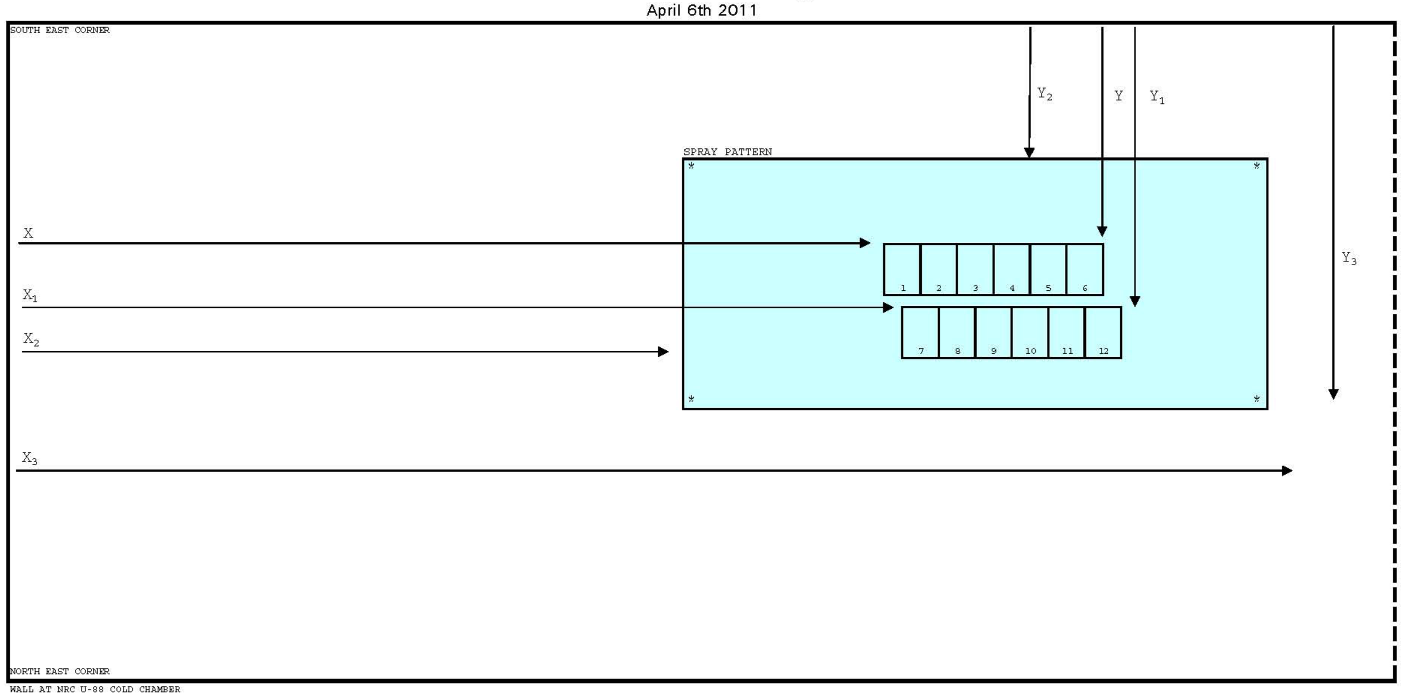
CYCLE TIME = 54 SECONDS

IMPACT TIME ON PLATE = 4 SECONDS (EST)

DETAILED VIDEO OF PLATE = NO

FREEZING RAIN -10, 25 g/dm^2/h

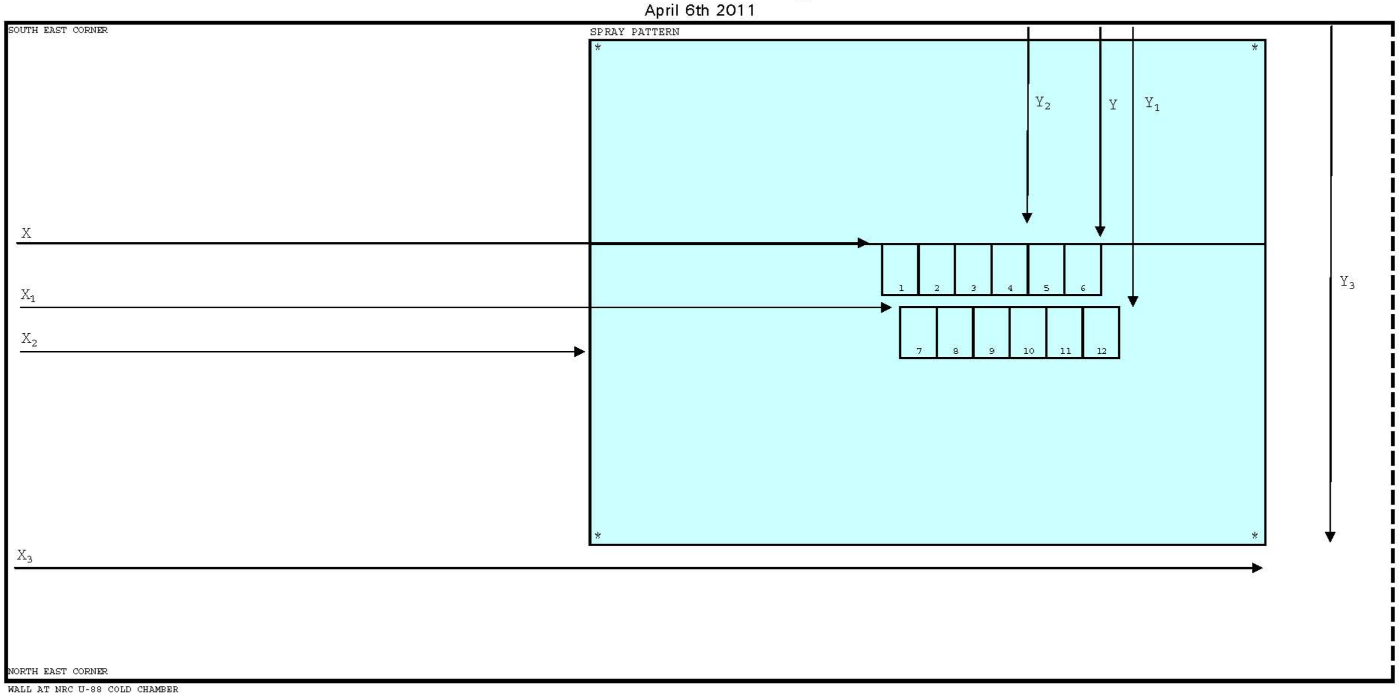
April 6th 2011



FINAL STAND POSITION		AREA OF SPRAY ZONE		
				CYCLE TIME = 27 SECONDS
X	24'2"	X2	19'	
Y	6'6"	Y2	4"6"	IMPACT TIME ON PLATE = 4 SECONDS (EST)
X1	24'8"	X3	34'6"	
Y1	8'7"	Y3	12'	DETAILED VIDEO OF PLATE = NO

FREEZING RAIN -10, 13 g/dm^2/h

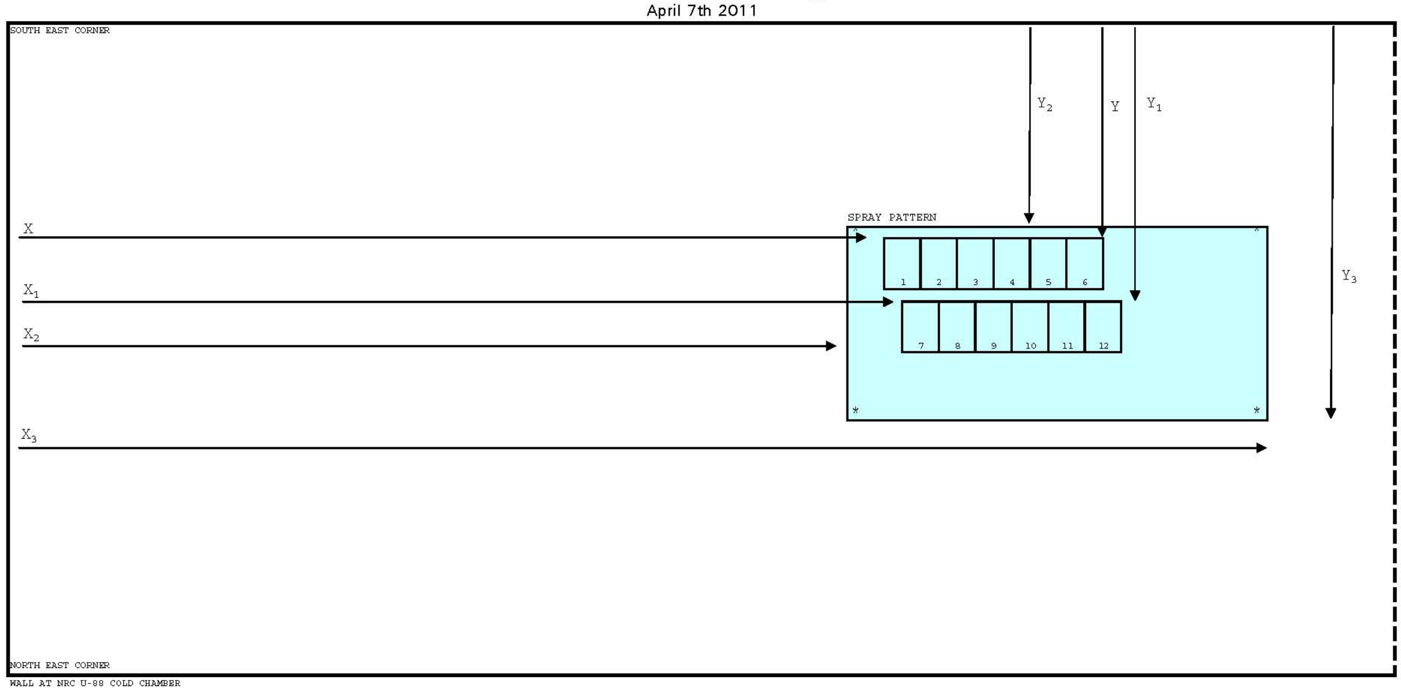
April 6th 2011



FINAL STAND POSITION		AREA OF SPRAY ZONE		
				CYCLE TIME = 54 SECONDS
X	24'2"	X2	16'	
Y	6'6"	Y2	0.6'	IMPACT TIME ON PLATE = 4 SECONDS (EST)
X1	24'8"	X3	35'	
Y1	8'7"	Y3	15'6"	DETAILED VIDEO OF PLATE = NO

FREEZING DRIZZLE -3, 13 g/dm^2/h

April 7th 2011



FINAL STAND POSITION		AREA OF SPRAY ZONE	
X	24'2"	X2	23'
Y	6'10"	Y2	6'6"
X1	24'8"	X3	34'
Y1	8'7"	Y3	11'

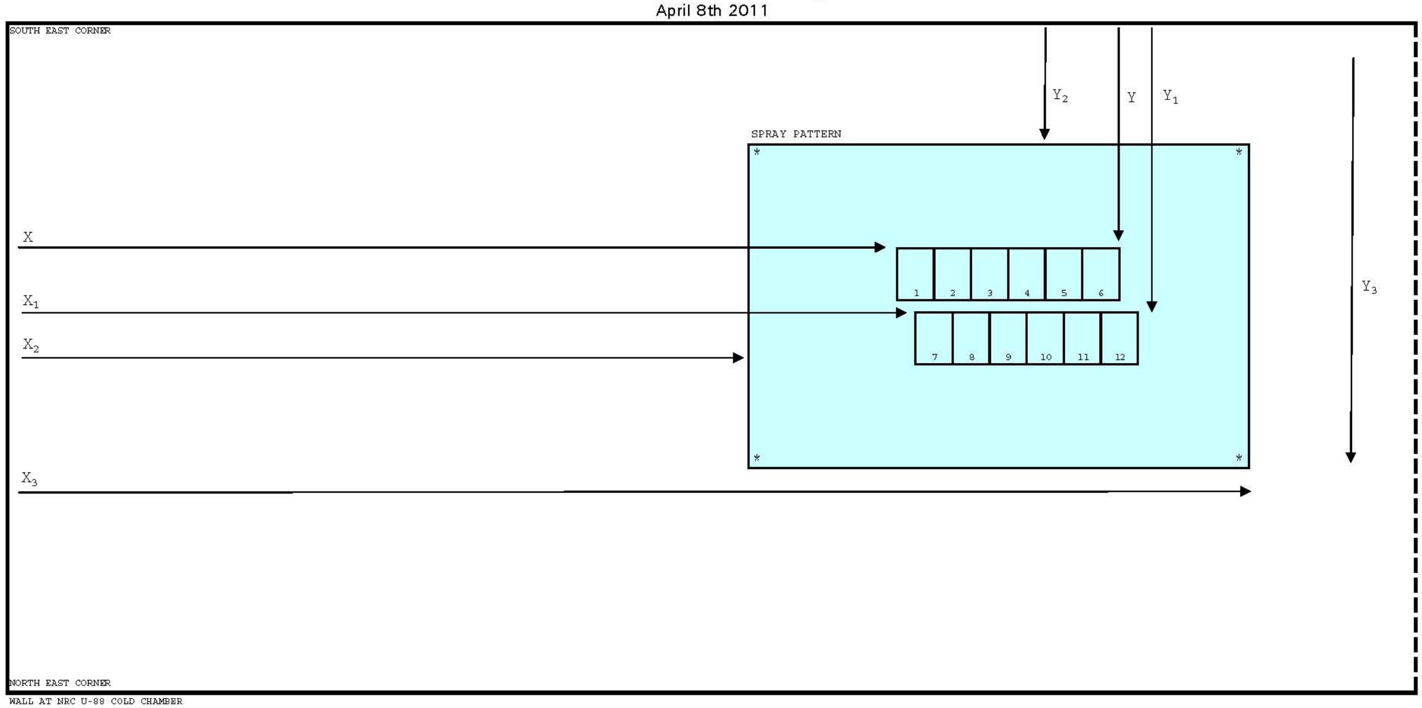
CYCLE TIME = 28 SECONDS

IMPACT TIME ON PLATE = 4 SECONDS (EST)

DETAILED VIDEO OF PLATE = NO

FREEZING DRIZZLE -3, 5 g/dm²/h

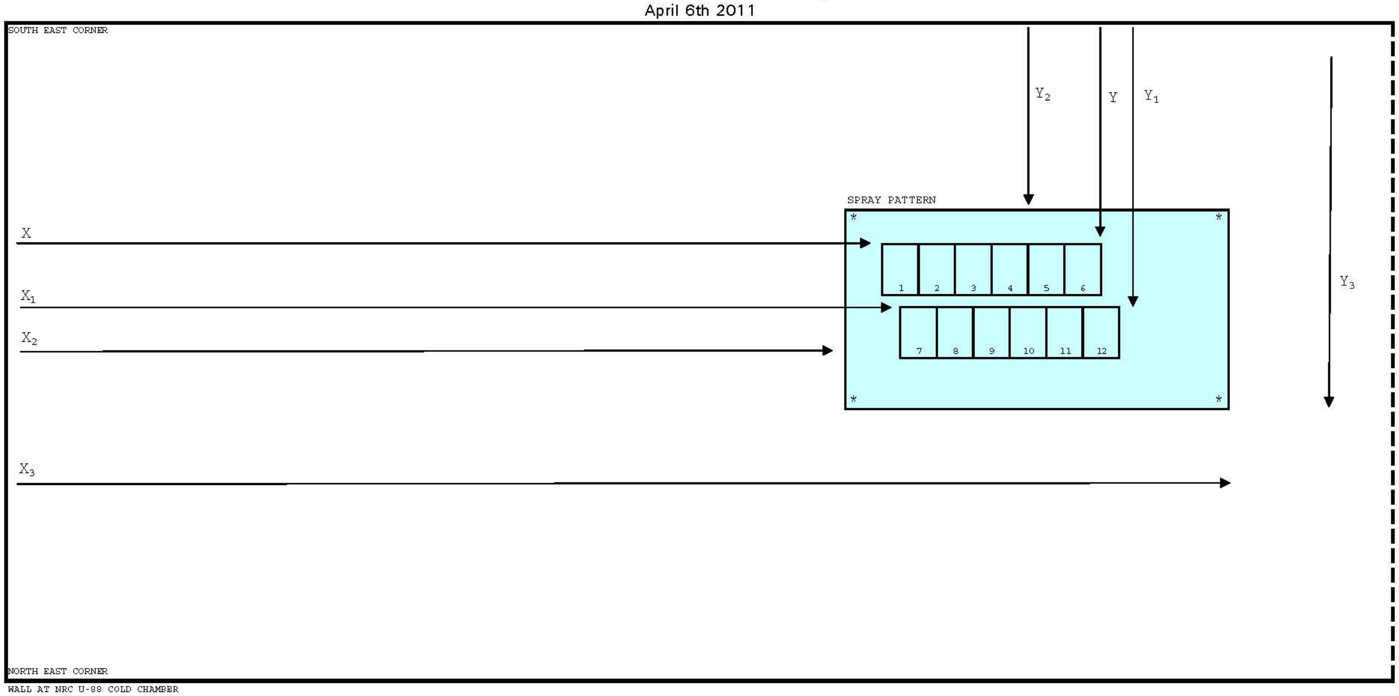
April 8th 2011



FINAL STAND POSITION		AREA OF SPRAY ZONE		
X	24'2"	X2	20'	CYCLE TIME = 55 SECONDS
Y	6'10"	Y2	3'6"	IMPACT TIME ON PLATE = 7 SECONDS (EST)
X1	24'8"	X3	33'6"	
Y1	8'11"	Y3	13'	DETAILED VIDEO OF PLATE = YES

FREEZING DRIZZLE -10, 13 g/dm²/h

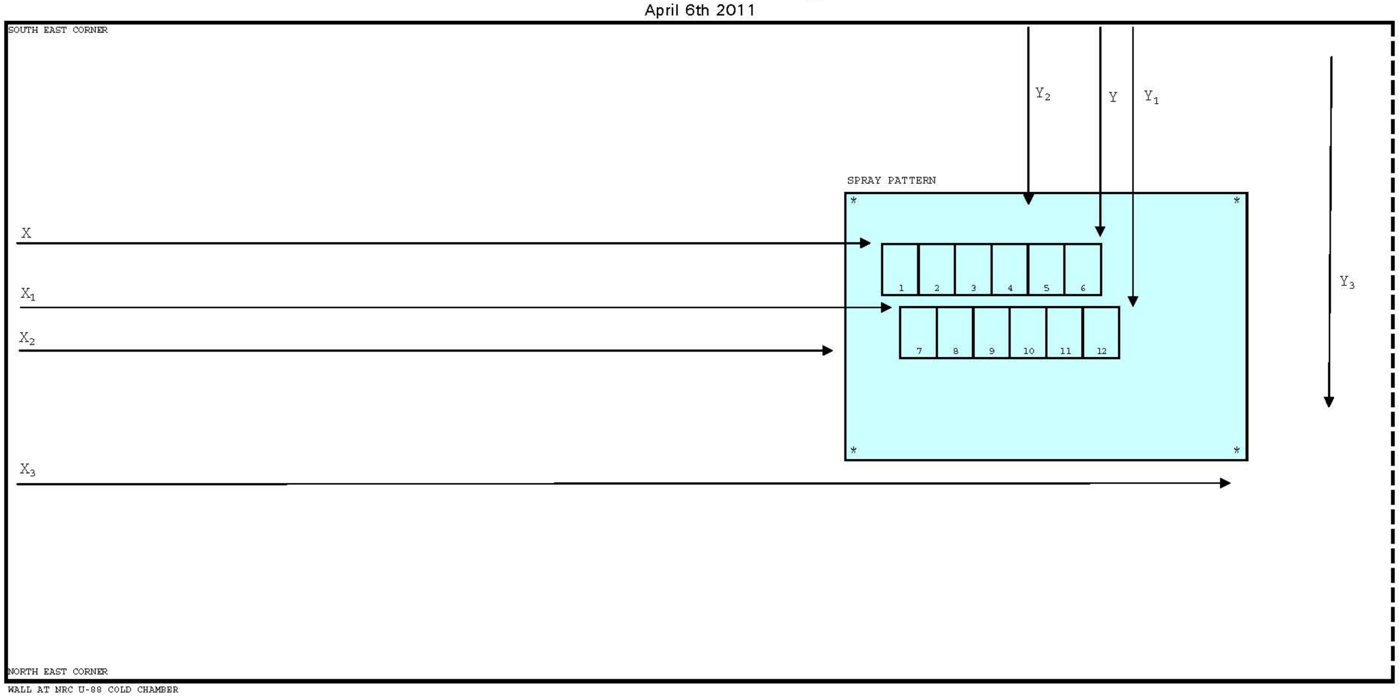
April 6th 2011



FINAL STAND POSITION		AREA OF SPRAY ZONE		
				CYCLE TIME = 26 SECONDS
X	24'2"	X2	23'	
Y	6'10"	Y2	5'6"	IMPACT TIME ON PLATE = 5 SECONDS (EST)
X1	24'8"	X3	33'6"	
Y1	8'11"	Y3	11'6"	DETAILED VIDEO OF PLATE = NO

FREEZING DRIZZLE -10, 5 g/dm²/h

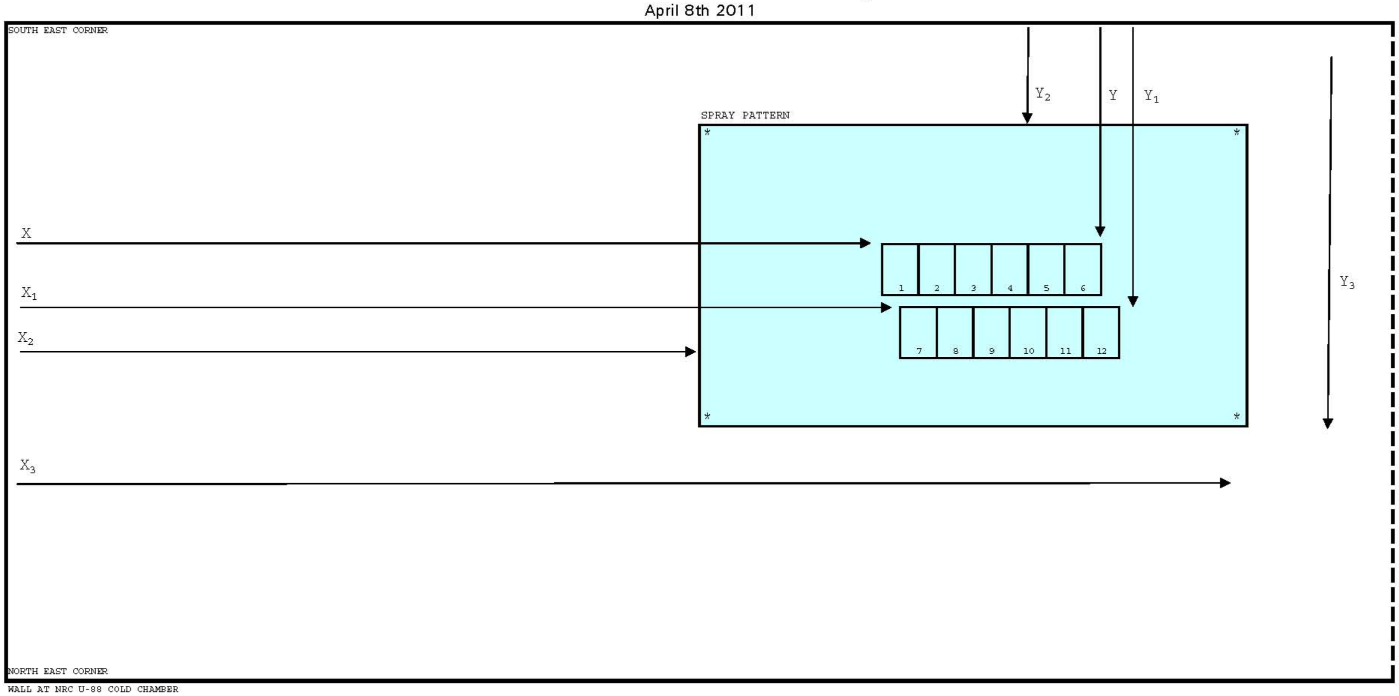
April 6th 2011



FINAL STAND POSITION		AREA OF SPRAY ZONE		
X	24'2"	X2	23'	CYCLE TIME = 54 SECONDS
Y	6'10"	Y2	4'10"	IMPACT TIME ON PLATE = 10 SECONDS (EST)
X1	24'8"	X3	34'	
Y1	8'11"	Y3	13'	DETAILED VIDEO OF PLATE = NO

RAIN ON COLD-SOAK WING 1, 75 g/dm^2/h

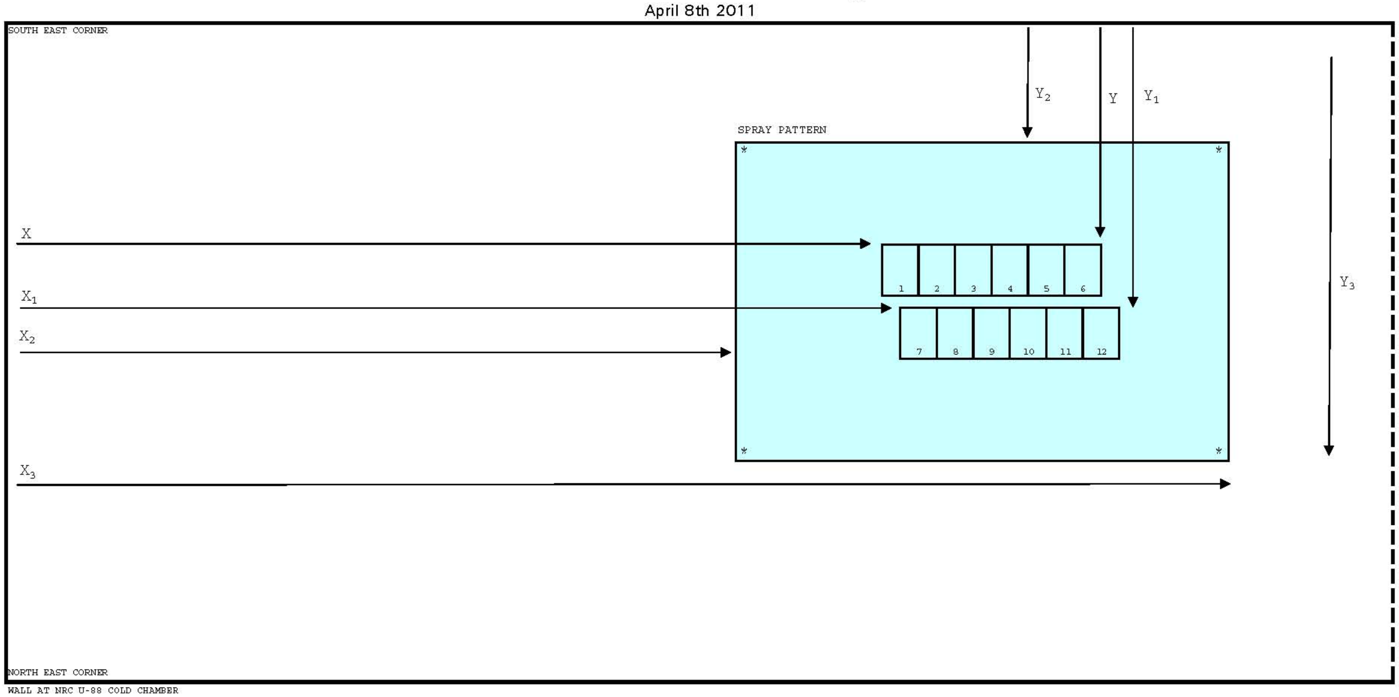
April 8th 2011



FINAL STAND POSITION		AREA OF SPRAY ZONE		
X	24'2"	X2	19'	CYCLE TIME = 27 SECONDS
Y	6'10"	Y2	4'	IMPACT TIME ON PLATE = NOT TAKEN
X1	24'8"	X3	34'	
Y1	8'11"	Y3	12'	DETAILED VIDEO OF PLATE = YES

RAIN ON COLD-SOAK WING 1, 5 g/dm²/h

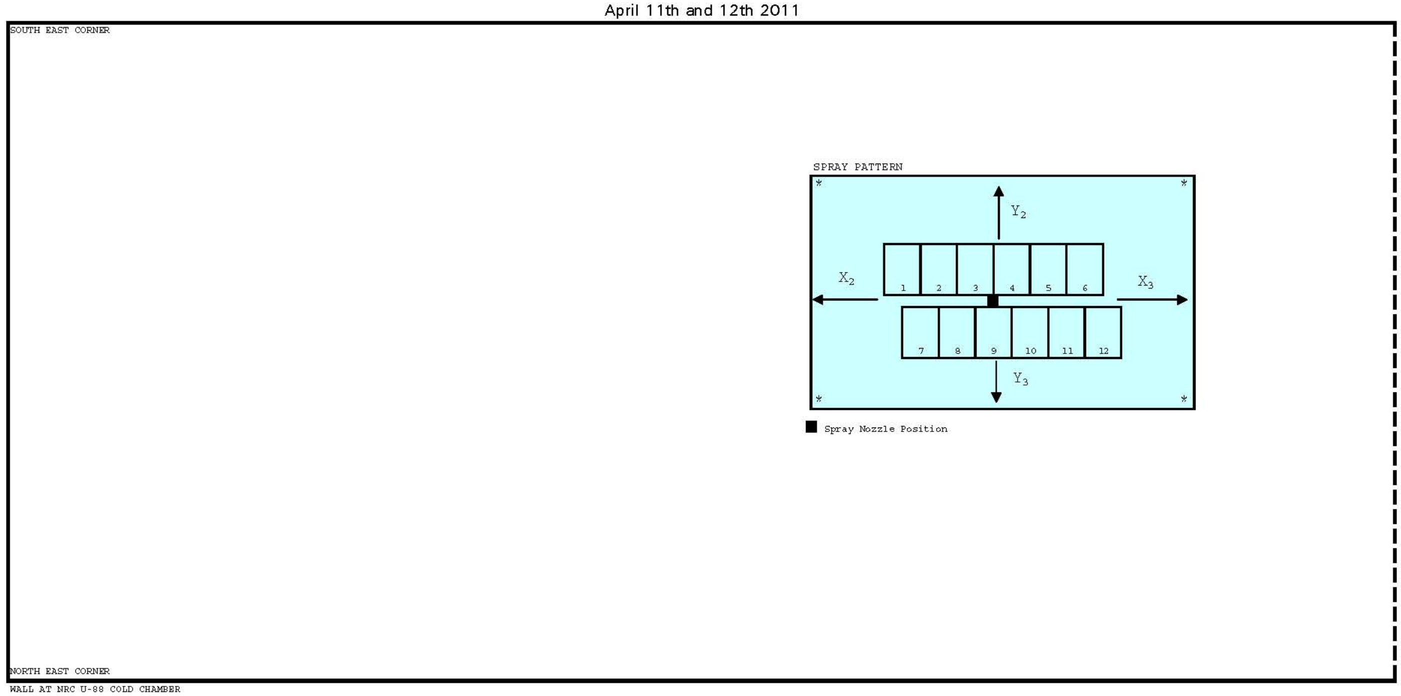
April 8th 2011



FINAL STAND POSITION		AREA OF SPRAY ZONE		
				CYCLE TIME = 55 SECONDS
X	24'2"	X2	20'	
Y	6'10"	Y2	3'6"	IMPACT TIME ON PLATE = 7 SECONDS (EST)
X1	24'8"	X3	33'6"	
Y1	8'11"	Y3	13'	DETAILED VIDEO OF PLATE = NO

FREEZING FOG (ALL CONDITIONS)

April 11th and 12th 2011



FINAL STAND POSITION		AREA OF SPRAY ZONE		
				CYCLE TIME = 94 SECONDS
X	24'2"	X2	2'	
Y	6'10"	Y2	2'	IMPACT TIME ON PLATE = 20 SECONDS (AVG)
X1	24'8"	X3	2'	
Y1	8'11"	Y3	2'	DETAILED VIDEO OF PLATE = YES FOR ZF14L

* Due to condensation from ZR/ZD sprayer trap, consider reposting stand (especially when changing from -25° C to 14° C

This page intentionally left blank.

APPENDIX F

TRANSPORT CANADA AND FEDERAL AVIATION ADMINISTRATION 2011-12 HOLDOVER TIME GUIDELINES

TRANSPORT CANADA
HOLDOVER TIME (HOT) GUIDELINES
WINTER 2011-2012

Transport Canada
Holdover Time (HOT) Guidelines
Winter 2011-2012

Original Issue, July 2011

This document should be used in conjunction with *Guidelines for Aircraft Ground-Icing Operations* (TP 14052E, second edition, April 2005).

The two documents complement each other and should be used together for a thorough understanding of the subject matter.

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 on Holdover Time Guidelines:
http://www.tc.gc.ca/eng/civilaviation/standards/commerce-holdovertime-menu-1877.htm

REVISION	DATE	DESCRIPTION OF CHANGES	AFFECTED PAGES	AUTHOR

SUMMARY OF CHANGES FROM PREVIOUS YEAR

The principal changes from the previous year are briefly indicated herein.

Frost Table

- The Frost table has been reformatted to clarify that dilutions apply only to Type II, III and IV fluids.

Type I Fluid

- The Type I holdover time (HOT) table has been divided into two tables. Table 1-A contains the holdover times for aluminum wing surfaces and Table 1-C contains the holdover times for composite wing surfaces. Guidance appears at the top of the tables to help users select the appropriate table. The holdover time values have not changed.

Type II Fluid

- Minor increases/decreases ranging from 1 to 4 minutes have been made to all eight Type II fluid-specific HOT tables and to the generic Type II HOT table as a result of changes made to HOT rounding protocols.
- The lower limit of the lowest temperature band in the Type II fluid-specific HOT tables has been changed from "-25°C or LOUT" to the actual numeric lowest operational use temperature (LOUT) value for the fluid.

Type III Fluid

- The Type III HOT table is unchanged.

Type IV Fluid

- A fluid-specific HOT table has been created for the new Type IV fluid Cryotech Polar Guard Advance. The addition of this fluid did not impact the generic holdover times.
- Octagon MaxFlo and Clariant Safewing MP IV 2012 Protect have been removed from the Type IV guidelines as per protocol for removing obsolete data. Removal of these fluids caused significant changes (all increases) to the generic Type IV fluid holdover times. Twelve cells were affected.
- Minor increases/decreases ranging from 1 to 4 minutes have been made to six Type IV fluid-specific HOT tables and to the generic Type IV HOT table as a result of changes made to HOT rounding protocols. The affected tables are: Table 4-Generic, Table 4-A-AD-480, Table 4-C-2001, Table 4-D-AD-480, Table 4-K-ABC-4S, Table 4-K-ABC-S and Table 4-L-ARCTIC Shield.
- The upper value in the Octagon Max-Flight 04 75/25 below -3 to -14°C snow cell has been increased from 1:20 to 1:25 due to a rounding error.
- The lower limit of the lowest temperature band in the Type IV fluid-specific HOT tables has been changed from "-25°C or LOUT" to the actual numerical LOUT value for the fluid.
- Notes have been added to the Type IV generic table to identify specific fluids that have more restrictive LOUTs.
- Notes have been added to the Cryotech Polar Guard and Lyondell Arctic Shield fluid-specific tables to identify their LOUT constraints.

Lowest Operational Use Temperature (LOUT) Table

- Additional LOUT data has been incorporated into the LOUT table including: additional LOUT data from fluid manufacturers, LOUTs for Type II/III/IV fluid dilutions, and fluid dilution information for Type I LOUTs.
- °F data has been be removed from the LOUT table (°C data remains).

Ice Pellet Allowance Time Table

- The ice pellet allowance time values are unchanged.

CHANGES TO *Guidelines for Aircraft Ground-Icing Operations* (TP 14052E, second ed., April 2005)

The following changes will be incorporated into TP 14052E at its next revision. They are recorded here in advance due to the longer life cycle time associated with the updating and publication of TP 14052E and are for immediate use.

Replace Sub-Paragraph 8.1.2 (2nd paragraph), "Fluid Description", with the following:

Anti-icing fluids are similar in composition except that they also contain polymeric thickeners. They are formulated to prevent formation of unabsorbed frozen contamination for a longer period of time than deicing fluids; however, the protection is still for a limited period of time. Although Type I fluids may be used for anti-icing, Type II, III and IV fluids are typically used in the anti-icing role because they can last for a significantly longer period of time than the Type I fluids.

Replace entire contents of Sub-Paragraph 8.1.4, "Certification Applicable to Qualified Fluids", with the following:

8.1.4 Acceptable Fluids

Transport Canada does not approve or qualify de/anti-icing fluids.

The aircraft manufacturer will generally indicate in the Aircraft Maintenance Manual the applicable industry specification for aircraft consumable materials. The industry fluid specifications for de/anti-icing fluids was discussed in Section 8.1.3.

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

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

Further, fluids undergo HOT evaluation to assess their HOT characteristics and establish the values for the HOT guidelines for that particular fluid.

Replace Sub-Paragraph 10.4 (6th paragraph), "Procedure Selection", with the following:

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

Replace Sub-Paragraph 10.4.2 (2nd paragraph), "Two Step De/Anti-Icing", with the following:

If a two-step procedure is used, the first step is typically performed using a deicing fluid; however, alternate deicing technology or mechanical methods may be used depending on the circumstances. The selection of fluid type and concentration depends on the ambient temperature, the weather conditions and the desired holdover time. When performing a two-step process, the freezing point of a fluid used for the first step must not be more than 3°C above ambient temperature. The freezing point of an SAE Type I fluid used for a one-step process, or as the second step of a two-step operation, must be at least 10°C below the ambient temperature. The second step must be completed as quickly as possible following first step fluid application (not more than 3 minutes). The two-step process may need to be performed area-by-area. When deicing fluid is used in step 1, the application of the second step fluid will flush away the first step fluid and leave a film of anti-icing fluid, which is designed to be of adequate thickness. If freezing of the deicing fluid has occurred, step 1 must be repeated. Refer to the SAE ARP 4737 document for additional details.

Add Sub-Paragraph 10.8.1, "De/Anti-icing Fluid Compatibility with Runway Deicer", as follows:

Recent research showed that when thickened aircraft anti-icing fluid came in contact with minimal amounts of runway deicing fluids (formate or acetate based), anti-icing protection provided by the aircraft anti-icing fluid could be diminished. The separation of the thickening agents in this fluid consequently reduce holdover time.

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

Replace Sub-Paragraph 10.11, "Applying Anti-Icing Fluid in a Hangar", with the following:

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

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

Replace Sub-Paragraph 10.12.1 (5th paragraph), "Brooms", with the following:

Using the wing broom to remove contamination does not always mean that the wing surface is clean and safe for flight. Every time a broom is used to remove contamination, a tactile inspection must be performed.

Replace Sub-Paragraph 10.13.3, "Hot Water", with the following:

Hot water may be used to remove large amounts of contamination (such as ice) from an aircraft, provided that the Outside Air Temperature is -3°C and above as per the application procedures for SAE Type I, II, III and IV fluids described in tables 6 and 7 of the Transport Canada HOT Guidelines document.

Delete Sub-Paragraph 10.13.3.1 Item g) only.

Replace entire contents of 10.13.5 to 10.13.5.4 with the following:

10.13.5 Ground Ice Detection Systems (GIDS)

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

For the purposes of this document, these sensors are referred to as Remote on Ground Ice Detection Systems (ROGIDS). A Minimum Operational Performance Specification (MOPS) for these systems is identified in the SAE document AS 5681.

Air operators or service providers seeking authorization to incorporate ROGIDS into their operations should consult Transport Canada Advisory Circular AC 602-001, "Operational Use of Remote on Ground Ice Detection Systems (ROGIDS) for Post De-icing Applications". This document is available at the following website:

http://www.tc.gc.ca/media/documents/ca-opssvs/602-001.pdf

Replace Sub-Paragraph 11.1.2, "Current Holdover Time Guidelines", with the following:

Current HOT Guidelines can be found at the following website: http://www.tc.gc.ca/eng/civilaviation/standards/commerce-holdovertime-menu-1877.htm.

The following information can be found at the above website:

a) Active Frost HOT Guidelines;
b) Type I Fluid Generic HOT Guidelines;
c) Type II Fluid HOT Guidelines;
d) Type III Fluid HOT Guidelines;
e) Type IV Fluid HOT Guidelines;
f) List of Fluids Tested for Anti-Icing Performance and Aerodynamic Acceptance;
g) SAE Type I De/Anti-Icing Fluid Application Procedures;
h) SAE Types II, Type III and Type IV De/Anti-Icing Fluid Application Procedures;
i) Visibility in Snow vs. Snowfall Intensity Chart;
j) Lowest On-Wing Viscosity Values for De/Anti-Icing Fluids;
k) Lowest Operational Use Temperatures of De/Anti-Icing Fluids; and
l) Ice Pellet Allowance Times.

Add the following sentence immediately before the example of Sub-Paragraph 11.1.4.1.a "Estimating the Precipitation Rate":

This estimate applies to all Type I, II, III, and IV fluids.

Replace Sub-Paragraph 11.1.5, "Elapsed time is less than the lowest time in the HOT cell", with the following:

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

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

a) The conditions present are NOT in excess of those conditions represented by the table (e.g. for snow, it would be a moderate snow condition); and

b) The impact of other factors (e.g. jet blast) has been considered and deemed not to affect the HOT.

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

Replace Sub-Paragraph 11.1.8, "Meteorological Conditions for which the HOT Guidelines are not applicable", with the following:

The HOT Guidelines do not include guidelines for all meteorological conditions.

Holdover time guidelines have not been assessed for the following conditions: a) Hail; b) Moderate and Heavy Freezing Rain; and c) Heavy Snow.

Note: Operators need to assess whether operations can be safely conducted under these conditions.

Additionally, holdover time guidelines have not been assessed for ice pellets, since a formal protocol for ice pellet testing has not yet been developed and included in standard SAE testing methodologies and no visual failure criteria have yet been identified for ice pellet conditions. Instead, an allowance time based upon research has been developed for operations during ice pellet conditions.

Replace entire contents of Sub-Paragraph 11.1.9, "Use of approved fluids", with the following:

11.1.9 Use of De/Anti-icing Fluids

The operator is ultimately responsible for ensuring that only fluids tested to SAE AMS 1424 or SAE AMS 1428 are applied when the HOT Guidelines will be utilized operationally.

The Transport Canada Holdover Time Guidelines document published on an annual basis, contains lists of fluids that have been tested with respect to anti-icing performance (SAE AMS 1424 or SAE AMS 1428) and aerodynamic acceptance (SAE AMS 1424 or SAE AMS 1428) only.

Therefore, the end user is cautioned that they must confirm that other SAE AMS 1424 or SAE AMS 1428 technical requirement tests such as fluid stability, toxicity, materials compatibility, etc. have been conducted. The fluid manufacturer will supply all samples for testing and, is responsible for obtaining independent laboratory confirmation of conformance to these requirements of AMS 1424 or AMS 1428. The fluid manufacturer should provide certificates of conformance upon request.

Add Sub-Paragraph 11.1.12, "Type I HOT Guidelines for Aircraft with Critical Surfaces Constructed Using Composite Materials", as follows:

The recent introduction of new aircraft constructed primarily with composite materials required a review of Type I fluid holdover time performance when used on these aircraft. This review has shown that the holdover time performance of Type I fluids on composite surfaces is reduced when compared to aluminum surfaces. Type I fluid holdover time evaluations were conducted and holdover times have been developed for use with aircraft critical surfaces constructed primarily with composite materials.

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

Replace Sub-Paragraph 12.1.2, "Ice Pellet Conditions", with the following:

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

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

Replace entire contents of Sub-Paragraph 12.1.7 "Frost", with the following:

12.1.7 Frost

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

12.1.7.1 Active Frost

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

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

1. radiation cooling; or
2. conductive cooling (due to cold soaked fuel).

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

12.1.7.2 Dew Point and Frost Point

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

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

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

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

12.1.7.3 Radiation Cooling

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

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

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

12.1.7.4 Cold Soaked Fuel Cooling

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

In extreme cases, cold soaking may reduce the surface temperature below the fluid LOUT and cause a risk of fluid freezing.

12.1.7.5 Combined Radiation and Cold Soaked Fuel Cooling Effects

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

12.1.7.6 De/Anti-Icing in Active Frost Conditions

Frost reforming after removal is an indication of active frost. During active frost, anti-icing protection is required and operations should be conducted in accordance with holdover time guidelines and minimum fluid quantity and temperature application procedures therein. In active frost conditions, deicing alone is insufficient, therefore, once the frost has been removed, a preventative anti-icing coating is required.

12.1.7.7 Fluid Holdover Times for Active Frost Conditions

Fluid holdover times in active frost conditions differ from holdover times in other conditions as they incorporate an allowance for the temperature differential (typically 6 to 8°C) between the OAT and the exposed surface temperature due to radiation cooling. As a result of this allowance, the OAT should be used to determine the appropriate active frost holdover time.

Active frost holdover times may be reduced in the presence of combined cooling effects or extreme surface cooling. In extreme cases, the surface temperature may be below the fluid LOUT and cause a risk of fluid freezing.

12.1.7.8 Frost on the Underside of the Wing

CAR 602.11(3) states: Notwithstanding subsection (12.1.7.9), a person may conduct a take-off in an aircraft that has frost adhering to the underside of its wings that is caused by cold-soaked fuel, if the take-off is conducted in accordance with the aircraft manufacturer's instructions for take-off under those conditions.

12.1.7.9 Frost on the Fuselage

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

Replace Sub-Paragraph 12.3 (5th paragraph), "Configuration During Deicing Procedures", with the following:

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

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

Replace Sub-Paragraph 12.6.7 "Recommended "Clean Aircraft Concept" practices", with the following:

e) The general rule for ground icing procedures is that the deicing and anti-icing processes must be done symmetrically. That is, whatever final treatment (i.e. same brand name fluid) is administered on one wing must be applied to the other wing for aerodynamic symmetry reasons.

HOLDOVER TIME (HOT) GUIDELINES FOR WINTER 2011-2012

TABLE 0

ACTIVE FROST HOLDOVER GUIDELINES FOR WINTER 2011-2012

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

Outside Air Temperature		Approximate Holdover Times (hours:minutes)
		Active Frost
Degrees Celsius	Degrees Fahrenheit	Type I[1,2]
-1 and above	30 and above	0:45 (0:35)[5]
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 -25	below -6 to -13	

Outside Air Temperature		Concentration Neat Fluid/Water (Volume %/Volume %)	Approximate Holdover Times (hours:minutes)		
			Active Frost		
Degrees Celsius	Degrees Fahrenheit		Type II[3,4]	Type III[3,4]	Type IV[3,4]
-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

NOTES

1 Type I Fluid / Water Mixture is selected so that the freezing point of the mixture is at least 10°C (18°F) below outside air temperature.
2 May be used below -25°C (-13°F) provided the lowest operational use temperature (LOUT) of the fluid is respected.
3 These fluids may not be used below -25°C (-13°F) in active frost conditions.
4 Ensure that the lowest operational use temperature (LOUT) is respected.
5 Value in parentheses is for composite surfaces.

CAUTIONS

- **Fluids used during ground de/anti-icing do not provide in-flight icing protection.**

Transport Canada Holdover Time Guidelines Winter 2011-2012

TABLE 1-A

SAE TYPE I FLUID HOLDOVER GUIDELINES ON ALUMINUM WING SURFACES FOR WINTER 2011-2012[1]

This table applies 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

Outside Air Temperature[2]		Approximate Holdover Times Under Various Weather Conditions (minutes)							
Degrees Celsius	Degrees Fahrenheit	Freezing Fog	Snow, Snow Grains or Snow Pellets			Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
			Very Light[3]	Light[3]	Moderate				
-3 and above	27 and above	11 – 17	18	11 – 18	6 – 11	9 – 13	4 – 6	2 – 5	CAUTION: No holdover time guidelines exist
below -3 to -6	below 27 to 21	8 – 13	14	8 – 14	5 – 8	5 – 9	4 – 6		
below -6 to -10	below 21 to 14	6 – 10	11	6 – 11	4 – 6	4 – 7	2 – 5		
below -10	below 14	5 – 9	7	4 – 7	2 – 4				

NOTES

1 Type I Fluid / Water Mixture is 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 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 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, and hail.

CAUTIONS

- **The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable holdover time 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.**
- **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.**

Transport Canada Holdover Time Guidelines — Winter 2011-2012

TABLE 1-C

SAE TYPE I FLUID HOLDOVER GUIDELINES ON COMPOSITE WING SURFACES FOR WINTER 2011-2012[1]

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

Outside Air Temperature[2]		Approximate Holdover Times Under Various Weather Conditions (minutes)								
Degrees Celsius	Degrees Fahrenheit	Freezing Fog	Snow, Snow Grains or Snow Pellets			Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
			Very Light[3]	Light[3]	Moderate				
-3 and above	27 and above	9 – 16	12	6 – 12	3 – 6	8 – 13	4 – 6	1 – 5	CAUTION: No holdover time guidelines exist
below -3 to -6	below 27 to 21	6 – 8	11	5 – 11	2 – 5	5 – 9	4 – 6	CAUTION: No holdover time guidelines exist	
below -6 to -10	below 21 to 14	4 – 8	9	5 – 9	2 – 5	4 – 7	2 – 5		
below -10	below 14	4 – 7	7	4 – 7	2 – 4				

NOTES
1 Type I Fluid / Water Mixture is 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 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
4 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, and hail.

CAUTIONS
- **The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable holdover time 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.**
- **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.**

Page 14 of 57 — July 2011

Transport Canada Holdover Time Guidelines — Winter 2011-2012

TABLE 2-Generic

SAE TYPE II FLUID HOLDOVER GUIDELINES FOR WINTER 2011-2012[1]

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

Outside Air Temperature[2]		Type II Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)					
Degrees Celsius	**Degrees Fahrenheit**		**Freezing Fog**	**Snow, Snow Grains or Snow Pellets[3]**	**Freezing Drizzle[4]**	**Light Freezing Rain**	**Rain on Cold Soaked Wing[5]**	**Other[6]**
-3 and above	27 and above	100/0	0:35 – 1:30	0:20 – 0:45	0:30 – 0:55	0:15 – 0:30	0:08 – 0:40	
		75/25	0:25 – 1:00	0:15 – 0:30	0:20 – 0:45	0:10 – 0:25	0:05 – 0:25	
		50/50	0:15 – 0:30	0:05 – 0:15	0:08 – 0:15	0:05 – 0:09	CAUTION: No holdover time guidelines exist	
below -3 to -14	below 27 to 7	100/0	0:20 – 1:05	0:15 – 0:30	0:20 – 0:45[7]	0:10 – 0:20[7]		
		75/25	0:25 – 0:50	0:10 – 0:20	0:15 – 0:30[7]	0:08 – 0:15[7]		
below -14 to -25 or LOUT	below 7 to -13 or LOUT	100/0	0:15 – 0:35	0:15 – 0:30				

NOTES
1 Based on the lowest holdover times of the fluids listed in Table 5-2 and Table 5-4.
2 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I when Type II fluid cannot be used.
3 Use light freezing rain holdover times in conditions of light snow mixed with light rain.
4 Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, and hail.
7 These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.

CAUTIONS
- **The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable holdover time 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.**
- **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.**

Transport Canada Holdover Time Guidelines — Winter 2011-2012

TABLE 2-A-E26

ABAX TYPE II FLUID HOLDOVER GUIDELINES FOR WINTER 2011-2012[1]
ECOWING 26

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

Outside Air Temperature[2]		Type II Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)					
Degrees Celsius	**Degrees Fahrenheit**		**Freezing Fog**	**Snow, Snow Grains or Snow Pellets[3]**	**Freezing Drizzle[4]**	**Light Freezing Rain**	**Rain on Cold Soaked Wing[5]**	**Other[6]**
-3 and above	27 and above	100/0	1:25 – 2:35	0:40 – 1:00	0:50 – 1:35	0:40 – 0:50	0:20 – 1:25	CAUTION: No holdover time guidelines exist
		75/25	1:05 – 1:55	0:25 – 0:45	0:45 – 1:05	0:25 – 0:35	0:10 – 1:00	
		50/50	0:30 – 0:45	0:10 – 0:20	0:15 – 0:25	0:08 – 0:10		
below -3 to -14	below 27 to 7	100/0	0:45 – 2:15	0:35 – 0:55	0:30 – 1:10[7]	0:15 – 0:35[7]		
		75/25	0:35 – 1:15	0:25 – 0:40	0:20 – 0:50[7]	0:15 – 0:25[7]		
below -14 to -25	below 7 to -13	100/0	0:25 – 0:45	0:15 – 0:30				

NOTES

1 These holdover times are derived from tests of this fluid having a viscosity as listed in Table 9.
2 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I when Type II fluid cannot be used.
3 Use light freezing rain holdover times in conditions of light snow mixed with light rain.
4 Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, and hail.
7 These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.

CAUTIONS

- **The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable holdover time 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.**
- **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.**

Transport Canada Holdover Time Guidelines — Winter 2011-2012

TABLE 2-AS-CLEANWING II

AVIATION SHAANXI HI-TECH TYPE II FLUID HOLDOVER GUIDELINES FOR WINTER 2011-2012[1]
CLEANWING II

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

Outside Air Temperature[2]		Type II Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog	Snow, Snow Grains or Snow Pellets[3]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 and above	27 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 -14	below 27 to 7	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 -29	below 7 to -20.2	100/0	0:20 – 0:50	0:15 – 0:30				

NOTES

1. These holdover times are derived from tests of this fluid having a viscosity as listed in Table 9.
2. Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I when Type II fluid cannot be used.
3. Use light freezing rain holdover times in conditions of light snow mixed with light rain.
4. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5. No holdover guidelines exist for this condition for 0°C (32°F) and below.
6. Heavy snow, ice pellets, moderate and heavy freezing rain, and hail.
7. These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.

CAUTIONS

- **The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable holdover time 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.**
- **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 2-C-2025

CLARIANT TYPE II FLUID HOLDOVER GUIDELINES FOR WINTER 2011-2012[1]
SAFEWING MP II 2025 ECO

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

Outside Air Temperature[2]		Type II Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog	Snow, Snow Grains or Snow Pellets[3]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 and above	27 and above	100/0	1:30 – 2:05	0:40 – 1:10	0:40 – 1:00	0:25 – 0:35	0:10 – 1:15	CAUTION: No holdover time guidelines exist
		75/25	0:55 – 1:45	0:25 – 0:45	0:25 – 0:45	0:20 – 0:25	0:08 – 0:50	
		50/50	0:20 – 0:35	0:09 – 0:15	0:10 – 0:15	0:07 – 0:10		
below -3 to -14	below 27 to 7	100/0	0:45 – 1:50	0:35 – 1:00	0:35 – 1:05[7]	0:20 – 0:35[7]		
		75/25	0:40 – 1:20	0:25 – 0:45	0:30 – 0:40[7]	0:15 – 0:25[7]		
below -14 to -27.5	below 7 to -17.5	100/0	0:25 – 0:45	0:15 – 0:30				

NOTES
1. These holdover times are derived from tests of this fluid having a viscosity as listed in Table 9.
2. Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I when Type II fluid cannot be used.
3. Use light freezing rain holdover times in conditions of light snow mixed with light rain.
4. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5. No holdover guidelines exist for this condition for 0°C (32°F) and below.
6. Heavy snow, ice pellets, moderate and heavy freezing rain, and hail.
7. These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.

CAUTIONS
- **The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable holdover time 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.**
- **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 2-C-FLIGHT

CLARIANT TYPE II FLUID HOLDOVER GUIDELINES FOR WINTER 2011-2012[1]
SAFEWING MP II FLIGHT

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

Outside Air Temperature[2]		Type II Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog	Snow, Snow Grains or Snow Pellets[3]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 and above	27 and above	100/0	3:30 – 4:00	1:00 – 1:35	1:20 – 2:00	0:45 – 1:25	0:10 – 1:30	
		75/25	1:50 – 2:45	0:40 – 1:20	1:10 – 1:30	0:30 – 0:55	0:06 – 0:50	
		50/50	0:55 – 1:45	0:10 – 0:25	0:20 – 0:30	0:10 – 0:15		
below -3 to -14	below 27 to 7	100/0	0:55 – 1:45	0:40 – 1:05	0:35 – 1:30[7]	0:25 – 0:45[7]	CAUTION: No holdover time guidelines exist	
		75/25	0:25 – 1:05	0:20 – 0:40	0:25 – 1:10[7]	0:20 – 0:35[7]		
below -14 to -29	below 7 to -20.2	100/0	0:30 – 0:50	0:15 – 0:30				

NOTES

1 These holdover times are derived from tests of this fluid having a viscosity as listed in Table 9.
2 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I when Type II fluid cannot be used.
3 Use light freezing rain holdover times in conditions of light snow mixed with light rain.
4 Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, and hail.
7 These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.

CAUTIONS

- **The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable holdover time 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.**
- **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.**

Transport Canada Holdover Time Guidelines — Winter 2011-2012

TABLE 2-K-ABC-2000

KILFROST TYPE II FLUID HOLDOVER GUIDELINES FOR WINTER 2011-2012[1]
ABC-2000

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

Outside Air Temperature[2]		Type II Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)					
Degrees Celsius	**Degrees Fahrenheit**		**Freezing Fog**	**Snow, Snow Grains or Snow Pellets[3]**	**Freezing Drizzle[4]**	**Light Freezing Rain**	**Rain on Cold Soaked Wing[5]**	**Other[6]**
-3 and above	27 and above	100/0	1:30 – 3:05	0:30 – 1:00	0:55 – 1:35	0:40 – 0:50	0:15 – 1:10	
		75/25	1:40 – 3:30	0:30 – 1:05	0:45 – 1:15	0:40 – 0:50	0:15 – 1:40	
		50/50	1:00 – 2:10	0:15 – 0:30	0:15 – 0:25	0:08 – 0:15	CAUTION: No holdover time guidelines exist	
below -3 to -14	below 27 to 7	100/0	0:35 – 1:25	0:25 – 0:45	0:25 – 0:50[7]	0:10 – 0:30[7]		
		75/25	0:35 – 1:15	0:25 – 0:50	0:25 – 0:55[7]	0:15 – 0:30[7]		
below -14 to -28	below 7 to -18.4	100/0	0:20 – 0:45	0:15 – 0:30				

NOTES

1. These holdover times are derived from tests of this fluid having a viscosity as listed in Table 9.
2. Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I when Type II fluid cannot be used.
3. Use light freezing rain holdover times in conditions of light snow mixed with light rain.
4. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5. No holdover guidelines exist for this condition for 0°C (32°F) and below.
6. Heavy snow, ice pellets, moderate and heavy freezing rain, and hail.
7. These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.

CAUTIONS

- **The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable holdover time 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.**
- **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 2-K-ABC-K+

KILFROST TYPE II FLUID HOLDOVER GUIDELINES FOR WINTER 2011-2012[1]
ABC-K PLUS

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

Outside Air Temperature[2]		Type II Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)					
Degrees Celsius	**Degrees Fahrenheit**		**Freezing Fog**	**Snow, Snow Grains or Snow Pellets[3]**	**Freezing Drizzle[4]**	**Light Freezing Rain**	**Rain on Cold Soaked Wing[5]**	**Other[6]**
-3 and above	27 and above	100/0	2:15 – 3:45	1:00 – 1:40	1:50 – 2:00	1:00 – 1:25	0:20 – 2:00	CAUTION: No holdover time guidelines exist
		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		
below -3 to -14	below 27 to 7	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 -29	below 7 to -20.2	100/0	0:30 – 0:55	0:15 – 0:30				

NOTES

1 These holdover times are derived from tests of this fluid having a viscosity as listed in Table 9.
2 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I when Type II fluid cannot be used.
3 Use light freezing rain holdover times in conditions of light snow mixed with light rain.
4 Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, and hail.
7 These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.

CAUTIONS

- **The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable holdover time 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.**
- **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.**

Transport Canada Holdover Time Guidelines Winter 2011-2012

TABLE 2-N-FCY-2

NEWAVE AEROCHEMICAL TYPE II FLUID HOLDOVER GUIDELINES FOR WINTER 2011-2012[1]
FCY-2

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

Outside Air Temperature[2]		Type II Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog	Snow, Snow Grains or Snow Pellets[3]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 and above	27 and above	100/0	1:15 – 2:25	0:30 – 0:55	0:35 – 1:05	0:25 – 0:35	0:08 – 0:45	CAUTION: No holdover time guidelines exist
		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		
below -3 to -14	below 27 to 7	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 -28	below 7 to -18.4	100/0	0:25 – 0:35	0:15 – 0:30				

NOTES
1 These holdover times are derived from tests of this fluid having a viscosity as listed in Table 9.
2 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I when Type II fluid cannot be used.
3 Use light freezing rain holdover times in conditions of light snow mixed with light rain.
4 Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, and hail.
7 These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.

CAUTIONS
- **The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable holdover time 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.**
- **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.**

Page 22 of 57 July 2011

Transport Canada Holdover Time Guidelines — Winter 2011-2012

TABLE 2-O-EM-II

OCTAGON TYPE II FLUID HOLDOVER GUIDELINES FOR WINTER 2011-2012[1]
E MAX II

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

Outside Air Temperature[2]		Type II Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)					
Degrees Celsius	**Degrees Fahrenheit**		**Freezing Fog**	**Snow, Snow Grains or Snow Pellets[3]**	**Freezing Drizzle[4]**	**Light Freezing Rain**	**Rain on Cold Soaked Wing[5]**	**Other[6]**
-3 and above	27 and above	100/0	2:05 – 3:45	0:40 – 1:20	0:45 – 1:35	0:30 – 0:40	0:15 – 1:30	CAUTION: No holdover time guidelines exist
		75/25	1:25 – 2:50	0:25 – 0:55	0:40 – 1:10	0:20 – 0:30	0:10 – 1:05	
		50/50	0:30 – 0:55	0:10 – 0:25	0:15 – 0:30	0:09 – 0:15		
below -3 to -14	below 27 to 7	100/0	0:50 – 1:45	0:35 – 1:10	0:35 – 1:00[7]	0:20 – 0:30[7]		
		75/25	0:30 – 1:20	0:25 – 0:50	0:35 – 1:05[7]	0:15 – 0:30[7]		
below -14 to -27	below 7 to -16.6	100/0	0:20 – 0:35	0:15 – 0:30				

NOTES
1. These holdover times are derived from tests of this fluid having a viscosity as listed in Table 9.
2. Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I when Type II fluid cannot be used.
3. Use light freezing rain holdover times in conditions of light snow mixed with light rain.
4. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5. No holdover guidelines exist for this condition for 0°C (32°F) and below.
6. Heavy snow, ice pellets, moderate and heavy freezing rain, and hail.
7. These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.

CAUTIONS
- **The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable holdover time 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.**
- **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.**

Transport Canada Holdover Time Guidelines — Winter 2011-2012

TABLE 3

SAE TYPE III FLUID HOLDOVER GUIDELINES FOR WINTER 2011-2012

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

Outside Air Temperature[1]		Type III Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (minutes)							
Degrees Celsius	**Degrees Fahrenheit**		**Freezing Fog**	**Snow, Snow Grains or Snow Pellets: Very Light[2]**	**Snow, Snow Grains or Snow Pellets: Light[2]**	**Snow, Snow Grains or Snow Pellets: Moderate**	**Freezing Drizzle[3]**	**Light Freezing Rain**	**Rain on Cold Soaked Wing[4]**	**Other[5]**
-3 and above	27 and above	100/0	20 – 40	35	20 – 35	10 – 20	10 – 20	8 – 10	6 – 20	
		75/25	15 – 30	25	15 – 25	8 – 15	8 – 15	6 – 10	2 – 10	
		50/50	10 – 20	15	8 – 15	4 – 8	5 – 9	4 – 6	CAUTION: No holdover time guidelines exist	
below -3 to -10	below 27 to 14	100/0	20 – 40	30	15 – 30	9 – 15	10 – 20	8 – 10		
		75/25	15 – 30[6]	25[6]	10 – 25[6]	7 – 10[6]	9 – 12[6]	6 – 9[6]		
below -10	below 14	100/0	20 – 40	30	15 – 30	8 – 15				

NOTES

1 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I when Type III fluid cannot be used.
2 Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain.
3 Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
4 No holdover guidelines exist for this condition for 0°C (32°F) and below.
5 Heavy snow, ice pellets, moderate and heavy freezing rain, and hail.
6 For outside air temperatures below -9°C (15.8°F) to -10°C (14°F), these holdover times only apply to aircraft with a take-off profile conforming to the high speed aerodynamic test criterion (refer to Section 8.1.6.1 f) of TP 14052E). If uncertain whether the aircraft performance conforms to this criterion, consult the aircraft manufacturer.

CAUTIONS

- **The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable holdover time table cell.**
- **High wind velocity or jet blast may reduce holdover time.**
- **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.**

Transport Canada Holdover Time Guidelines — Winter 2011-2012

TABLE 4-Generic

SAE TYPE IV FLUID HOLDOVER GUIDELINES FOR WINTER 2011-2012[1]

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

Outside Air Temperature[2]		Type IV Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)					
Degrees Celsius	**Degrees Fahrenheit**		**Freezing Fog**	**Snow, Snow Grains or Snow Pellets[3]**	**Freezing Drizzle[4]**	**Light Freezing Rain**	**Rain on Cold Soaked Wing[5]**	**Other[6]**
-3 and above	27 and above	100/0	1:20 – 3:10	0:35 – 1:15	0:45 – 1:30	0:25 – 0:40	0:10 – 1:15	
		75/25	1:00 – 1:45	0:30 – 0:55	0:35 – 1:05	0:25 – 0:35	0:09 – 0:50	
		50/50	0:15 – 0:35	0:07 – 0:15	0:10 – 0:20	0:07 – 0:10	CAUTION: No holdover time guidelines exist	
below -3 to -14	below 27 to 7	100/0	0:20 – 1:20	0:25 – 0:50	0:20 – 1:00[7]	0:10 – 0:25[7]		
		75/25	0:25 – 0:50[8]	0:20 – 0:35[8]	0:15 – 1:00[7,8]	0:10 – 0:25[7,8]		
below -14 to -25 or LOUT	below 7 to -13 or LOUT	100/0	0:15 – 0:40[9]	0:15 – 0:30[9]				

NOTES

1. Based on the lowest holdover times of the fluids listed in Table 5-4.
2. Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I when Type IV fluid cannot be used.
3. Use light freezing rain holdover times in conditions of light snow mixed with light rain.
4. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5. No holdover guidelines exist for this condition for 0°C (32°F) and below.
6. Heavy snow, ice pellets, moderate and heavy freezing rain, and hail.
7. These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.
8. For Lyondell Arctic Shield, the temperature is limited to -9.5°C (14.9°F); and for Cryotech Polar Guard, the temperature is limited to -5.5°C (22.1°F). If the fluid is unknown, these holdover times only apply down to -5.5°C (22.1°F).
9. For Cryotech Polar Guard, the temperature is limited to -23.5°C (-10.3°F); for Dow Ultra+, the temperature is limited to -24°C (-11.2°F); and for Lyondell Arctic Shield, the temperature is limited to -24.5°C (-12.1°F). If the fluid is unknown, these holdover times only apply down to -23.5°C (-10.3°F).

CAUTIONS

- **The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable holdover time 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.**
- **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.**

Transport Canada Holdover Time Guidelines — Winter 2011-2012

TABLE 4-A-AD-480

ABAX TYPE IV FLUID HOLDOVER GUIDELINES FOR WINTER 2011-2012[1]
AD-480

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

Outside Air Temperature[2]		Type IV Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog	Snow, Snow Grains or Snow Pellets[3]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 and above	27 and above	100/0	2:00 – 3:30	0:40 – 1:20	0:50 – 1:30	0:35 – 0:55	0:15 – 1:35	
		75/25	1:30 – 2:45	0:30 – 1:05	0:50 – 1:15	0:30 – 0:45	0:10 – 1:15	
		50/50	0:30 – 0:45	0:09 – 0:20	0:15 – 0:25	0:09 – 0:15		
below -3 to -14	below 27 to 7	100/0	0:20 – 1:20	0:30 – 0:55	0:25 – 1:20[7]	0:15 – 0:30[7]	CAUTION: No holdover time guidelines exist	
		75/25	0:25 – 0:50	0:20 – 0:45	0:25 – 1:05[7]	0:15 – 0:30[7]		
below -14 to -26	below 7 to -14.8	100/0	0:15 – 0:40	0:15 – 0:30				

NOTES
1 These holdover times are derived from tests of this fluid having a viscosity as listed in Table 9.
2 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I when Type IV fluid cannot be used.
3 Use light freezing rain holdover times in conditions of light snow mixed with light rain.
4 Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, and hail.
7 These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.

CAUTIONS
- **The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable holdover time 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.**
- **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-A-Ecowing AD-49

ABAX TYPE IV FLUID HOLDOVER GUIDELINES FOR WINTER 2011-2012[1]
ECOWING AD-49

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

Outside Air Temperature[2]		Type IV Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog	Snow, Snow Grains or Snow Pellets[3]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 and above	27 and above	100/0	3:20 – 4:00	1:10 – 1:50	1:25 – 2:00	1:00 – 1:25	0:10 – 1:55	CAUTION: No holdover time guidelines exist
		75/25	2:25 – 4:00	1:20 – 1:40	1:55 – 2:00	0:50 – 1:30	0:10 – 1:40	
		50/50	0:25 – 0:50	0:15 – 0:25	0:15 – 0:30	0:10 – 0:15		
below -3 to -14	below 27 to 7	100/0	0:20 – 1:35	1:10 – 1:50	0:25 – 1:25[7]	0:20 – 0:25[7]		
		75/25	0:30 – 1:10	1:20 – 1:40	0:15 – 1:05[7]	0:15 – 0:25[7]		
below -14 to -26	below 7 to -14.8	100/0	0:25 – 0:40	0:15 – 0:30				

NOTES

1. These holdover times are derived from tests of this fluid having a viscosity as listed in Table 9.
2. Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I when Type IV fluid cannot be used.
3. Use light freezing rain holdover times in conditions of light snow mixed with light rain.
4. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5. No holdover guidelines exist for this condition for 0°C (32°F) and below.
6. Heavy snow, ice pellets, moderate and heavy freezing rain, and hail.
7. These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.

CAUTIONS

- **The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable holdover time 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.**
- **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-C-2001

CLARIANT TYPE IV FLUID HOLDOVER GUIDELINES FOR WINTER 2011-2012[1]
SAFEWING MP IV 2001

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

Outside Air Temperature[2]		Type IV Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog	Snow, Snow Grains or Snow Pellets[3]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 and above	27 and above	100/0	1:20 – 3:20	1:00 – 1:55	0:55 – 1:55	0:40 – 1:00	0:15 – 2:00	CAUTION: No holdover time guidelines exist
		75/25	1:20 – 2:00	0:35 – 1:00	0:35 – 1:10	0:25 – 0:35	0:10 – 1:25	
		50/50	0:15 – 0:40	0:10 – 0:20	0:10 – 0:20	0:08 – 0:15		
below -3 to -14	below 27 to 7	100/0	0:45 – 1:35	0:30 – 0:50	0:55 – 1:35[7]	0:30 – 0:45[7]		
		75/25	0:30 – 1:00	0:20 – 0:35	0:40 – 1:10[7]	0:20 – 0:30[7]		
below -14 to -29.5	below 7 to -21.1	100/0	0:20 – 0:45	0:15 – 0:30				

NOTES
1 These holdover times are derived from tests of this fluid having a viscosity as listed in Table 9.
2 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I when Type IV fluid cannot be used.
3 Use light freezing rain holdover times in conditions of light snow mixed with light rain.
4 Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, and hail.
7 These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.

CAUTIONS
- **The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable holdover time 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.**
- **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-C-LAUNCH

CLARIANT TYPE IV FLUID HOLDOVER GUIDELINES FOR WINTER 2011-2012[1]
SAFEWING MP IV LAUNCH

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

Outside Air Temperature[2]		Type IV Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)					
Degrees Celsius	**Degrees Fahrenheit**		**Freezing Fog**	**Snow, Snow Grains or Snow Pellets[3]**	**Freezing Drizzle[4]**	**Light Freezing Rain**	**Rain on Cold Soaked Wing[5]**	**Other[6]**
-3 and above	27 and above	100/0	4:00 – 4:00	1:05 – 1:45	1:30 – 2:00	1:00 – 1:40	0:15 – 1:40	
		75/25	3:40 – 4:00	1:00 – 1:45	1:40 – 2:00	0:45 – 1:15	0:10 – 1:45	
		50/50	1:25 – 2:45	0:25 – 0:45	0:30 – 0:50	0:20 – 0:25		
below -3 to -14	below 27 to 7	100/0	1:00 – 1:55	0:50 – 1:20	0:35 – 1:40[7]	0:25 – 0:45[7]	CAUTION: No holdover time guidelines exist	
		75/25	0:40 – 1:20	0:45 – 1:25	0:25 – 1:10[7]	0:25 – 0:45[7]		
below -14 to -28.5	below 7 to -19.3	100/0	0:30 – 0:50	0:15 – 0:30				

NOTES
1 These holdover times are derived from tests of this fluid having a viscosity as listed in Table 9.
2 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I when Type IV fluid cannot be used.
3 Use light freezing rain holdover times in conditions of light snow mixed with light rain.
4 Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, and hail.
7 These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.

CAUTIONS
- **The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable holdover time 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.**
- **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-CR-PG

CRYOTECH TYPE IV FLUID HOLDOVER GUIDELINES FOR WINTER 2011-2012[1]
POLAR GUARD

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

Outside Air Temperature[2]		Type IV Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog	Snow, Snow Grains or Snow Pellets[3]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 and above	27 and above	100/0	2:15 – 3:30	0:50 – 1:30	1:15 – 2:00	0:50 – 1:15	0:15 – 1:25	
		75/25	1:40 – 2:40	0:35 – 1:10	1:05 – 1:25	0:35 – 1:00	0:10 – 1:15	
		50/50	0:25 – 0:40	0:10 – 0:15	0:15 – 0:25	0:10 – 0:15	CAUTION: No holdover time guidelines exist	
below -3 to -14	below 27 to 7	100/0	0:45 – 1:45	0:30 – 0:55	0:25 – 1:10[7]	0:15 – 0:35[7]		
		75/25	0:35 – 1:30[8]	0:20 – 0:40[8]	0:25 – 1:05[8]	0:20 – 0:30[8]		
below -14 to -23.5	below 7 to -10.3	100/0	0:20 – 0:40	0:15 – 0:30				

NOTES
1 These holdover times are derived from tests of this fluid having a viscosity as listed in Table 9.
2 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I when Type IV fluid cannot be used.
3 Use light freezing rain holdover times in conditions of light snow mixed with light rain.
4 Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, and hail.
7 These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.
8 These holdover times only apply to outside air temperatures to -5.5°C (22.1°F) and above.

CAUTIONS
- **The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable holdover time 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.**
- **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.**

Transport Canada Holdover Time Guidelines Winter 2011-2012

TABLE 4-CR-PG-A

CRYOTECH TYPE IV FLUID HOLDOVER GUIDELINES FOR WINTER 2011-2012[1]
POLAR GUARD ADVANCE

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

Outside Air Temperature[2]		Type IV Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog	Snow, Snow Grains or Snow Pellets[3]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 and above	27 and above	100/0	2:50 – 4:00	1:20 – 1:50	1:35 – 2:00	1:15 – 1:30	0:15 – 2:00	CAUTION: No holdover time guidelines exist
		75/25	2:30 – 4:00	0:45 – 1:20	1:40 – 2:00	0:40 – 1:10	0:09 – 1:40	
		50/50	0:50 – 1:25	0:15 – 0:35	0:20 – 0:45	0:09 – 0:20		
below -3 to -14	below 27 to 7	100/0	0:55 – 2:30	0:55 – 1:15	0:35 – 1:35[7]	0:35 – 0:45[7]		
		75/25	0:40 – 1:30	0:35 – 1:00	0:25 – 1:05[7]	0:35 – 0:45[7]		
below -14 to -30.5	below 7 to -22.9	100/0	0:25 – 0:50	0:15 – 0:30				

NOTES

1 These holdover times are derived from tests of this fluid having a viscosity as listed in Table 9.
2 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I when Type IV fluid cannot be used.
3 Use light freezing rain holdover times in conditions of light snow mixed with light rain.
4 Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, and hail.
7 These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.

CAUTIONS

- **The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable holdover time 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.**
- **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-D-ULTRA+

DOW CHEMICAL TYPE IV FLUID HOLDOVER GUIDELINES FOR WINTER 2011-2012[1]
UCAR™ ADF/AAF ULTRA+

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

Outside Air Temperature[2]		Type IV Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog	Snow, Snow Grains or Snow Pellets[3]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 and above	27 and above	100/0	1:35 – 3:35	0:35 – 1:15	0:45 – 1:35	0:25 – 0:40	0:10 – 1:20	CAUTION: No holdover time guidelines exist
		75/25						
		50/50						
below -3 to -14	below 27 to 7	100/0	1:25 – 3:00	0:25 – 0:55	0:45 – 1:25[7]	0:30 – 0:45[7]		
		75/25						
below -14 to -24	below 7 to -11	100/0	0:40 – 2:10	0:20 – 0:45				

NOTES
1. These holdover times are derived from tests of this fluid having a viscosity as listed in Table 9.
2. Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I when Type IV fluid cannot be used.
3. Use light freezing rain holdover times in conditions of light snow mixed with light rain.
4. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5. No holdover guidelines exist for this condition for 0°C (32°F) and below.
6. Heavy snow, ice pellets, moderate and heavy freezing rain, and hail.
7. These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.

CAUTIONS
- **The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable holdover time 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.**
- **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-D-E106

DOW CHEMICAL TYPE IV FLUID HOLDOVER GUIDELINES FOR WINTER 2011-2012[1]
UCAR™ ENDURANCE EG106

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

Outside Air Temperature[2]		Type IV Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog	Snow, Snow Grains or Snow Pellets[3]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 and above	27 and above	100/0	2:05 – 3:10	0:40 – 1:20	1:10 – 2:00	0:50 – 1:15	0:20 – 2:00	
		75/25						
		50/50						CAUTION: No holdover time guidelines exist
below -3 to -14	below 27 to 7	100/0	1:50 – 3:20	0:30 – 1:05	0:55 – 1:50[7]	0:45 – 1:10[7]		
		75/25						
below -14 to -27	below 7 to -16.6	100/0	0:30 – 1:05	0:15 – 0:30				

NOTES

1 These holdover times are derived from tests of this fluid having a viscosity as listed in Table 9.
2 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I when Type IV fluid cannot be used.
3 Use light freezing rain holdover times in conditions of light snow mixed with light rain.
4 Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, and hail.
7 These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.

CAUTIONS

- **The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable holdover time 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.**
- **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-D-AD-480

DOW CHEMICAL TYPE IV FLUID HOLDOVER GUIDELINES FOR WINTER 2011-2012[1]
UCAR™ FLIGHTGUARD AD-480

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

Outside Air Temperature[2]		Type IV Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)					
Degrees Celsius	**Degrees Fahrenheit**		**Freezing Fog**	**Snow, Snow Grains or Snow Pellets[3]**	**Freezing Drizzle[4]**	**Light Freezing Rain**	**Rain on Cold Soaked Wing[5]**	**Other[6]**
-3 and above	27 and above	100/0	2:00 – 3:30	0:40 – 1:20	0:50 – 1:30	0:35 – 0:55	0:15 – 1:35	CAUTION: No holdover time guidelines exist
		75/25	1:30 – 2:45	0:30 – 1:05	0:50 – 1:15	0:30 – 0:45	0:10 – 1:15	
		50/50	0:30 – 0:45	0:09 – 0:20	0:15 – 0:25	0:09 – 0:15		
below -3 to -14	below 27 to 7	100/0	0:20 – 1:20	0:30 – 0:55	0:25 – 1:20[7]	0:15 – 0:30[7]		
		75/25	0:25 – 0:50	0:20 – 0:45	0:25 – 1:05[7]	0:15 – 0:30[7]		
below -14 to -26	below 7 to -14.8	100/0	0:15 – 0:40	0:15 – 0:30				

NOTES

1 These holdover times are derived from tests of this fluid having a viscosity as listed in Table 9.
2 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I when Type IV fluid cannot be used.
3 Use light freezing rain holdover times in conditions of light snow mixed with light rain.
4 Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, and hail.
7 These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.

CAUTIONS

- **The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable holdover time 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.**
- **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-D-AD-49

DOW CHEMICAL TYPE IV FLUID HOLDOVER GUIDELINES FOR WINTER 2011-2012[1]
UCAR™ FLIGHTGUARD AD-49

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

Outside Air Temperature[2]		Type IV Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog	Snow, Snow Grains or Snow Pellets[3]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 and above	27 and above	100/0	3:20 – 4:00	1:10 – 1:50	1:25 – 2:00	1:00 – 1:25	0:10 – 1:55	CAUTION: No holdover time guidelines exist
		75/25	2:25 – 4:00	1:20 – 1:40	1:55 – 2:00	0:50 – 1:30	0:10 – 1:40	
		50/50	0:25 – 0:50	0:15 – 0:25	0:15 – 0:30	0:10 – 0:15		
below -3 to -14	below 27 to 7	100/0	0:20 – 1:35	1:10 – 1:50	0:25 – 1:25[7]	0:20 – 0:25[7]		
		75/25	0:30 – 1:10	1:20 – 1:40	0:15 – 1:05[7]	0:15 – 0:25[7]		
below -14 to -26	below 7 to -14.8	100/0	0:25 – 0:40	0:15 – 0:30				

NOTES
1 These holdover times are derived from tests of this fluid having a viscosity as listed in Table 9.
2 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I when Type IV fluid cannot be used.
3 Use light freezing rain holdover times in conditions of light snow mixed with light rain.
4 Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, and hail.
7 These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.

CAUTIONS
- **The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable holdover time 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.**
- **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-K-ABC-4S

KILFROST TYPE IV FLUID HOLDOVER GUIDELINES FOR WINTER 2011-2012[1]
ABC-4^{sustain}

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

Outside Air Temperature[2]		Type IV Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog	Snow, Snow Grains or Snow Pellets[3]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 and above	27 and above	100/0	1:45 – 3:55	1:00 – 1:45	1:35 – 2:00	1:05 – 1:30	0:20 – 2:00	CAUTION: No holdover time guidelines exist
		75/25	1:00 – 1:50	0:30 – 0:55	0:40 – 1:05	0:25 – 0:40	0:10 – 1:20	
		50/50	0:20 – 0:35	0:07 – 0:15	0:10 – 0:20	0:07 – 0:10		
below -3 to -14	below 27 to 7	100/0	0:55 – 2:55	1:00 – 1:45	0:35 – 1:50[7]	1:05 – 1:25[7]		
		75/25	0:35 – 2:10	0:30 – 0:55	0:25 – 1:20[7]	0:15 – 0:40[7]		
below -14 to -29	below 7 to -20.2	100/0	0:40 – 1:00	0:15 – 0:30				

NOTES
1 These holdover times are derived from tests of this fluid having a viscosity as listed in Table 9.
2 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I when Type IV fluid cannot be used.
3 Use light freezing rain holdover times in conditions of light snow mixed with light rain.
4 Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, and hail.
7 These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.

CAUTIONS
- **The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable holdover time 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.**
- **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-K-ABC-S

KILFROST TYPE IV FLUID HOLDOVER GUIDELINES FOR WINTER 2011-2012[1]
ABC-S

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

Outside Air Temperature[2]		Type IV Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog	Snow, Snow Grains or Snow Pellets[3]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 and above	27 and above	100/0	2:35 – 4:00	1:00 – 1:40	1:20 – 1:50	1:00 – 1:25	0:20 – 1:15	
		75/25	1:05 – 1:45	0:30 – 0:55	0:45 – 1:10	0:35 – 0:50	0:10 – 0:50	
		50/50	0:20 – 0:35	0:07 – 0:15	0:15 – 0:20	0:08 – 0:10	CAUTION: No holdover time guidelines exist	
below -3 to -14	below 27 to 7	100/0	0:45 – 2:05	0:45 – 1:20	0:20 – 1:00[7]	0:10 – 0:30[7]		
		75/25	0:25 – 1:00	0:25 – 0:50	0:20 – 1:10[7]	0:10 – 0:35[7]		
below -14 to -28	below 7 to -18.4	100/0	0:20 – 0:40	0:15 – 0:30				

NOTES

1 These holdover times are derived from tests of this fluid having a viscosity as listed in Table 9.
2 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I when Type IV fluid cannot be used.
3 Use light freezing rain holdover times in conditions of light snow mixed with light rain.
4 Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, and hail.
7 These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.

CAUTIONS

- **The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable holdover time 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.**
- **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-K-ABC-S+

KILFROST TYPE IV FLUID HOLDOVER GUIDELINES FOR WINTER 2011-2012[1]
ABC-S PLUS

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

Outside Air Temperature[2]		Type IV Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog	Snow, Snow Grains or Snow Pellets[3]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 and above	27 and above	100/0	2:10 – 4:00	1:15 – 2:00	1:50 – 2:00	1:05 – 2:00	0:25 – 2:00	CAUTION: No holdover time guidelines exist
		75/25	1:25 – 2:40	0:45 – 1:15	1:00 – 1:20	0:30 – 0:50	0:10 – 1:20	
		50/50	0:30 – 0:55	0:15 – 0:30	0:15 – 0:40	0:15 – 0:20		
below -3 to -14	below 27 to 7	100/0	0:55 – 3:30	1:00 – 1:45	0:25 – 1:35[7]	0:20 – 0:30[7]		
		75/25	0:45 – 1:50	0:35 – 1:00	0:20 – 1:10[7]	0:15 – 0:25[7]		
below -14 to -28	below 7 to -18.4	100/0	0:40 – 1:00	0:15 – 0:30				

NOTES

1 These holdover times are derived from tests of this fluid having a viscosity as listed in Table 9.
2 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I when Type IV fluid cannot be used.
3 Use light freezing rain holdover times in conditions of light snow mixed with light rain.
4 Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, and hail.
7 These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.

CAUTIONS

- **The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable holdover time 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.**
- **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.**

Transport Canada Holdover Time Guidelines Winter 2011-2012

TABLE 4-L-ARCTIC Shield

LYONDELL TYPE IV FLUID HOLDOVER GUIDELINES FOR WINTER 2011-2012[1]
ARCTIC SHIELD™

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

Outside Air Temperature[2]		Type IV Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog	Snow, Snow Grains or Snow Pellets[3]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 and above	27 and above	100/0	1:55 – 3:10	0:50 – 1:25	0:55 – 1:40	0:45 – 1:05	0:15 – 1:25	CAUTION: No holdover time guidelines exist
		75/25	1:20 – 2:15	0:40 – 1:05	0:55 – 1:25	0:30 – 0:45	0:09 – 1:20	
		50/50	0:35 – 0:45	0:20 – 0:35	0:20 – 0:30	0:10 – 0:15		
below -3 to -14	below 27 to 7	100/0	1:00 – 2:25	0:45 – 1:15	0:25 – 1:30[7]	0:25 – 0:30[7]		
		75/25	0:50 – 1:45[8]	0:35 – 0:55[8]	0:30 – 1:15[8]	0:25 – 0:30[8]		
below -14 to -24.5	below 7 to -12.1	100/0	0:25 – 0:45	0:15 – 0:30				

NOTES
1 These holdover times are derived from tests of this fluid having a viscosity as listed in Table 9.
2 Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I when Type IV fluid cannot be used.
3 Use light freezing rain holdover times in conditions of light snow mixed with light rain.
4 Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5 No holdover guidelines exist for this condition for 0°C (32°F) and below.
6 Heavy snow, ice pellets, moderate and heavy freezing rain, and hail.
7 These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.
8 These holdover times only apply to outside air temperatures to -9.5°C (14.9°F) and above.

CAUTIONS
- **The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable holdover time 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.**
- **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-O-MF-04

OCTAGON TYPE IV FLUID HOLDOVER GUIDELINES FOR WINTER 2011-2012[1]
MAX-FLIGHT 04

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

Outside Air Temperature[2]		Type IV Fluid Concentration Neat Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog	Snow, Snow Grains or Snow Pellets[3]	Freezing Drizzle[4]	Light Freezing Rain	Rain on Cold Soaked Wing[5]	Other[6]
-3 and above	27 and above	100/0	2:40 – 4:00	1:25 – 2:00	2:00 – 2:00	1:10 – 1:30	0:20 – 2:00	CAUTION: No holdover time guidelines exist
		75/25	2:05 – 3:15	1:05 – 2:00	1:50 – 2:00	1:00 – 1:20	0:20 – 2:00	
		50/50	0:55 – 1:45	0:25 – 1:15	0:35 – 1:10	0:25 – 0:35	CAUTION: No holdover time guidelines exist	
below -3 to -14	below 27 to 7	100/0	0:50 – 2:30	0:35 – 1:10	0:25 – 1:30[7]	0:20 – 0:40[7]		
		75/25	0:30 – 1:05	0:40 – 1:25	0:20 – 1:00[7]	0:15 – 0:30[7]		
below -14 to -26.5	below 7 to -15.7	100/0	0:20 – 0:45	0:15 – 0:30				

NOTES

1. These holdover times are derived from tests of this fluid having a viscosity as listed in Table 9.
2. Ensure that the lowest operational use temperature (LOUT) is respected. Consider use of Type I when Type IV fluid cannot be used.
3. Use light freezing rain holdover times in conditions of light snow mixed with light rain.
4. Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.
5. No holdover guidelines exist for this condition for 0°C (32°F) and below.
6. Heavy snow, ice pellets, moderate and heavy freezing rain, and hail.
7. These holdover times only apply to outside air temperatures to -10°C (14°F) under freezing drizzle and light freezing rain.

CAUTIONS

- **The only acceptable decision-making criterion, for takeoff without a pre-takeoff contamination inspection, is the shorter time within the applicable holdover time 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.**
- **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.**

Transport Canada Holdover Time Guidelines Winter 2011-2012

TABLE 5

LIST OF FLUIDS TESTED FOR ANTI-ICING PERFORMANCE AND AERODYNAMIC ACCEPTANCE (2011-2012)

Table 5-1: Tested Type I De/Anti-icing Fluids[(1) (2)]

#	COMPANY NAME	FLUID NAME	EXPIRY (Y-M-D)
1-1	ABAX Industries	DE-950	12-06-25
1-2	ABAX Industries	DE-950 Colorless	12-06-26
1-3	Arcton Ltd.	Arctica DG ready-to-use	13-04-08
1-4	Aviation Shaanxi High-Tech Physical Co. Ltd.	Cleanwing I	12-01-06
1-5	Aviation Xi'an High-Tech Physical Co. Ltd.	KHF-1	11-09-20
1-6	*Battelle Memorial Institute*	*D^3: Degradable by Design™ ADF1006A*	*08-01-13*[(3)]
1-7	Beijing Phoenix Air Traffic Product Development and Trading Co.	CBSX-1	12-04-21
1-8	Beijing Wangye Aviation Chemical Product Co.	KLA-1	11-09-20
1-9	Beijing Wangye Aviation Chemical Product Co.	*YJF-1*	*09-02-23*[(3)]
1-10	*Clariant Produkte (Deutschland) GmbH*	*Safewing MP I 1938 TF*	*08-08-21*[(3)]
1-11	*Clariant Produkte (Deutschland) GmbH*	*Safewing MP I 1938 TF PreMix 60% i.g. ready-to-use (multiple location)*	*07-09-14*[(3)]
1-12	Clariant Produkte (Deutschland) GmbH	Safewing MP I 1938 ECO (80)	12-07-24
1-13	Clariant Produkte (Deutschland) GmbH	Safewing MP I 1938 ECO (80) PreMix 55% i.g. ready-to-use	13-05-20
1-14	Clariant Produkte (Deutschland) GmbH	Safewing MP I 1938 ECO	12-06-10
1-15	Clariant Produkte (Deutschland) GmbH	Safewing EG I 1996	12-06-10
1-16	Clariant Produkte (Deutschland) GmbH	Safewing EG I 1996 (88)	11-08-26
1-17	Clariant Produkte (Deutschland) GmbH	Safewing MP I ECO PLUS (80)	15-03-15
1-18	*Chemical Specialists Development Inc.*	*Prist Wing De-Icer*	*08-05-17*[(3)]
1-19	Cryotech Deicing Technology	Polar Plus	12-02-09
1-20	Dow Chemical Company	UCAR™ Aircraft Deicing Fluid Concentrate	11-09-10[(4)]
1-21	Dow Chemical Company	UCAR™ ADF XL54	13-01-21
1-22	Dow Chemical Company	UCAR™ PG Aircraft Deicing Fluid Concentrate	12-02-05
1-23	Dow Chemical Company	UCAR™ PG ADF Dilute 55/45	12-02-05
1-24	Harbin Aeroclean Aviation Tech Co. Ltd.	HJF-1	13-10-05
1-25	*HOC Industries*	*SafeTemp I ES*	*07-10-27*[(3)]
1-26	HOC Industries	SafeTemp ES Plus	14-11-16
1-27	Kilfrost Limited	DF Plus	11-09-27
1-28	Kilfrost Limited	DF Plus (80)	12-07-21
1-29	Kilfrost Limited	DF Plus (88)	11-09-27
1-30	Kilfrost Limited	DFsustain™	13-02-10
1-31	*Lyondell Chemical Company*	*ARCOPlus*	*08-02-14*[(3)]
1-32	Newave Aerochemical Co. Ltd.	FCY-1A	15-05-16
1-33	Octagon Process Inc.	EcoFlo Concentrate	13-07-06
1-34	Octagon Process Inc.	EcoFlo 2 Concentrate	13-07-25
1-35	Octagon Process Inc.	Octaflo EF Concentrate	14-03-25
1-36	Octagon Process Inc.	Octaflo EF-80	13-12-21
1-37	Octagon Process Inc.	Octaflo EG Concentrate	13-06-10

(1) The expiry date was determined based upon the earliest expiry date of the High Speed Aerodynamic Test or Water Spray Endurance Test. Fluids that are tested after the issuance of this list will appear in a later update.
(2) Concentrate fluids have also been tested at 50/50 (glycol/water) dilution.
(3) Fluids listed in italics have expired and will be removed from this listing four years after expiry.
(4) Currently in the test/re-retest process.

CAUTION

This table lists fluids that have been tested with respect to anti-icing performance (SAE AMS 1424 Paragraph 3.5.2) and aerodynamic acceptance (SAE AMS 1424 Paragraph 3.5.3) only! The aerodynamic acceptance tests were conducted by Anti-icing Materials International Laboratory, Université du Québec à Chicoutimi (a test facility certified as per SAE AS 5900). Website: http://www.uqac.ca/amil/index.htm.

The end user is responsible to confirm that other SAE AMS 1424 technical requirement tests, such as fluid stability, toxicity, materials compatibility, etc. have been conducted by contacting the fluid manufacturer.

Transport Canada Holdover Time Guidelines Winter 2011-2012

TABLE 5 (cont.)

LIST OF FLUIDS TESTED FOR ANTI-ICING PERFORMANCE AND AERODYNAMIC ACCEPTANCE (2011-2012)

Table 5-2: Tested(1) Type II De/Anti-icing Fluids

#	COMPANY NAME	FLUID NAME	EXPIRY (Y-M-D)
2-1	ABAX Industries	Ecowing 26	13-06-15
2-2	Aviation Shaanxi Hi-Tech Physical Chemical Co. Ltd.	Cleanwing II	11-02-19(3)
2-3	*Clariant Produkte (Deutschland) GmbH*	*Safewing MP II 1951*	*11-05-20(2)*
2-4	*Clariant Produkte (Deutschland) GmbH*	*Safewing MP II 2025 ECO*	*08-06-28(2)*
2-5	Clariant Produkte (Deutschland) GmbH	Safewing MP II FLIGHT	12-06-03
2-6	Kilfrost Limited	ABC-3	12-08-05
2-7	*Kilfrost Limited*	*ABC-2000*	*10-07-21(2)*
2-8	Kilfrost Limited	ABC-K Plus	12-09-08
2-9	Newave Aerochemical Co. Ltd.	FCY-2	13-05-18
2-10	*Octagon Process Inc.*	*E Max II*	*08-10-31(2)*

Table 5-3: Tested (1) Type III De/Anti-icing Fluids

#	COMPANY NAME	FLUID NAME	EXPIRY (Y-M-D)
3-1	Clariant Produkte (Deutschland) GmbH	Safewing MP III 2031 ECO	11-06-16(3)

Table 5-4: Tested (1) Type IV De/Anti-icing Fluids

#	COMPANY NAME	FLUID NAME	EXPIRY (Y-M-D)
4-1	*ABAX Industries*	*AD-480*	*11-07-17(2)*
4-2	ABAX Industries	Ecowing AD-49	12-08-05
4-3	*Clariant Produkte (Deutschland) GmbH*	*Safewing MP IV 2001*	*08-06-26(2)*
4-4	Clariant Produkte (Deutschland) GmbH	Safewing MP IV LAUNCH	12-05-28
4-5	Cryotech Deicing Technology	Polar Guard	12-08-30
4-6	Cryotech Deicing Technology	Polar Guard Advance	13-07-25
4-7	*Dow Chemical Company*	*UCAR™ ADF/AAF ULTRA+*	*08-08-21(2)*
4-8	Dow Chemical Company	UCAR™ Endurance EG106 De/Anti-Icing Fluid	13-07-25
4-9	Dow Chemical Company	UCAR™ FlightGuard AD-480	12-06-15
4-10	Dow Chemical Company	UCAR™ FlightGuard AD-49	13-04-14
4-11	*Kilfrost Limited*	*ABC-4^{sustain}*	*11-07-28(2)*
4-12	*Kilfrost Limited*	*ABC-S*	*11-07-06(2)*
4-13	Kilfrost Limited	ABC-S Plus	13-06-30
4-14	*Lyondell Chemical Company*	*ARCTIC Shield™*	*10-05-21(2)*
4-15	Octagon Process Inc.	Max-Flight 04	12-07-13

(1) The expiry date was determined based upon the earliest expiry date of the High Speed Aerodynamic Test or Water Spray Endurance Test. Fluids that are tested after the issuance of this list will appear in a later update.
(2) Fluids listed in italics have expired and will be removed from this listing four years after expiry.
(3) Currently in the test/re-test process.

CAUTION

This table lists fluids that have been tested with respect to anti-icing performance (SAE AMS 1428 Paragraph 3.2.4) and aerodynamic acceptance (SAE AMS 1428 Paragraph 3.2.5) only! The aerodynamic acceptance tests were conducted by Anti-icing Materials International Laboratory, Université du Québec à Chicoutimi (a test facility certified as per SAE AS 5900). Website: http://www.uqac.ca/amil/index.htm.

The end user is responsible to confirm that other SAE AMS 1428 technical requirement tests, such as fluid stability, toxicity, materials compatibility, etc. have been conducted by contacting the fluid manufacturer.

Transport Canada Holdover Time Guidelines Winter 2011-2012

TABLE 6

SAE TYPE I DE/ANTI-ICING FLUID APPLICATION PROCEDURES

Guidelines for the application of SAE Type I fluid mixtures at minimum concentrations for the prevailing outside air temperature (OAT)

Outside Air Temperature (OAT)[1]	One-Step Procedure De/Anti-icing	Two-Step Procedure	
		First Step: Deicing	Second Step: Anti-icing[2]
-3°C (27°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 mix of fluid and water	Heated mix of fluid and water with a freezing point of at least 10°C (18°F) below OAT
Below -3°C (27°F)		Freezing point of heated fluid mixture shall not be more than 3°C (5°F) above OAT	

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.

NOTES

- 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 time guidelines, at least 1 litre/m² (~ 2 gal./100 sq. ft.) must be applied to the deiced surfaces.
- This table is applicable for the use of Type I Holdover Time Guidelines. If holdover times are not required, a temperature of 60°C (140°F) at the nozzle is desirable.
- The lowest operational use temperature (LOUT) for a given fluid is the higher 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).

CAUTION

- **Wing skin temperatures may differ and in some cases may be lower than outside air temperatures; a stronger mix (more glycol) may be needed under these conditions.**

TABLE 7

SAE TYPE II, TYPE III and TYPE IV DE/ANTI-ICING FLUID APPLICATION PROCEDURES

Guidelines for the application of SAE Type II, III and IV fluid mixtures
(minimum concentrations in % by volume) as a function of outside air temperature (OAT)

Outside Air Temperature (OAT)[1]	One-Step Procedure De/Anti-icing	Two-Step Procedure	
		First Step: Deicing	Second Step: Anti-icing[2]
-3°C (27°F) and above	50/50 Heated[3] Type II/III/IV	Heated water or a heated mix of Type I, II, III or IV with water	50/50 Type II/III/IV
-14°C (7°F) and above	75/25 Heated[3] Type II/III/IV	Heated suitable mix of Type I, Type II/III/IV and water with FP not more than 3°C (5°F) above actual OAT	75/25 Type II/III/IV
-25°C (-13°F) and above	100/0 Heated[3] Type II/III/IV	Heated suitable mix of Type I, Type II/III/IV and water with FP not more than 3°C (5°F) above actual OAT	100/0 Type II/III/IV
Below -25°C (-13°F)	Type II/III/IV fluid may be used below -25°C (-13°F) provided that the OAT is at or above the LOUT. Consider the use of Type I when Type II/III/IV fluid cannot be used (see Table 6).		

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.
3 Clean aircraft may be anti-iced with unheated fluid.

NOTES

- For heated fluids, a fluid temperature not less than 60°C (140°F) at the nozzle is desirable. When the first step is performed using a fluid/water mix with a freezing point above OAT, the temperature at the nozzle shall be at least 60°C and at least 1 litre/m^2 (2 gal./100 sq. ft.) shall be applied to the surfaces to be de-iced.
- Upper temperature limit shall not exceed fluid and aircraft manufacturers' recommendations.
- The lowest operational use temperature (LOUT) for a given fluid is the higher 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).

CAUTIONS

- **Wing skin temperatures may differ and in some cases may be lower than outside air temperatures; 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, III 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.**

Transport Canada Holdover Time Guidelines Winter 2011-2012

TABLE 8

VISIBILITY IN SNOW VS. SNOWFALL INTENSITY CHART[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)

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

This visibility table applies to all Type I, II, III, and IV fluids.

Assume that the daytime visibility in snowfall is 1 statute mile and the temperature is -7°C. Based on these conditions, the snowfall intensity is light. This snowfall intensity is used to determine which holdover time guideline value is appropriate for the fluid in use.

Transport Canada Holdover Time Guidelines Winter 2011-2012

TABLE 9

LOWEST ON-WING VISCOSITY VALUES FOR DE/ANTI-ICING FLUIDS

(See Table 9 endnotes)

Table 9-1: Type II De/Anti-Icing Fluids

FLUID NAME	FLUID DILUTION	LOWEST ON-WING VISCOSITY [a] (mPa.s)	
		MANUFACTURER METHOD	AIR 9968 REVISION A METHOD
ABAX Ecowing 26	100/0	4 900 [e]	4 600 [g]
	75/25	2 200 [g]	2 200 [g]
	50/50	50 [g]	50 [g]
Aviation Shaanxi Hi-Tech Cleanwing II	100/0	4 650 [c]	4 500 [g]
	75/25	9 450 [c]	10 000 [g]
	50/50	10 150 [c]	10 200 [g]
Clariant Safewing MP II 2025 ECO	100/0	5 500 [b]	5 750 [g]
	75/25	10 000 [b]	10 000 [g]
	50/50	3 000 [b]	3 250 [g]
Clariant Safewing MP II FLIGHT	100/0	3 340 [g]	3 340 [g]
	75/25	12 900 [l]	12 900 [l]
	50/50	11 500 [g]	11 500 [g]
Clariant Safewing MP II 1951	100/0	2 500 [b]	2 750 [g]
	75/25	2 900 [b]	3 000 [g]
	50/50	50 [b]	50 [g]
Kilfrost ABC-3	100/0	2 500 [c]	2 500 [j]
	75/25	2 000 [c]	2 000 [j]
	50/50	400 [c]	400 [j]
Kilfrost ABC-2000	100/0	2 350 [c]	2 350 [g]
	75/25	3 000 [c]	3 000 [j]
	50/50	1 000 [c]	1 000 [j]
Kilfrost ABC-K Plus	100/0	2 850 [c]	2 640 [g]
	75/25	12 650 [c]	12 650 [c]
	50/50	4 200 [c]	5 260 [g]
Newave Aerochemical FCY-2	100/0	7 000 [c]	8 920 [g]
	75/25	18 550 [c]	18 550 [c]
	50/50	6 750 [c]	7 030 [g]
Octagon E Max II	100/0	13 520 [d]	13 520 [g]
	75/25	11 400 [g]	11 400 [g]
	50/50	2 820 [g]	2 820 [g]

Table 9-2: Type III De/Anti-Icing Fluids

FLUID NAME	FLUID DILUTION	LOWEST ON-WING VISCOSITY [a] (mPa.s)	
		MANUFACTURER METHOD	AIR 9968 REVISION A METHOD
Clariant Safewing MP III 2031 ECO	100/0	30 [h]	Not Applicable
	75/25	55 [h]	Not Applicable
	50/50	10 [h]	Not Applicable

TABLE 9 (cont.)

LOWEST ON-WING VISCOSITY VALUES FOR DE/ANTI-ICING FLUIDS
(See Table 9 endnotes)

Table 9-3: Type IV De/Anti-Icing Fluids

FLUID NAME	FLUID DILUTION	LOWEST ON-WING VISCOSITY [a] (mPa.s) MANUFACTURER METHOD	LOWEST ON-WING VISCOSITY [a] (mPa.s) AIR 9968 REVISION A METHOD
ABAX AD-480	100/0	15 200 [e]	12 800 [c]
	75/25	16 000 [e]	12 400 [c]
	50/50	4 000 [e]	3 800 [g]
ABAX Ecowing AD-49	100/0	12 150 [k]	11 000 [g]
	75/25	30 700 [k]	32 350 [l]
	50/50	19 450 [k]	21 150 [l]
Clariant Safewing MP IV 2001	100/0	18 000 [b]	18 000 [c]
	75/25	8 000 [b]	11 500 [g]
	50/50	1 200 [b]	1 750 [g]
Clariant Safewing MP IV LAUNCH	100/0	7 550 [g]	7 550 [g]
	75/25	18 000 [g]	18 000 [g]
	50/50	17 800 [g]	17 800 [g]
Cryotech Polar Guard	100/0	32 100 [m]	36 300 [l]
	75/25	24 200 [m]	27 800 [l]
	50/50	6 200 [m]	7 500 [g]
Cryotech Polar Guard Advance	100/0	4 400 [n]	4 050 [g]
	75/25	11 600 [n]	9 750 [g]
	50/50	80 [g]	80 [g]
Dow UCAR™ ADF/AAF ULTRA+	100/0	36 000 [f]	28 000 [c]
	75/25	Dilution Not Applicable	Dilution Not Applicable
	50/50	Dilution Not Applicable	Dilution Not Applicable
Dow UCAR™ Endurance EG106	100/0	24 850 [f]	2 230 [g]
	75/25	Dilution Not Applicable	Dilution Not Applicable
	50/50	Dilution Not Applicable	Dilution Not Applicable
Dow UCAR™ FlightGuard AD-480	100/0	15 200 [e]	12 800 [c]
	75/25	16 000 [e]	12 400 [c]
	50/50	4 000 [e]	3 800 [g]
Dow UCAR™ FlightGuard AD-49	100/0	12 150 [k]	11 000 [g]
	75/25	30 700 [k]	32 350 [l]
	50/50	19 450 [k]	21 150 [l]
Kilfrost ABC-4sustain	100/0	18 400 [c]	18 400 [c]
	75/25	15 400 [c]	15 400 [c]
	50/50	4 700 [c]	5 050 [g]
Kilfrost ABC-S	100/0	17 000 [c]	17 000 [c]
	75/25	12 000 [c]	12 000 [c]
	50/50	2 000 [c]	2 000 [j]
Kilfrost ABC-S Plus	100/0	17 900 [c]	17 900 [c]
	75/25	18 300 [c]	18 300 [c]
	50/50	7 500 [c]	7 500 [j]

See next page for additional Type IV fluids

TABLE 9 (cont.)

LOWEST ON-WING VISCOSITY VALUES FOR DE/ANTI-ICING FLUIDS
(See Table 9 endnotes)

Table 9-3: Type IV De/Anti-Icing Fluids (cont.)			
FLUID NAME	FLUID DILUTION	LOWEST ON-WING VISCOSITY [a] (mPa.s)	
		MANUFACTURER METHOD	AIR 9968 REVISION A METHOD
Lyondell ARCTIC Shield™	100/0	23 150 [i]	28 000 [c]
	75/25	21 700 [i]	22 100 [c]
	50/50	6 400 [i]	7 640 [g]
Octagon Max-Flight 04	100/0	5 540 [d]	5 540 [g]
	75/25	15 000 [g]	15 000 [g]
	50/50	5 200 [g]	5 200 [g]

NOTES

a The Aerospace Information Report (AIR) 9968 Revision A (December 2004) 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.
b Brookfield Spindle SC4-34/13R, small sample adapter, 10 mL of fluid, at 20°C, 0.3 rpm, for 15 minutes 0 seconds.
c Brookfield Spindle LV2-disc with guard leg, 150 mL of fluid, at 20°C, 0.3 rpm, for 10 minutes 0 seconds.
d Brookfield Spindle LV1 with guard leg, 500 mL of fluid, at 20°C, 0.3 rpm, for 33 minutes 20 seconds.
e Brookfield Spindle SC4-34/13R, small sample adapter, 10 mL of fluid, at 20°C, 0.3 rpm, for 30 minutes 0 seconds.
f Brookfield Spindle SC4-31/13R, small sample adapter, 10 mL of fluid, at 0°C, 0.3 rpm, for 10 minutes 0 seconds.
g Brookfield Spindle LV1 with guard leg, 500 mL of fluid, at 20°C, 0.3 rpm, for 10 minutes 0 seconds.
h Brookfield Spindle LV0, UL-Adapter, 16 mL of fluid, at 20°C, 0.3 rpm, for 10 minutes 0 seconds.
i Brookfield Spindle SC4-31/13R, small sample adapter, 9 mL of fluid, at 20°C, 0.3 rpm, for 33 minutes 0 seconds.
j Brookfield Spindle LV1 with guard leg, 150 mL of fluid, at 20°C, 0.3 rpm, for 10 minutes 0 seconds.
k Brookfield Spindle SC4-31/13R, small sample adapter, 10 mL of fluid, at 20°C, 0.3 rpm, for 10 minutes 0 seconds.
l Brookfield Spindle LV-2 disc with guard leg, 500 mL of fluid, at 20°C, 0.3 rpm, for 10 minutes 0 seconds.
m Brookfield Spindle SC4-31/13R, small sample adapter, 9 mL of fluid, at 20°C, 0.3 rpm, for 10 minutes 0 seconds.
n Brookfield Spindle SC4-34/13R, small sample adapter, 10 mL of fluid, at 20°C, 0.3 rpm, for 10 minutes 0 seconds.

SIGNIFICANCE OF THIS TABLE

The viscosity values of the fluids in this table are those of the fluids provided by the manufacturers for holdover time testing. For the holdover time guidelines to be valid, the viscosity of the fluid on the wing shall not be lower than that listed in this table. The user should periodically ensure that the viscosity value of a fluid sample taken from the wing is not lower than that listed.

TABLE 10

LOWEST OPERATIONAL USE TEMPERATURES[1] OF DE/ANTI-ICING FLUIDS (2011-2012)

Table 10-1: Type I De/Anti-Icing Fluids		
FLUID NAME	LOWEST OPERATIONAL USE TEMPERATURES[1] (°C) WITH CORRESPONDING FLUID DILUTION, NEAT FLUID/WATER (VOLUME %/VOLUME %)	
	LOW SPEED AERODYNAMIC TEST[2]	HIGH SPEED AERODYNAMIC TEST[2]
ABAX DE-950	Not tested[4]	**-24** for 60/40 dilution
ABAX DE-950 Colorless	Not tested[4]	**-24** for 60/40 dilution
Arcton Arctica DG ready-to-use	**-26** as supplied	**-26** as supplied
Aviation Shaanxi Hi-Tech Cleanwing I	Not tested[4]	**-39** for 75/25 dilution
Aviation Xi'an Hi-Tech KHF-1	Not tested[4]	**-38** for 75/25 dilution
Batelle D[3]: Degradable by Design™ ADF1006A	Not available[3]	Not available[3]
Beijing Phoenix Air Traffic CBSX-1	Not tested[4]	**-26** for 75/25 dilution
Beijing Wangye Aviation Chemical KLA-1	Not available[3]	Not available[3]
Beijing Wangye Aviation Chemical YJF-1	Not available[3]	Not available[3]
Clariant Safewing EG I 1996	**-35.5** for 75/25 dilution	**-43** for 75/25 dilution
Clariant Safewing EG I 1996 (88)	**-39.5** for 70/30 dilution	**-44** for 70/30 dilution
Clariant Safewing MP I 1938 ECO	**-25.5** for 65/35 dilution	**-32** for 65/35 dilution
Clariant Safewing MP I 1938 ECO (80)	**-25** for 71/29 dilution	**-32.5** for 71/29 dilution
Clariant Safewing MP I 1938 ECO (80) PreMix 55 i.e. ready-to-use	Not tested[4]	**-19** as supplied
Clariant Safewing MP I 1938 TF	**-26.5** for 71/29 dilution	Not available[3]
Clariant Safewing MP I 1938 TF PreMix 60% i.e. ready-to-use (multiple location)	Not available[3]	**-29.5** as supplied
Clariant Safewing MP I ECO PLUS (80)	**-25** for 71/29 dilution	**-33** for 71/29 dilution
Chemical Specialists Prist Wing De-Icer	Not available[3]	Not available[3]
See next page for additional Type I fluids		

NOTES

1 The lowest operational use temperature (LOUT) for a given fluid is the higher 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).
   The values in this table were determined using 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.
2 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 AS 5900 (latest version).
3 Manufacturer has not provided LOUT information at the time of this publication. Contact the fluid manufacturer or use another fluid.
4 Manufacturer has indicated fluid was not tested. Consult with the fluid manufacturer and/or airframe manufacturer for further guidance.

CAUTION

- LOUT data provided in this table is based strictly on the manufacturer's data, the end user is responsible for verifying the validity of this data. In case of discrepancies between the values in this table and the fluid manufacturer's data, use the manufacturer's data.
- Fluids supplied in concentrated form must not be used in that form and must be diluted.
- For the fluids in the table that are intended to be diluted, the LOUT is derived from a dilution that provides the lowest possible operational use temperature. For other 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.

Transport Canada Holdover Time Guidelines Winter 2011-2012

TABLE 10 (cont.)

LOWEST OPERATIONAL USE TEMPERATURES[1] OF DE/ANTI-ICING FLUIDS (2011-2012)

Table 10-1: Type I De/Anti-Icing Fluids (cont.)		
FLUID NAME	**LOWEST OPERATIONAL USE TEMPERATURES[1] (°C)** WITH CORRESPONDING FLUID DILUTION, NEAT FLUID/WATER (VOLUME %/VOLUME %)	
	LOW SPEED AERODYNAMIC TEST[2]	HIGH SPEED AERODYNAMIC TEST[2]
Cryotech Polar Plus	**-27** for 63/37 dilution	**-32** for 63/37 dilution
Dow UCAR™ ADF XL54	**-33** as supplied	**-33** as supplied
Dow UCAR™ Aircraft Deicing Fluid Concentrate	**-36.5** for 75/25 dilution	**-45** for 75/25 dilution
Dow UCAR™ PG ADF Dilute 55/45	**-24** as supplied	**-25** as supplied
Dow UCAR™ PG Aircraft Deicing Fluid Concentrate	**-25** for 65/35 dilution	**-32** for 65/35 dilution
Harbin Aeroclean Aviation HJF-1	Not tested[4]	**-35** for 60/40 dilution
HOC SafeTemp I ES	Not tested[4]	**-23.5** for 55/45 dilution
HOC SafeTemp ES Plus	Not tested[4]	**-29** for 65/35 dilution
Kilfrost DF Plus	**-24** for 69/31 dilution	**-32** for 69/31 dilution
Kilfrost DF Plus (80)	**-23.5** for 69/31 dilution	**-31.5** for 69/31 dilution
Kilfrost DF Plus (88)	**-24** for 63/37 dilution	**-32** for 63/37 dilution
Kilfrost DF^{sustain}™	**-36** for 68/32 dilution	**-41.5** for 68/32 dilution
Lyondell ARCOPlus	**-13** for 63/37 dilution	**-27.4** for 63/37 dilution
Newave FCY-1A	**-34** for 75/25 dilution	**-34.5** for 75/25 dilution
Octagon EcoFlo Concentrate	**-27** for 60/40 dilution	**-30.5** for 65/35 dilution
Octagon EcoFlo 2 Concentrate	Not tested[4]	**-29** for 65/35 dilution
Octagon Octaflo EF Concentrate	**-25** for 65/35 dilution	**-33** for 65/35 dilution
Octagon Octaflo EF-80 Concentrate	**-25** for 70/30 dilution	**-33** for 70/30 dilution
Octagon Octaflo EG Concentrate	**-40.5** for 70/30 dilution	**-44** for 70/30 dilution

NOTES

1. The lowest operational use temperature (LOUT) for a given fluid is the higher 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).
   The values in this table were determined using 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.
2. 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 AS 5900 (latest version).
3. Manufacturer has not provided LOUT information at the time of this publication. Contact the fluid manufacturer or use another fluid.
4. Manufacturer has indicated fluid was not tested. Consult with the fluid manufacturer and/or airframe manufacturer for further guidance.

CAUTION

- LOUT data provided in this table is based strictly on the manufacturer's data, the end user is responsible for verifying the validity of this data. In case of discrepancies between the values in this table and the fluid manufacturer's data, use the manufacturer's data.
- Fluids supplied in concentrated form must not be used in that form and must be diluted.
- For the fluids in the table that are intended to be diluted, the LOUT is derived from a dilution that provides the lowest possible operational use temperature. For other 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.

Transport Canada Holdover Time Guidelines — Winter 2011-2012

TABLE 10 (cont.)

LOWEST OPERATIONAL USE TEMPERATURES[1] OF DE/ANTI-ICING FLUIDS (2011-2012)

Table 10-2: Type II De/Anti-Icing Fluids		
FLUID NAME	DILUTION, NEAT FLUID/WATER (VOLUME %/VOLUME %)	LOWEST OPERATIONAL USE TEMPERATURES[1] (°C) HIGH SPEED AERODYNAMIC TEST[2]
ABAX Ecowing 26	100/0	-25
	75/25	-14
	50/50	-3
Aviation Shaanxi Hi-Tech Cleanwing II	100/0	-29
	75/25	-14
	50/50	-3
Clariant Safewing MP II 1951	100/0	-28
	75/25	-14
	50/50	-3
Clariant Safewing MP II 2025 ECO	100/0	-27.5
	75/25	-14
	50/50	-3
Clariant Safewing MP II FLIGHT	100/0	-29
	75/25	-14
	50/50	-3
Kilfrost ABC-3	100/0	-27
	75/25	-14
	50/50	-3
Kilfrost ABC-2000	100/0	-28
	75/25	-14
	50/50	-3
See next page for additional Type II fluids		

NOTES

1 The lowest operational use temperature (LOUT) for a given fluid is the higher 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).
For the 75/25 and 50/50 dilutions, the holdover time table temperature band limits are posted in the cases where the manufacturer's LOUT is lower than those limits.
The values in this table were determined using 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.

2 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 AS 5900 (latest version).

CAUTION

- LOUT data provided in this table is based strictly on the manufacturer's data, the end user is responsible for verifying the validity of this data. In case of discrepancies between the values in this table and the fluid manufacturer's data, use the manufacturer's data.

TABLE 10 (cont.)

LOWEST OPERATIONAL USE TEMPERATURES[1] OF DE/ANTI-ICING FLUIDS (2011-2012)

Table 10-2: Type II De/Anti-Icing Fluids (cont.)

FLUID NAME	DILUTION, NEAT FLUID/WATER (VOLUME %/VOLUME %)	LOWEST OPERATIONAL USE TEMPERATURES[1] (°C)
		HIGH SPEED AERODYNAMIC TEST[2]
Kilfrost ABC-K Plus	100/0	-29
	75/25	-14
	50/50	-3
Newave Aerochemical FCY-2	100/0	-28
	75/25	-14
	50/50	-3
Octagon E Max II	100/0	-27
	75/25	-14
	50/50	-3

Table 10-3: Type III De/Anti-Icing Fluids

FLUID NAME	DILUTION, NEAT FLUID/WATER (VOLUME %/VOLUME %)	LOWEST OPERATIONAL USE TEMPERATURES[1] (°C)	
		LOW SPEED AERODYNAMIC TEST[2]	HIGH SPEED AERODYNAMIC TEST[2]
Clariant Safewing MP III 2031	100/0	-16.5	-29
	75/25	-9	-10
	50/50	-3	-3

NOTES

1 The lowest operational use temperature (LOUT) for a given fluid is the higher 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).
 For the 75/25 and 50/50 dilutions, the holdover time table temperature band limits are posted in the cases where the manufacturer's LOUT is lower than those limits.
 The values in this table were determined using 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.

2 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 AS 5900 (latest version).

CAUTION

- LOUT data provided in this table is based strictly on the manufacturer's data, the end user is responsible for verifying the validity of this data. In case of discrepancies between the values in this table and the fluid manufacturer's data, use the manufacturer's data.

TABLE 10 (cont.)

LOWEST OPERATIONAL USE TEMPERATURES[1] OF DE/ANTI-ICING FLUIDS (2011-2012)

Table 10-4: Type IV De/Anti-Icing Fluids		
FLUID NAME	**DILUTION, NEAT FLUID/WATER (VOLUME %/VOLUME %)**	**LOWEST OPERATIONAL USE TEMPERATURES[1] (°C)** **HIGH SPEED AERODYNAMIC TEST[2]**
ABAX AD-480	100/0	-26
	75/25	-14
	50/50	-3
ABAX Ecowing AD-49	100/0	-26
	75/25	-14
	50/50	-3
Clariant Safewing MP IV 2001	100/0	-29.5
	75/25	-14
	50/50	-3
Clariant Safewing MP IV LAUNCH	100/0	-28.5
	75/25	-14
	50/50	-3
Cryotech Polar Guard	100/0	-23.5
	75/25	-5.5
	50/50	-3
Cryotech Polar Guard Advance	100/0	-30.5
	75/25	-14
	50/50	-3
Dow UCAR™ ADF/AAF ULTRA+	100/0	-24
	75/25	Dilution Not Applicable
	50/50	Dilution Not Applicable
Dow UCAR™ Endurance EG106 De/Anti-Icing Fluid	100/0	-27
	75/25	Dilution Not Applicable
	50/50	Dilution Not Applicable
See next page for additional Type IV fluids		

NOTES

1 The lowest operational use temperature (LOUT) for a given fluid is the higher 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).
  For the 75/25 and 50/50 dilutions, the holdover time table temperature band limits are posted in the cases where the manufacturer's LOUT is lower than those limits.
  The values in this table were determined using 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.

2 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 AS 5900 (latest version).

CAUTION

- LOUT data provided in this table is based strictly on the manufacturer's data, the end user is responsible for verifying the validity of this data. In case of discrepancies between the values in this table and the fluid manufacturer's data, use the manufacturer's data.

TABLE 10 (cont.)

LOWEST OPERATIONAL USE TEMPERATURES[1] OF DE/ANTI-ICING FLUIDS (2011-2012)

Table 10-4: Type IV De/Anti-Icing Fluids (cont.)		
FLUID NAME	DILUTION, NEAT FLUID/WATER (VOLUME %/VOLUME %)	LOWEST OPERATIONAL USE TEMPERATURES[1] (°C) HIGH SPEED AERODYNAMIC TEST[2]
Dow UCAR™ FlightGuard AD-480	100/0	-26
	75/25	-14
	50/50	-3
Dow UCAR™ FlightGuard AD-49	100/0	-26
	75/25	-14
	50/50	-3
Kilfrost ABC-4[sustain]	100/0	-29
	75/25	-14
	50/50	-3
Kilfrost ABC-S	100/0	-28
	75/25	-14
	50/50	-3
Kilfrost ABC-S Plus	100/0	-28
	75/25	-14
	50/50	-3
Lyondell ARCTIC Shield™	100/0	-24.5
	75/25	-9.5
	50/50	-3
Octagon Max-Flight 04	100/0	-26.5
	75/25	-14
	50/50	-3

NOTES

1 The lowest operational use temperature (LOUT) for a given fluid is the higher 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).
  For the 75/25 and 50/50 dilutions, the holdover time table temperature band limits are posted in the cases where the manufacturer's LOUT is lower than those limits.
  The values in this table were determined using 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.

2 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 AS 5900 (latest version).

CAUTION

- LOUT data provided in this table is based strictly on the manufacturer's data, the end user is responsible for verifying the validity of this data. In case of discrepancies between the values in this table and the fluid manufacturer's data, use the manufacturer's data.

ICE PELLET ALLOWANCE TIMES FOR WINTER 2011-2012

Comprehensive ice pellet research was conducted jointly by the research teams of the FAA and Transport Canada. This research consisted of extensive climatic chamber, wind tunnel, and live aircraft testing with ice pellets (light or moderate) and light ice pellets mixed with other forms of precipitation.

Results of this research provide the basis for allowance times for operations in ice pellets (light or moderate) and operations in light ice pellets mixed with other forms of precipitation.

Additionally, Type IV anti-icing fluid with ice pellets embedded was evaluated for its aging qualities over periods of time beyond the allowance times, when the active precipitation time was limited to the allowance times.

Operational Guidelines

1) Tests have shown that ice pellets generally remain in a frozen state embedded in Type IV anti-icing fluid and are not dissolved by the fluid in the same manner as other forms of precipitation. Using current guidelines for determining anti-icing fluid failure, the presence of a contaminant not dissolved by the fluid (remaining embedded) is an indication that the fluid has failed. These embedded ice pellets are generally not readily detectable by the human eye during pre-takeoff contamination inspection procedures.

2) The research data have also shown that after proper deicing and anti-icing, the accumulation of light ice pellets, moderate ice pellets, and light ice pellets mixed with other forms of precipitation in Type IV fluid will not prevent the fluid from flowing off of the aerodynamic surfaces during takeoff.

3) The allowance times were developed based on this aerodynamic testing and are contained in Table 11.

4) Research has also shown that propylene glycol (PG) and ethylene glycol (EG) fluids behave differently under certain temperature and ice pellet precipitation conditions. Specifically, higher aircraft rotation speeds are required to effectively remove PG fluid contaminated with light or moderate ice pellets at temperatures less than -10°C. Therefore, there are no allowance times associated with the use of PG fluids on aircraft with rotation speeds of less than 115 knots in conditions of light or moderate ice pellets at temperatures below -10°C.

5) Furthermore, recent research with newer generation type airfoils has shown that the allowance times are shorter when using PG fluids under certain conditions. Since it is challenging to determine exactly which aircraft may be affected, the allowance time when using PG fluids at temperatures of -5°C and above is limited to 15 minutes in moderate ice pellets.

6) The ice pellet allowances are contingent on the operator's approved ground icing program being updated to incorporate the ice pellet information contained herein, including the following conditions and restrictions that must be satisfied:

   a) The aircraft critical surfaces must be properly deiced before the application of Type IV anti-icing fluid;

   b) The allowance time is valid only if the aircraft is anti-iced with undiluted Type IV fluid;

   c) These allowance times are applicable from the start of the Type IV anti-icing fluid application;

d) The allowance time is limited to aircraft with a rotation speed of 100 knots or greater (subject to 4) above);

e) If the takeoff is not accomplished within the applicable allowance time in Table 11, the aircraft must be completely deiced, and if precipitation is still present, anti-iced again prior to a subsequent takeoff;

f) The allowance time cannot be extended by an inspection of the aircraft critical surfaces from either inside or outside the aircraft;

g) If the temperature decreases below the temperature on which the allowance time was based, where the new lower temperature has an associated allowance time for the precipitation condition and the present time is within the new allowance time, then that new time must be used as the allowance time limit;

h) If ice pellet precipitation becomes heavier than moderate or if the light ice pellets mixed with other forms of allowable precipitation exceeds the listed intensities or temperature range, the allowance time cannot be used;

i) If the precipitation condition stops at, or before, the time limit of the applicable allowance time in Table 11 and does not restart, the aircraft may take off up to 90 minutes after the start of the application of the Type IV anti-icing fluid. However, under conditions of light ice pellets mixed with light freezing rain, the OAT must not decrease during the 90-minute period.

7) Examples:

a) Type IV anti-icing fluid is applied with a start of application time of 10:00, OAT is 0°C, light ice pellets fall until 10:20 and stop and do not restart. The allowance time stops at 10:50; however, provided that no precipitation restarts after the allowance time of 10:50; the aircraft may take off without any further action until 11:30.

b) Type IV anti-icing fluid is applied with a start of application time of 10:00, OAT is 0°C, light ice pellets mixed with freezing drizzle falls until 10:10, stops and restarts at 10:15, and stops at 10:20. The allowance time stops at 10:25; however, provided no precipitation restarts after the end of the allowance time at 10:25, the aircraft may take off without any further action until 11:30.

c) Type IV anti-icing fluid is applied with a start of application time of 10:00, OAT is 0°C, light ice pellets mixed with light freezing rain falls until 10:10, stops and restarts at 10:15, and stops at 10:20. The allowance time stops at 10:25; however, provided that the OAT remains constant or increases and no precipitation restarts after the end of the allowance time at 10:25, the aircraft may take off without any further action until 11:30.

d) On the other hand, if Type IV anti-icing fluid is applied with a start of application time of 10:00, OAT is 0°C, light ice pellets mixed with freezing drizzle falls until 10:10, stops and restarts at 10:30, with the allowance time stopping at 10:25, the aircraft may not take off, no matter how short the time or type of precipitation after 10:25, without being deiced and anti-iced if precipitation is present.

Transport Canada Holdover Time Guidelines — Winter 2011-2012

TABLE 11

ICE PELLET ALLOWANCE TIMES FOR WINTER 2011-2012

	OAT -5°C and above	OAT less than -5°C to -10°C	OAT less than -10°C
Light Ice Pellets	50 minutes	30 minutes	30 minutes[1]
Moderate Ice Pellets	25 minutes[2]	10 minutes	10 minutes[1]
Light Ice Pellets Mixed with Light or Moderate Freezing Drizzle	25 minutes	10 minutes	**Caution: No allowance times currently exist**
Light Ice Pellets Mixed with Light Freezing Rain	25 minutes	10 minutes	
Light Ice Pellets Mixed with Light Rain	25 minutes[3]		
Light Ice Pellets Mixed with Moderate Rain	25 minutes[4]		
Light Ice Pellets Mixed with Light Snow	25 minutes	15 minutes	
Light Ice Pellets Mixed with Moderate Snow	10 minutes		

NOTES

1. No allowance times exist for propylene glycol (PG) fluids, when used on aircraft with rotation speeds less than 115 knots. (For these aircraft, if the fluid type is not known, assume zero allowance time).
2. Allowance time is 15 minutes for propylene glycol (PG) fluids, or when the fluid type is unknown.
3. No allowance times exist in this condition for temperatures below 0°C; consider use of light ice pellets mixed with light freezing rain.
4. No allowance times exist in this condition for temperatures below 0°C.

Page 57 of 57 July 2011

This page intentionally left blank.

FAA
HOLDOVER TIME GUIDELINES
WINTER 2011-2012

OFFICIAL FAA HOLDOVER TIME TABLES

WINTER 2011-2012

The information contained in this document is the FAA official guidance, Holdover Tables, and Allowance Times for use the Winter 2011- 2012. The content of this document is included by reference in the FAA Winter 2011 - 2012 Update N 8900.167 that is published in FSIMS. The content of this document in conjunction with N 8900.167 should be used as the official winter 2011-2012 HOT/Allowance Times and associated guidance.

Questions concerning FAA aircraft ground de/anti-icing requirements or Flight Standards policies should be addressed to charles.j.enders@faa.gov or 202-493-1422.

Questions on the technical content of the holdover time tables should be addressed to warren.underwood@faa.gov or 404-305-7163.

Questions regarding editorial content or web access issues should be addressed to sung.shin@faa.gov or 202-267-8086

2011-2012 Holdover Times Tables 8/29/11

SUMMARY OF CHANGES FROM 2009-2010

TYPE I FLUIDS. The Type I holdover time table has been divided into two tables, Table 1 for aircraft with critical surfaces constructed predominantly of aluminum, and Table 1A for aircraft with critical surfaces constructed predominantly of composites.

The recent introduction of new aircraft constructed primarily of composite materials required a review of Type I fluid holdover time performance when used on these aircraft. This review has shown that the holdover time performance of Type I fluids on composite surfaces is reduced when compared to aluminum surfaces. As a result of extensive research and testing showing that holdover times of Type I fluids are shorter on composite surfaces than aluminum surfaces, holdover time values for composite surfaces have been developed and added to the Type I table and the Active Frost table .

The Type I fluid holdover times for composite surfaces (Table 1A) must be applied to aircraft with all critical surfaces that are predominantly or entirely constructed of composite materials. However, the Type I fluid holdover times for composite surfaces do not need to be applied to aircraft that are currently in service, have a demonstrated safe operating history using Type I fluid aluminum structure holdover times, and have critical surfaces only partially constructed of composite material. If there is any doubt, consult with the aircraft manufacturer to determine whether aluminum or composite holdover times are appropriate for the specific aircraft.

TYPE II FLUIDS. Minor increases or decreases ranging from 1 to 4 minutes have been made to all eight of the Type II fluid-specific holdover tables, and to the Type II generic holdover table due to changes made in holdover time rounding protocol.

The lower limit of the lowest temperature band for the fluid in the Type II fluid-specific holdover tables has been changed from -25 °C(13 °F) or LOUT to the actual lowest operational use temperature

TYPE III FLUIDS. The Type III fluid HOT table values are unchanged.

TYPE IV FLUIDS. A fluid-specific table has been created for a new Type IV fluid: Cryotech Polar Guard Advance. The addition of this fluid did not impact the generic holdover times.

Clariant Safewing MP IV 2012 Protect and Octagon MaxFlo have been removed from the Type IV guidelines as per the protocol for removing obsolete data. Removal of these fluids caused significant increases in twelve cells in the Type IV generic holdover table.

Minor increases or decreases ranging from 1 to 4 minutes have been made to six Type IV fluid-specific holdover tables, and to the Type IV generic holdover table due to changes made in holdover time rounding protocol. The affected tables are: Table 4 SAE Type IV fluid, the generic table, Table 4A AD-480 (ABAX), Table 4C 2001, Table 4I AD-480 (Dow), Table 4K ABC-4^{SUSTAIN}, Table 4L ABC-S, and Table 4N ARCTIC Shield.

1

The lower limit of the lowest temperature band in the Type IV fluid specific holdover tables has been changes from -25 °C (-13 °F) or LOUT to the actual lowest operational use temperature (LOUT) value for the fluid.

ACTIVE FROST HOLDOVER TIMES. The Type I fluid portion of the frost table has been separated from the Type II, III, IV fluid portion for clarity.

ICE PELLET ALLOWANCE TIMES. The Ice Pellet Alowance Time Table values are unchanged for 2011-12.

EARLY FLUID FAILURE ON EXTENDED SLATS AND FLAPS. Research has determined that fluid degradation may be accelerated by the steeper angles of the flaps/slats in the takeoff configuration. The degree of potential degradation is significantly affected by the specific aircraft design. Further research is anticipated to characterize the extent of the effect on the Holdover Times and Allowance times. The FAA advises all operators to review their policies and procedures in light of this information to assure appropriate consideration.

LOWEST OPERATIONAL USE TEMPERATURE (LOUT) TABLE. Lowest Operational Use Temperature (LOUT) information for Type I, II, III and IV fluids has been added to the holdover time guidelines. This information has been derived by the FAA based on data provided by the fluid manufacturers. The LOUT information can be found in Table 7. Contact the fluid manufacturer if further clarification with respect to the information in these tables is required. The Lowest Operational Use Temperature, or LOUT is the lowest temperature at which a de-/anti-icing fluid will adequately flow off aircraft critical surfaces and maintain the required anti-icing freezing point buffer which is 7 ºC (13 ºF) below outside air temperature (OAT) for SAE Type II, Type III, and Type IV fluids and 10 ºC (18 ºF) below (OAT) for SAE Type I fluids,

For example if a Type IV fluid has been aerodynamically tested and demonstrated adequate flow off capability down to -30 ºC (-22 ºF), and the freezing point of this fluid is -35 ºC (-31 ºF), the LOUT would be -28 ºC (-18.4 ºF) to account for the required 7 ºC (13 ºF) freezing point buffer. In this case, the freezing point buffer requirement is the LOUT limiting factor

Similarly if a Type I fluid has been found to adequately flow off down to -29 ºC (-20.2 ºF), and the freezing point is -40 ºC (-40 ºF) , the LOUT would be -29 ºC (-20.2 ºF) to account for the lowest temperature at which the fluid adequately flows off the aircraft. Here, in this example, the fluid aerodynamic flow off capability limits the LOUT.

There are two aerodynamic fluid flow-off test protocols for fluids; the low speed test is for aircraft with rotation speeds less than 100 knots and the high speed test for aircraft with rotation speeds greater than 100 knots. Type II, and Type IV fluids generally do not pass the low speed test. Therefore in order for these fluids to be used on a low rotation speed aircraft (rotation speed of 100 knots or less), the aircraft manufacturer must conduct testing to determine if these fluids can be safely applied on these aircraft and to identify operational procedures that must be implemented to insure the safe operation when these fluids have been applied.
In the case of Types II, III, and IV fluids there can be multiple LOUTs to account for the neat (100/0) and the 50/50 and 75/25 dilutions. The LOUTs for these fluids are accounted for in the

temperature bands which are an integral part of their holdover tables. If a fluid has a LOUT which is warmer than the lowest temperature in a particular band, this information will be noted on the appropriate table.

The LOUTs for Type I fluids are provided in Table 7-1 as well as the manufacturer specified fluid/ water concentration used to establish the LOUT for each fluid. This concentration should not be exceeded.

The LOUTs for undiluted Type II, Type III, and Type IV fluids (100/0) are provided in Tables 7-2 through 7-4 at the end of this document. The LOUTs for the 50/50, and 75/25 dilutions are shown in the fluid-specific holdover tables if the temperature is warmer than the lowest temperature in a given band.

As previously stated, for 2011-12 the fluid-specific LOUT data has been included in the corresponding HOTs.

STANDARDIZED INTERNATIONAL GROUND DEICING PROGRAM (SIGDP) For those air carriers participating in the SIGDP one change was agreed upon after the 2010-2011 winter revisions were made to the SIGDP. This change will be included in the 2011-2012 revision. This change addresses a concern that the air carriers have expressed over the completion of the annual audits within the anniversary month. In addition to the scheduling difficulties that this has generated, it has also necessitated that many of the audits be conducted in late summer and early fall prior to the service providers being in a full operational mode. In many cases this has limited the auditor's effectiveness and has not been conducive to the high quality audit that is fundamental to the success of the SIGDP. Therefore it was agreed upon by the member air carriers participating in the SIGDP and the FAA policy office that the grace month concept that is currently applied to the training/qualification annual requirements under the SIGDP will be also applied to the annual audit requirements. This allows a three month period in which the audit can be conducted and credited as though it was conducted in the month it was originally due. For example if the audit in 2009 was completed in September the next audit is due in September 2010. The 2010 audit can be completed in either August, September or October 2010 and credited as completed in its original due month of September 2010. The next audit will be due in September 2011 regardless of which of the three months the audit was completed in 2010. The same grace month rational will apply for the 2011 audit as well. If the recurring audit is not completed in the three month applicable period then the service provider would be considered as a new service provider under the SIGDP and an initial detailed qualification audit would need to be completed prior to any SIGDP participating air carrier utilizing their services under the SIGDP.

2011-2012 Holdover Times Tables 8/29/11

2011-2012 Holdover Times Tables 8/29/11

2011-2012 Holdover Times Tables 8/29/11

TABLE 0. FAA GUIDELINES FOR HOLDOVER TIMES IN ACTIVE FROST, SAE TYPE I, TYPE II, TYPE III, AND TYPE IV FLUIDS

Outside Air Temperature		Approximate Holdover Times (hours:minutes)
		Active Frost
Degrees Celsius	Degrees Fahrenheit	Type 1 [1, 2]
-1 and Above	30 and above	0:45 (0:35)[4]
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 -25	Below -6 to -13	

Outside Air Temperature		Concentration Neat Fluid/Water (Volume%/Volume%)	Approximate Holdover Times (hours:minutes)		
			Active Frost		
Degrees Celsius	Degrees Fahrenheit		Type II[3]	Type III[3]	Type IV[3]
-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

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER

FOOTNOTES:
1. Type I Fluid / Water Mixture is selected so that the freezing point of the mixture is at least 10°C (18°F) below outside air temperature.
2. May be used below -25°C (-13°F) provided the lowest operational use temperature (LOUT) of the fluid is not exceeded.
3. These fluids may not be used below -25°C (-13°F) in active frost conditions For Type II, III, or IV fluids with a LOUT warmer than -25°C (-13F) undiluted or -3°C (27°F) in the 50/50 dilution, or -14°C (7°F) in the 75/25 dilution, limit usage to the actual LOUT value.
4. Value in parenthesis is for composite aircraft.

CAUTION: FLUIDS USED DURING GROUND DEICING/ANTI-ICING DO NOT PROVIDE IN-FLIGHT ICING PROTECTION.

6

2011-2012 Holdover Times Tables 8/29/11

FAA TYPE I HOLDOVER TIME GUIDELINE

TABLE 1. FAA GUIDELINES FOR HOLDOVER TIMES SAE TYPE I FLUID MIXTURES ON CRITICAL AIRCRAFT SURFACES COMPOSED PREDOMINANTLY OF ALUMINUM AS A FUNCTION OF WEATHER CONDITIONS AND OUTSIDE AIR TEMPERATURE

CAUTION: THIS TABLE IS FOR DEPARTURE PLANNING ONLY AND SHOULD BE USED IN CONJUNCTION WITH PRETAKEOFF CHECK PROCEDURES.

Outside Air Temperature		Wing Surface	Approximate Holdover Times Under Various Weather Conditions (hours: minutes)							
			Freezing Fog	Snow, Snow Grains or Snow Pellets			Freezing Drizzle*	Light Freezing Rain†	Rain on Cold Soaked Wing**	Other‡
Degrees Celsius	Degrees Fahrenheit			Very Light	Light	Moderate				
-3 and above	27 and above	Aluminum	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	below 27 to 21	Aluminum	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	below 21 to 14	Aluminum	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	below 14	Aluminum	0:05-0:09	0:07-0:08	0:04-0:07	0:02-0:04				

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER.

* Use light freezing rain holdover times if positive identification of freezing drizzle is not possible
** This column is for use at temperatures above 0 degrees Celsius (32 degrees Fahrenheit) only
‡ Heavy snow, ice pellets, moderate and heavy freezing rain, hail
† Use light freezing rain holdover times in conditions of light snow mixed with light rain.

SAE Type I fluid/water mixture is selected so that the freezing point of the mixture is at least 10 °C (18 °F) below OAT.

CAUTIONS: 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 OAT.

7

2011-2012 Holdover Times Tables 8/29/11

FAA TYPE I HOLDOVER TIME GUIDELINE

TABLE 1A. FAA GUIDELINES FOR HOLDOVER TIMES SAE TYPE I FLUID MIXTURES ON AIRCRAFT CRITICAL SURFACES COMPOSED PREDOMINANTLY OF COMPOSITES AS A FUNCTION OF WEATHER CONDITIONS AND OUTSIDE AIR TEMPERATURE

CAUTION: THIS TABLE IS FOR DEPARTURE PLANNING ONLY AND SHOULD BE USED IN CONJUNCTION WITH PRETAKEOFF CHECK PROCEDURES.

Outside Air Temperature		Wing Surface	Approximate Holdover Times Under Various Weather Conditions (hours: minutes)							
Degrees Celsius	Degrees Fahrenheit		Freezing Fog	Snow, Snow Grains or Snow Pellets: Very Light	Snow, Snow Grains or Snow Pellets: Light	Snow, Snow Grains or Snow Pellets: Moderate	Freezing Drizzle*	Light Freezing Rain†	Rain on Cold Soaked Wing**	Other‡
-3 and above	27 and above	Composite	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	below 27 to 21	Composite	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	below 21 to 14	Composite	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	below 14	Composite	0:04-0:07	0:07-0:08	0:04-0:07	0:02-0:04				

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER.

* Use light freezing rain holdover times if positive identification of freezing drizzle is not possible
** This column is for use at temperatures above 0 degrees Celsius (32 degrees Fahrenheit) only
‡ Heavy snow, ice pellets, moderate and heavy freezing rain, hail
† Use light freezing rain holdover times in conditions of light snow mixed with light rain.

SAE Type I fluid/water mixture is selected so that the freezing point of the mixture is at least 10 °C (18 °F) below OAT.

CAUTIONS:

- 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 OAT.
- **SAE TYPE I** FLUID USED DURING GROUND DEICING/ANTI-ICING IS NOT INTENDED FOR AND DOES NOT PROVIDE PROTECTION DURING FLIGHT.

8

2011-2012 Holdover Times Tables 8/29/11

TABLE 1B. FAA GUIDELINES FOR THE APPLICATION OF SAE TYPE I FLUID MIXTURE MINIMUM CONCENTRATIONS AS A FUNCTION OF OUTSIDE AIR TEMPERATURE

Outside Air Temperature (OAT)	One-step Procedure Deicing/Anti-icing[1]	Two-step Procedure	
		First step: Deicing	Second step: Anti-icing [1, 2]
-3 °C (27 °F) and above	Mix of fluid and water heated to 60 °C (140 °F) minimum at the nozzle, with a freezing point of at least 10 °C (18 °F) below OAT	Heated water or a mix of fluid and water heated to 60 °C (140 °F) minimum at the nozzle	Mix of fluid and water heated to 60 °C (140 °F) minimum at the nozzle, with a freezing point of at least 10 °C (18 °F) below OAT
Below -3 °C (27 °F)		Freezing point of heated fluid mixture shall not be more than 3 °C (5 °F) above OAT	

1) Fluids must only be used at temperatures above their lowest operational use temperature (LOUT).
2) To be applied before first-step fluid freezes, typically within 3 minutes.

Notes:

- Upper temperature limit shall not exceed fluid and aircraft manufacturers' recommendations.
- To use Type I holdover time guidelines, at least 1 liter per square meter (2 gal. Per 100 square feet) fluid must be applied to the deiced surfaces.
- This table is applicable for the use of Type I Holdover Time Guidelines. If holdover times are not required, a temperature of 60 °C (140 °F) at the nozzle is desirable.
- The lowest operational use temperature (LOUT) for a given Type 1 fluid is the higher 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).

Caution: Wing skin temperatures may differ and, in some cases, be lower than OAT.
A stronger mix (more glycol) may be needed under these conditions.

9

2011-2012 Holdover Times Tables 8/29/11

TABLE 1C. SNOWFALL INTENSITIES AS A FUNCTION OF PREVAILING VISIBILITY

Time of Day	Temp. Degrees Celsius	Temp. Degrees Fahrenheit	Visibility (Statute Mile) ≥ 2 1/2	2	1 1/2	1	3/4	1/2	≤ 1/4	
Day	colder/equal -1	colder/equal 30	Very Light	Very Light	Light	Light	Moderate	Moderate	**Heavy**	Snowfall Intensity
	warmer than -1	warmer than 30	Very Light	Light	Light	Moderate	Moderate	**Heavy**	**Heavy**	
Night	colder/equal -1	colder/equal 30	Very Light	Light	Moderate	Moderate	**Heavy**	**Heavy**	**Heavy**	
	warmer than -1	warmer than 30	Very Light	Light	Moderate	**Heavy**	**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.

HEAVY = Caution—No Holdover Time Guidelines Exist

10

2011-2012 Holdover Times Tables 8/29/11

FAA TYPE II HOLDOVER TIME GUIDELINE

TABLE 2. FAA GUIDELINES FOR HOLDOVER TIMES SAE TYPE II FLUID MIXTURES AS A FUNCTION OF WEATHER CONDITIONS AND OUTSIDE AIR TEMPERATURE

CAUTION: THIS TABLE IS FOR DEPARTURE PLANNING ONLY AND SHOULD BE USED IN CONJUNCTION WITH PRETAKEOFF CHECK PROCEDURES.

Outside Air Temperature		Type II Fluid Concentration	**Approximate Holdover Times Under Various Weather Conditions (hours: minutes)**					
Degrees Celsius	Degrees Fahrenheit	Neat-Fluid/Water (Volume %/Volume %)	Freezing Fog	Snow, Snow Grains or Snow Pellets	Freezing Drizzle*	Light Freezing Rain†	Rain on Cold Soaked Wing**	Other‡
-3 and above	27 and above	100/0	0:35-1:30	0:20-0:45	0:30-0:55	0:15-0:30	0:08-0:40	
		75/25	0:25-1:00	0:15-0:30	0:20-0:45	0:10-0:25	0:05-0:25	
		50/50	0:15-0:30	0:05-0:15	0:08-0:15	0:05-0:09	CAUTION: No holdover time guidelines exist	
below -3 to -14	below 27 to 7	100/0	0:20-1:05	0:15-0:30	***0:20-0:45	***0:10-0:20		
		75/25	0:25-0:50	0:10-0:20	***0:15-0:30	***0: 08-0: 15		
Below -14 to -25 or LOUT	Below7 to -13 or LOUT	100/0	0:15-0:35	0:15-0:30				

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER.

* Use light freezing rain holdover times if positive identification of freezing drizzle is not possible
** This column is for use at temperatures above 0 °C (32 °F) only
*** No holdover time guidelines exist for this condition below -10 °C (14 °F)
‡ Heavy snow, ice pellets, moderate and heavy freezing rain, and hail
† Use light freezing rain holdover times in conditions of light snow mixed with light rain.

CAUTIONS:

- 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 OAT.
- SAE TYPE II FLUID USED DURING GROUND DEICING/ANTI-ICING IS NOT INTENDED FOR AND DOES NOT PROVIDE PROTECTION DURING FLIGHT.

2011-2012 Holdover Times Tables 8/29/11

TABLE 2A. FAA GUIDELINES FOR HOLDOVER TIMES ABAX ECOWING 26 TYPE II FLUID MIXTURES AS A FUNCTION OF WEATHER CONDITIONS AND OUTSIDE AIR TEMPERATURE

CAUTION: THIS TABLE IS FOR DEPARTURE PLANNING ONLY AND SHOULD BE USED IN CONJUNCTION WITH PRETAKEOFF CHECK PROCEDURES.

Outside Air Temperature		Manufacturer Specific Type II Fluid Concentration Neat-Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours: minutes)					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog	Snow, Snow Grains or Snow Pellets	Freezing Drizzle*	Light Freezing Rain†	Rain on Cold Soaked Wing**	Other‡
-3 and above	27 and above	100/0	1:25-2:35	0:40-1:00	0:50-1:35	0:40-0:50	0:20-1:25	
		75/25	1:05-1:55	0:25-0:45	0:45-1:05	0:25-0:35	0:10-1:00	
		50/50	0:30-0:45	0:10-0:20	0:15-0:25	0:08-0:10	CAUTION: No holdover time guidelines exist	
below -3 to -14	below 27 to 7	100/0	0:45-2:15	0:35-0:55	***0:30-1:10	***0:15-0:35		
		75/25	0:35-1:15	0:25-0:40	***0:20-0:50	***0:15-0:25		
below -14 to -25	below 7 to -13	100/0	0:25-0:45	0:15-0:30				

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER.

* Use light freezing rain holdover times if positive identification of freezing drizzle is not possible
** This column is for use at temperatures above 0 °C (32 °F) only
*** No holdover time guidelines exist for this condition below -10 °C (14 °F)
‡ Heavy snow, ice pellets, moderate and heavy freezing rain, and hail
† Use light freezing rain holdover times in conditions of light snow mixed with light rain.

CAUTIONS:

- 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 OAT.

- ABAX ECOWING 26 TYPE II FLUID USED DURING GROUND DEICING/ANTI-ICING IS NOT INTENDED FOR AND DOES NOT PROVIDE PROTECTION DURING FLIGHT.

12

2011-2012 Holdover Times Tables 8/29/11

TABLE 2B. FAA GUIDELINES FOR HOLDOVER TIMES AVIATION SHAANXI HI-TECH CLEAN WING II TYPE II FLUID MIXTURES AS A FUNCTION OF WEATHER CONDITIONS AND OUTSIDE AIR TEMPERATURE

CAUTION: THIS TABLE IS FOR DEPARTURE PLANNING ONLY AND SHOULD BE USED IN CONJUNCTION WITH PRETAKEOFF CHECK PROCEDURES

Outside Air Temperature		Manufacturer Specific Type II Fluid Concentration Neat-Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours: minutes)					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog	Snow, Snow Grains or Snow Pellets	Freezing Drizzle*	Light Freezing Rain†	Rain on Cold Soaked Wing**	Other‡
-3 and above	27 and above	100/0	0:55-1:50	0:30-0:55	0:35-1:05	0:25-0:35	0:10-0:55	CAUTION: No holdover time guidelines exist
		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		
below -3 to -14	below 27 to 7	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 -14 to -29	below 7 to -20.2	100/0	0:20-0:50	0:15-0:30				

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER.

* Use light freezing rain holdover times if positive identification of freezing drizzle is not possible
** This column is for use at temperatures above 0 °C (32 °F) only
*** No holdover time guidelines exist for this condition below -10 °C (14 °F)
‡ Heavy snow, ice pellets, moderate and heavy freezing rain, and hail
† Use light freezing rain holdover times in conditions of light snow mixed with light rain.

CAUTIONS:

- 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 OAT.
- AVIATION SHANXI HI-TECH TYPE II FLUID USED DURING GROUND DEICING/ANTI-ICING IS NOT INTENDED FOR AND DOES NOT PROVIDE PROTECTION DURING FLIGHT.

13

2011-2012 Holdover Times Tables 8/29/11

TABLE 2C. FAA GUIDELINES FOR HOLDOVER TIMES CLARIANT SAFEWING MP II 2025 ECO TYPE II FLUID MIXTURES AS A FUNCTION OF WEATHER CONDITIONS AND OUTSIDE AIR TEMPERATURE

CAUTION: THIS TABLE IS FOR DEPARTURE PLANNING ONLY AND SHOULD BE USED IN CONJUNCTION WITH PRETAKEOFF CHECK PROCEDURES.

Outside Air Temperature		Manufacturer Specific Type II Fluid Concentration Neat-Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours: minutes)					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog	Snow, Snow Grains or Snow Pellets	Freezing Drizzle*	Light Freezing Rain†	Rain on Cold Soaked Wing**	Other‡
-3 and above	27 and above	100/0	1:30-2:05	0:40-1:10	0:40-1:00	0:25-0:35	0:10-1:15	CAUTION: No holdover time guidelines exist
		75/25	0:55-1:45	0:25-0:45	0:25-0:45	0:20-0:25	0:08-0:50	
		50/50	0:20-0:35	0:09-0:15	0:10-0:15	0:07-0:10		
below -3 to -14	below 27 to 7	100/0	0:45-1:50	0:35-1:00	***0:35-1:05	***0:20-0:35		
		75/25	0:40-1:20	0:25-0:45	***0:30-0:40	***0:15-0:25		
below -14 to -27.5	below 7 to -17.5	100/0	0:25-0:45	0:15-0:30				

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER.

* Use light freezing rain holdover times if positive identification of freezing drizzle is not possible
** This column is for use at temperatures above 0 °C (32 °F) only
*** No holdover time guidelines exist for this condition below -10 °C (14 °F)
‡ Heavy snow, ice pellets, moderate and heavy freezing rain, and hail
† Use light freezing rain holdover times in conditions of light snow mixed with light rain.

CAUTIONS:

- 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 OAT.

- CLARIANT SAFEWING MP II 2025 ECO TYPE II FLUID USED DURING GROUND DEICING/ANTI-ICING IS NOT INTENDED FOR AND DOES NOT PROVIDE PROTECTION DURING FLIGHT.

14

2011-2012 Holdover Times Tables 8/29/11

TABLE 2D. FAA GUIDELINES FOR HOLDOVER TIMES CLARIANT SAFEWING MP II FLIGHT TYPE II FLUID MIXTURES AS A FUNCTION OF WEATHER CONDITIONS AND OUTSIDE AIR TEMPERATURE

CAUTION: THIS TABLE IS FOR DEPARTURE PLANNING ONLY AND SHOULD BE USED IN CONJUNCTION WITH PRETAKEOFF CHECK PROCEDURES.

Outside Air Temperature		Manufacturer Specific Type II Fluid Concentration Neat-Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours: minutes)					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog	Snow, Snow Grains or Snow Pellets	Freezing Drizzle*	Light Freezing Rain†	Rain on Cold Soaked Wing**	Other‡
-3 and above	27 and above	100/0	3:30-4:00	1:00-1:35	1:20-2:00	0:45-1:25	0:10-1:30	CAUTION: No holdover time guidelines exist
		75/25	1:50-2:45	0:40-1:20	1:10-1:30	0:30-0:55	0:06-0:50	
		50/50	0:55-1:45	0:10-0:25	0:20-0:30	0:10-0:15		
below -3 to -14	below 27 to 7	100/0	0:55-1:45	0:40-1:05	***0:35-1:30	***0:25-0:45		
		75/25	0:25-1:05	0:20-0:40	***0:25-1:10	***0:20-0:35		
Below -14 to -29	Below 7 to -20.2	100/0	0:30-0:50	0:15-0:30				

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER.

* Use light freezing rain holdover times if positive identification of freezing drizzle is not possible
** This column is for use at temperatures above 0 °C (32 °F) only
*** No holdover time guidelines exist for this condition below -10 °C (14 °F)
‡ Heavy snow, ice pellets, moderate and heavy freezing rain, and hail
†Use light freezing rain holdover times in conditions of light snow mixed with light rain.

CAUTIONS:

- 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 OAT
- CLARIANT SAFEWING MPII FLIGHT TYPE II FLUID USED DURING GROUND DEICING/ANTI-ICING IS NOT INTENDED FOR AND DOES NOT PROVIDE PROTECTION DURING FLIGHT.

15

2011-2012 Holdover Times Tables 8/29/11

TABLE 2E. FAA GUIDELINES FOR HOLDOVER TIMES KILFROST ABC-2000 TYPE II FLUID MIXTURES AS A FUNCTION OF WEATHER CONDITIONS AND OUTSIDE AIR TEMPERATURE

CAUTION: THIS TABLE IS FOR DEPARTURE PLANNING ONLY AND SHOULD BE USED IN CONJUNCTION WITH PRETAKEOFF CHECK PROCEDURES.

Outside Air Temperature		Manufacturer Specific Type II Fluid Concentration Neat-Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours: minutes)					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog	Snow, Snow Grains or Snow Pellets	Freezing Drizzle*	Light Freezing Rain†	Rain on Cold Soaked Wing**	Other‡
-3 and above	27 and above	100/0	1:30-3:05	0:30-1:00	0:55-1:35	0:40-0:50	0:15-1:10	CAUTION: No holdover time guidelines exist
		75/25	1:40-3:30	0:30-1:05	0:45-1:15	0:40-0:50	0:15-1:40	
		50/50	1:00-2:10	0:15-0:30	0:15-0:25	0:08-0:15		
below -3 to -14	below 27 to 7	100/0	0:35-1:25	0:25-0:45	***0:25-0:50	***0:10-0:30		
		75/25	0:35-1:15	0:25-0:50	***0:25-0:55	***0:15-0:30		
Below -14 to -28	Below 7 to -18.4	100/0	0:20-0:45	0:15-0:30				

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER.

* Use light freezing rain holdover times if positive identification of freezing drizzle is not possible
** This column is for use at temperatures above 0 degrees Celsius (32 degrees Fahrenheit) only
*** No holdover time guidelines exist for this condition below -10 °C (14 °F)
‡ Heavy snow, ice pellets, moderate and heavy freezing rain, and hail
† Use light freezing rain holdover times in conditions of light snow mixed with light rain.

CAUTIONS:

- 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 OAT.

- KILFROST ABC-2000 TYPE II FLUID USED DURING GROUND DEICING/ANTI-ICING IS NOT INTENDED FOR AND DOES NOT PROVIDE PROTECTION DURING FLIGHT.

16

2011-2012 Holdover Times Tables 8/29/11

TABLE 2F. FAA GUIDELINES FOR HOLDOVER TIMES KILFROST ABC-K PLUS TYPE II FLUID MIXTURES AS A FUNCTION OF WEATHER CONDITIONS AND OUTSIDE AIR TEMPERATURE

CAUTION: THIS TABLE IS FOR DEPARTURE PLANNING ONLY AND SHOULD BE USED IN CONJUNCTION WITH PRETAKEOFF CHECK PROCEDURES.

Outside Air Temperature		Manufacturer Specific Type II Fluid Concentration Neat-Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours: minutes)					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog	Snow, Snow Grains or Snow Pellets	Freezing Drizzle*	Light Freezing Rain†	Rain on Cold Soaked Wing**	Other‡
-3 and above	27 and above	100/0	2:15-3:45	1:00-1:40	1:50-2:00	1:00-1:25	0:20-2:00	CAUTION: No holdover time guidelines exist
		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	0:05-0:15	0:20-0:30	0:10-0:15		
below -3 to -14	below 27 to 7	100/0	0:30-1:05	0:50-1:25	***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 -14 to -29	below 7 to -20.2	100/0	0:30-0:55	0:15-0:30				

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER.

* Use light freezing rain holdover times if positive identification of freezing drizzle is not possible
** This column is for use at temperatures above 0 degrees Celsius (32 degrees Fahrenheit) only
*** No holdover time guidelines exist for this condition below -10 °C (14 °F)
‡ Heavy snow, ice pellets, moderate and heavy freezing rain, and hail
† Use light freezing rain holdover times in conditions of light snow mixed with light rain.

CAUTIONS:

- 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 OAT.
- KILFROST ABC-K PLUS TYPE II FLUID USED DURING GROUND DEICING/ANTI-ICING IS NOT INTENDED FOR AND DOES NOT PROVIDE PROTECTION DURING FLIGHT

17

2011-2012 Holdover Times Tables 8/29/11

TABLE 2G. FAA GUIDELINES FOR HOLDOVER TIMES NEWAVE AEROCHEMICAL FCY-2 TYPE II MIXTURES AS A FUNCTION OF WEATHER CONDITIONS AND OUTSIDE AIR TEMPERATURE

CAUTION: THIS TABLE IS FOR DEPARTURE PLANNING ONLY AND SHOULD BE USED IN CONJUNCTION WITH PRETAKEOFF CHECK PROCEDURES.

Outside Air Temperature		Manufacturer Specific Type II Fluid Concentration Neat-Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours: minutes)					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog	Snow, Snow Grains or Snow Pellets	Freezing Drizzle*	Light Freezing Rain†	Rain on Cold Soaked Wing**	Other‡
-3 and above	27 and above	100/0	1:15-2:25	0:30-0:55	0:35-1:05	0:25-0:35	0:08-0:45	CAUTION: No holdover time guidelines exist
		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		
below -3 to -14	below 27 to 7	100/0	0:45-1:30	0:15-0:30	***0:20-0:45	***0:15-0:20		
		75/25	0:30-1:05	0:10-0:20	***0:15-0:30	***0:08-0:15		
below -14 to -28	below 7 to -18.4	100/0	0:25-0:35	0:15-0:30				

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER.

* Use light freezing rain holdover times if positive identification of freezing drizzle is not possible
** This column is for use at temperatures above 0 °C (32 °F) only
*** No holdover time guidelines exist for this condition below -10 °C (14 °F)
‡ Heavy snow, ice pellets, moderate and heavy freezing rain, and hail
† Use light freezing rain holdover times in conditions of light snow mixed with light rain.

CAUTIONS:

- 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 OAT.

- NEWAVE AEROCHEMICAL FCY-2 TYPE II FLUID USED DURING GROUND DEICING/ANTI-ICING IS NOT INTENDED FOR AND DOES NOT PROVIDE PROTECTION DURING FLIGHT.

18

2011-2012 Holdover Times Tables 8/29/11

TABLE 2H. FAA GUIDELINES FOR HOLDOVER TIMES OCTAGON E-MAX TYPE II FLUID MIXTURES AS A FUNCTION OF WEATHER CONDITIONS AND OUTSIDE AIR TEMPERATURE

CAUTION: THIS TABLE IS FOR DEPARTURE PLANNING ONLY AND SHOULD BE USED IN CONJUNCTION WITH PRETAKEOFF CHECK PROCEDURES.

Outside Air Temperature		Manufacturer Specific Type II Fluid Concentration Neat-Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours: minutes)					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog	Snow, Snow Grains or Snow Pellets	Freezing Drizzle*	Light Freezing Rain†	Rain on Cold Soaked Wing**	Other‡
-3 and above	27 and above	100/0	2:05-3:45	0:40-1:20	0:45-1:35	0:30-0:40	0:15-1:30	CAUTION: No holdover time guidelines exist
		75/25	1:25-2:50	0:25-0:55	0:40-1:10	0:20-0:30	0:10-1:05	
		50/50	0:30-0:55	0:10-0:25	0:15-0:30	0:09-0:15		
below -3 to -14	below 27 to 7	100/0	0:50-1:45	0:35-1:10	***0:35-1:00	***0:20-0:30		
		75/25	0:30-1:20	0:25-0:50	***0:35-1:05	***0:15-0:30		
below -14 TO -27	below 7 to -16.6	100/0	0:20-0:35	0:15-0:30				

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER.

* Use light freezing rain holdover times if positive identification of freezing drizzle is not possible
** This column is for use at temperatures above 0 °C (32 °F) only
*** No holdover time guidelines exist for this condition below -10 °C (14 °F)
‡Heavy snow, ice pellets, moderate and heavy freezing rain, and hail
† Use light freezing rain holdover times in conditions of light snow mixed with light rain.

CAUTIONS:

- 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 OAT.

- OCTAGON E-MAX TYPE II FLUID USED DURING GROUND DEICING/ANTI-ICING IS NOT INTENDED FOR AND DOES NOT PROVIDE PROTECTION DURING FLIGHT.

19

2011-2012 Holdover Times Tables 8/29/11

FAA TYPE III HOLDOVER TIME GUIDELINE

TABLE 3. FAA GUIDELINES FOR HOLDOVER TIMES SAE TYPE III FLUID MIXTURE AS A FUNCTION OF WEATHER CONDITIONS AND OUTSIDE AIR TEMPERATURE

CAUTION: THIS TABLE IS FOR DEPARTURE PLANNING ONLY AND SHOULD BE USED IN CONJUNCTION WITH PRETAKEOFF CHECK PROCEDURES.

Outside Air Temperature		Approximate Holdover Times Under Various Weather Conditions (hours: minutes)								
Degrees Celsius	**Degrees Fahrenheit**	**Type III Fluid Concentration Neat Fluid/Water** (Volume %/Volume %)	**Freezing Fog**	**Snow, Snow Grains or Snow Pellets**			**Freezing Drizzle***	**Light Freezing Rain†**	**Rain on Cold Soaked Wing****	**Other‡**
				Very Light	**Light**	**Moderate**				
-3 and above	27 and above	100/0	0:20 - 0:40	0:35 - 0:40	0:20 - 0:35	0:10 - 0:20	0:10 - 0:20	0:08 - 0:10	0:06 - 0:20	
		75/25	0:15 - 0:30	0:25 - 0:35	0:15 - 0:25	0:08 - 0:15	0:08 - 0:15	0:06 - 0:10	0:02 - 0:10	
		50/50	0:10 - 0:20	0:15 - 0:20	0:08 - 0:15	0:04 - 0:08	0:05 - 0:09	0:04 - 0:06		
below -3 to -10	below 27 to 14	100/0	0:20 - 0:40	0:30 - 0:35	0:15 - 0:30	0:09 - 0:15	0:10 - 0:20	0:08 - 0:10	CAUTION: No holdover time guidelines exist	
		***75/25	0:15 - 0:30	0:25 - 0:30	0:10 - 0:25	0:07 - 0:10	0:09 - 0:12	0:06 - 0:09		
below -10	below 14	100/0	0:20 - 0:40	0:30 - 0:35	0:15 - 0:30	0:08 - 0:15				

SAE Type III fluid may be used below -10 °C (14 °F), provided the freezing point of the fluid is at least 7 °C (13 °F) below OAT and aerodynamic acceptance criteria (LOUT) are met. For the currently available Type III product, the High Speed LOUT is -29 °C (-20.2 °F) and the Low Speed LOUT is -16.5 °C (2.3 °F). Consider the use of **SAE Type I** when **Type III** fluid cannot be used.

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER.

* Use light freezing rain holdover times if positive identification of freezing drizzle is not possible

**This column is for use at temperatures above 0 °C (32 °F) only

***For aircraft with rotation speeds less than 100 knots, these holdover times only apply to outside air temperatures of -9°C (15.8°F) and above

‡ Heavy snow, ice pellets, moderate and heavy freezing rain, and hail

† Use light freezing rain holdover times in conditions of light snow mixed with light rain.

CAUTIONS:

- THE TIME OF PROTECTION WILL BE SHORTENED IN HEAVY WEATHER CONDITIONS. HEAVY PRECIPITATION RATES OR HIGH MOISTURE CONTENT, HIGH WIND VELOCITY, OR JET BLAST WILL REDUCE HOLDOVER TIME BELOW THE LOWEST TIME STATED IN THE RANGE. HOLDOVER TIME MAY BE REDUCED WHEN AIRCRAFT SKIN TEMPERATURE IS LOWER THAN OAT.
- SAE TYPE III FLUID USED DURING GROUND DEICING/ANTI-ICING IS NOT INTENDED FOR AND DOES NOT PROVIDE PROTECTION DURING FLIGHT.

20

2011-2012 Holdover Times Tables 8/29/11

FAA TYPE IV HOLDOVER TIME GUIDELINES

TABLE 4. FAA GUIDELINES FOR HOLDOVER TIMES SAE TYPE IV FLUID MIXTURES AS A FUNCTION OF WEATHER CONDITIONS AND OUTSIDE AIR TEMPERATURE

CAUTION: THIS TABLE IS FOR DEPARTURE PLANNING ONLY AND SHOULD BE USED IN CONJUNCTION WITH PRETAKEOFF CHECK PROCEDURES.

Outside Air Temperature		Type IV Fluid Concentration Neat-Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours: minutes)					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog	Snow, Snow Grains or Snow Pellets	Freezing Drizzle*	Light Freezing Rain†	Rain on Cold Soaked Wing**	Other‡
-3 and above	27 and above	100/0	1:20-3:10	0:35-1:15	0:45-1:30	0:25-0:40	0:10-1:15	CAUTION: No holdover time guidelines exist
		75/25	1:00-1:45	0:30-0:55	0:35-1:05	0:25-0:35	0:09-0:50	
		50/50	0:15-0:35	0:07-0:15	0:10-0:20	0:07-0:10		
below -3 to -14	below 27 to 7	100/0	0:20-1:20	0:25-0:50	***0:20-1:00	***0:10-0:25		
		75/25♦	0:25-0:50	0:20-0:35	***0:15-1:00	***0:10-0:25		
below -14 to -25 or LOUT	below 7 to -13 or LOUT	100/0♦♦	0:15-0:40	0:15-0:30				

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER.

* Use light freezing rain holdover times if positive identification of freezing drizzle is not possible
** This column is for use at temperatures above 0 °C (32 °F) only
*** No holdover time guidelines exist for this condition below -10 °C (14 °F)
‡ Heavy snow, ice pellets, moderate and heavy freezing rain, and hail
† Use light freezing rain holdover times in conditions of light snow mixed with light rain.
♦ For Lyondell Arctic Shield temperature is limited to -9.5 ºC (15 ºF); for Cryotech Polar Guard temperature is limited to -5.5 ºC (22 ºF).
♦♦ For Cryotech Polar Guard, temperature is limited to -23.5 ºC (-10.3 ºF); for Dow Ultra+ temperature is limited to -24 ºC (-11.2 ºF) and for Lyondell Arctic Shield temperature limited to -24.5 ºC (-12.1 ºF). If the fluid-specific brand is unknown, all of the temperature limitations in this and the preceding note apply.

CAUTIONS:

- 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 OAT.
- SAE TYPE IV FLUID USED DURING GROUND DEICING/ANTI-ICING IS NOT INTENDED FOR AND DOES NOT PROVIDE PROTECTION DURING FLIGHT.

21

2011-2012 Holdover Times Tables 8/29/11

TABLE 4A. FAA GUIDELINES FOR HOLDOVER TIMES ABAX AD-480 TYPE IV FLUID MIXTURES AS A FUNCTION OF WEATHER CONDITIONS AND OUTSIDE AIR TEMPERATURE

CAUTION: THIS TABLE IS FOR DEPARTURE PLANNING ONLY AND SHOULD BE USED IN CONJUNCTION WITH PRETAKEOFF CHECK PROCEDURES.

Outside Air Temperature		Manufacturer Specific Type IV Fluid Concentration Neat-Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours: minutes)					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog	Snow, Snow Grains or Snow Pellets	Freezing Drizzle*	Light Freezing Rain†	Rain on Cold Soaked Wing**	Other‡
-3 and above	27 and above	100/0	2:00-3:30	0:40-1:20	0:50-1:30	0:35-0:55	0:15-1:35	CAUTION: No holdover time guidelines exist
		75/25	1:30-2:45	0:30-1:05	0:50-1:15	0:30-0:45	0:10-1:15	
		50/50	0:30-0:45	0:09-0:20	0:15-0:25	0:09-0:15		
below -3 to -14	below 27 to 7	100/0	0:20-1:20	0:30-0:55	***0:25-1:20	***0:15-0:30		
		75/25	0:25-0:50	0:20-0:45	***0:25-1:05	***0:15-0:30		
below -14 to -26	below 7 to -14.8	100/0	0:15-0:40	0:15-0:30				

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER.

* Use light freezing rain holdover times if positive identification of freezing drizzle is not possible
** This column is for use at temperatures above 0 degrees Celsius (32 degrees Fahrenheit) only
*** No holdover time guidelines exist for this condition below -10 °C (14 °F)
‡ Heavy snow, ice pellets, moderate and heavy freezing rain, and hail
† Use light freezing rain holdover times in conditions of light snow mixed with light rain.

CAUTIONS:

- 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 OAT.
- ABAX AD-480 TYPE IV FLUID USED DURING GROUND DEICING/ANTI-ICING IS NOT INTENDED FOR AND DOES NOT PROVIDE PROTECTION DURING FLIGHT.

22

2011-2012 Holdover Times Tables 8/29/11

TABLE 4B. FAA GUIDELINES FOR HOLDOVER TIMES ABAX ECOWING AD-49 TYPE IV FLUID MIXTURES AS A FUNCTION OF WEATHER CONDITIONS AND OUTSIDE AIR TEMPERATURE

CAUTION: THIS TABLE IS FOR DEPARTURE PLANNING ONLY AND SHOULD BE USED IN CONJUNCTION WITH PRETAKEOFF CHECK PROCEDURES.

Outside Air Temperature		Manufacturer Specific Type IV Fluid Concentration Neat-Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours: minutes)					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog	Snow, Snow Grains or Snow Pellets	Freezing Drizzle*	Light Freezing Rain†	Rain on Cold Soaked Wing**	Other‡
-3 and above	27 and above	100/0	3:20-4:00	1:10-1:50	1:25-2:00	1:00-1:25	0:10-1:55	CAUTION: No holdover time guidelines exist
		75/25	2:25-4:00	1:20-1:40	1:55-2:00	0:50-1:30	0:10-1:40	
		50/50	0:25-0:50	0:15-0:25	0:15-0:30	0:10-0:15		
below -3 to -14	below 27 to 7	100/0	0:20-1:35	1:10-1:50	***0:25-1:25	***0:20-0:25		
		75/25	0:30-1:10	1:20-1:40	***0:15-1:05	***0:15-0:25		
below -14 to -26	below 7 to -14.8	100/0	0:25-0:40	0:15-0:30				

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER.

* Use light freezing rain holdover times if positive identification of freezing drizzle is not possible
** This column is for use at temperatures above 0 °C (32 °F) only
*** No holdover time guidelines exist for this condition below -10 °C (14 °F)
‡ Heavy snow, ice pellets, moderate and heavy freezing rain, and hail
† Use light freezing rain holdover times in conditions of light snow mixed with light rain.

CAUTIONS:

- 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 OAT.

- ABAX ECOWING AD-49 TYPE IV FLUID USED DURING GROUND DEICING/ANTI-ICING IS NOT INTENDED FOR AND DOES NOT PROVIDE PROTECTION DURING FLIGHT.

23

2011-2012 Holdover Times Tables 8/29/11

TABLE 4C. FAA GUIDELINES FOR HOLDOVER TIMES CLARIANT SAFEWING MP IV 2001 TYPE IV FLUID MIXTURES AS A FUNCTION OF WEATHER CONDITIONS AND OUTSIDE AIR TEMPERATURE

CAUTION: THIS TABLE IS FOR DEPARTURE PLANNING ONLY AND SHOULD BE USED IN CONJUNCTION WITH PRETAKEOFF CHECK PROCEDURES.

Outside Air Temperature		Manufacturer Specific Type IV Fluid Concentration Neat-Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours: minutes)					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog	Snow, Snow Grains or Snow Pellets	Freezing Drizzle*	Light Freezing Rain†	Rain on Cold Soaked Wing**	Other‡
-3 and above	27 and above	100/0	1:20-3:20	1:00-1:55	0:55-1:55	0:40-1:00	0:15-2:00	CAUTION: No holdover time guidelines exist
		75/25	1:20-2:00	0:35-1:00	0:35-1:10	0:25-0:35	0:10-1:25	
		50/50	0:15-0:40	0:10-0:20	0:10-0:20	0:08-0:15		
below -3 to -14	below 27 to 7	100/0	0:45-1:35	0:30-0:50	***0:55-1:35	***0:30-0:45		
		75/25	0:30-1:00	0:20-0:35	***0:40-1:10	***0:20-0:30		
below -14 to -29.5	Below 7 to -21.1	100/0	0:20-0:45	0:15-0:30				

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER.

* Use light freezing rain holdover times if positive identification of freezing drizzle is not possible
** This column is for use at temperatures above 0 °C (32 °F) only
*** No holdover time guidelines exist for this condition below -10 °C (14 °F)
‡ Heavy snow, ice pellets, moderate and heavy freezing rain, and hail
† Use light freezing rain holdover times in conditions of light snow mixed with light rain.

CAUTIONS:

- 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 OAT.

- CLARIANT SAFEWING MP IV 2001 TYPE IV FLUID USED DURING GROUND DEICING/ANTI-ICING IS NOT INTENDED FOR AND DOES NOT PROVIDE PROTECTION DURING FLIGHT.

24

2011-2012 Holdover Times Tables 8/29/11

TABLE 4D. FAA GUIDELINES FOR HOLDOVER TIMES CLARIANT SAFEWING MP IV LAUNCH TYPE IV FLUID MIXTURES AS A FUNCTION OF WEATHER CONDITIONS AND OUTSIDE AIR TEMPERATURE

CAUTION: THIS TABLE IS FOR DEPARTURE PLANNING ONLY AND SHOULD BE USED IN CONJUNCTION WITH PRETAKEOFF CHECK PROCEDURES.

Outside Air Temperature		Manufacturer Specific Type IV Fluid Concentration Neat-Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours: minutes)					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog	Snow, Snow Grains or Snow Pellets	Freezing Drizzle*	Light Freezing Rain†	Rain on Cold Soaked Wing**	Other‡
-3 and above	27 and above	100/0	4:00-4:00	1:05-1:45	1:30-2:00	1:00-1:40	0:15-1:40	CAUTION: No holdover time guidelines exist
		75/25	3:40-4:00	1:00-1:45	1:40-2:00	0:45-1:15	0:10-1:45	
		50/50	1:25-2:45	0:25-0:45	0:30-0:50	0:20-0:25		
below -3 to -14	below 27 to 7	100/0	1:00-1:55	0:50-1:20	***0:35-1:40	***0:25-0:45		
		75/25	0:40-1:20	0:45-1:25	***0:25-1:10	***0:25-0:45		
below -14 to -28.5	below 7 to -19.3	100/0	0:30-0:50	0:15-0:30				

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER.

* Use light freezing rain holdover times if positive identification of freezing drizzle is not possible
** This column is for use at temperatures above 0 °C (32 °F) only
*** No holdover time guidelines exist for this condition below -10 °C (14 °F)
‡ Heavy snow, ice pellets, moderate and heavy freezing rain, and hail
† Use light freezing rain holdover times in conditions of light snow mixed with light rain.

CAUTIONS:

- 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 OAT.
- CLARIANT SAFEWING MP IV LAUNCH TYPE IV FLUID USED DURING GROUND DEICING/ANTI-ICING IS NOT INTENDED FOR AND DOES NOT PROVIDE PROTECTION DURING FLIGHT.

25

2011-2012 Holdover Times Tables 8/29/11

TABLE 4E. FAA GUIDELINES FOR HOLDOVER TIMES CRYOTECH POLAR GUARD TYPE IV FLUID MIXTURES AS A FUNCTION OF WEATHER CONDITIONS AND OUTSIDE AIR TEMPERATURE

CAUTION: THIS TABLE IS FOR DEPARTURE PLANNING ONLY AND SHOULD BE USED IN CONJUNCTION WITH PRETAKEOFF CHECK PROCEDURES.

Outside Air Temperature		Manufacturer Specific Type IV Fluid Concentration Neat-Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours: minutes)					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog	Snow, Snow Grains or Snow Pellets	Freezing Drizzle*	Light Freezing Rain†	Rain on Cold Soaked Wing**	Other‡
-3 and above	27 and above	100/0	2:15-3:30	0:50-1:30	1:15-2:00	0:50-1:15	0:15-1:25	CAUTION: No holdover time guidelines exist
		75/25	1:40-2:40	0:35-1:10	1:05-1:25	0:35-1:00	0:10-1:15	
		50/50	0:25-0:40	0:10-0:15	0:15-0:25	0:10-0:15		
below -3 to -14	below 27 to 7	100/0	0:45-1:45	0:30-0:55	***0:25-1:10	***0:15-0:35		
		75/25◆	0:35-1: 30◆	0:20-0:40◆	0:25-1:05◆	0:20-0:30◆		
Below -14 to -23.5	Below 7 to -10.3	100/0	0:20-0:40	0:15-0:30				

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER.

* Use light freezing rain holdover times if positive identification of freezing drizzle is not possible
** This column is for use at temperatures above 0 °C (32 °F) only
*** No holdover time guidelines exist for this condition below -10 °C (14 °F)
‡ Heavy snow, ice pellets, moderate and heavy freezing rain, and hail
† Use light freezing rain holdover times in conditions of light snow mixed with light rain.
◆ Temperature is limited to -5.5 ºC (22 ºF) when using 75/25 dilution of this fluid.

CAUTIONS:

- 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 OAT.

- CRYOTECH POLAR GUARD TYPE IV FLUID USED DURING GROUND DEICING/ANTI-ICING IS NOT INTENDED FOR AND DOES NOT PROVIDE PROTECTION DURING FLIGHT.

26

2011-2012 Holdover Times Tables 8/29/11

TABLE 4F. FAA GUIDELINES FOR HOLDOVER TIMES CRYOTECH POLAR GUARD ADVANCE TYPE IV FLUID MIXTURES AS A FUNCTION OF WEATHER CONDITIONS AND OUTSIDE AIR TEMPERATURE

CAUTION: THIS TABLE IS FOR DEPARTURE PLANNING ONLY AND SHOULD BE USED IN CONJUNCTION WITH PRETAKEOFF CHECK PROCEDURES.

Outside Air Temperature		Manufacturer Specific Type IV Fluid Concentration Neat-Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours: minutes)					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog	Snow, Snow Grains or Snow Pellets	Freezing Drizzle*	Light Freezing Rain†	Rain on Cold Soaked Wing**	Other‡
-3 and above	27 and above	100/0	2:50-4:00	1:20-1:50	1:35-2:00	1:15-1:30	0:15-2:00	CAUTION: No holdover time guidelines exist
		75/25	2:30-4:00	0:45-1:20	1:40-2:00	0:40-1:10	0:09-1:40	
		50/50	0:50-1:25	0:15-0:35	0:20-0:45	0:09-0:20		
below -3 to -14	below 27 to 7	100/0	0:55-2:30	0:55-1:15	***0:35-1:35	***0:35-0:45		
		75/25	0:40-1: 30	0:35-1:00	0:25-1:05	0:35-0:45		
Below -14 to -30.5	Below 7 to -22.9	100/0	0:25-0:50	0:15-0:30				

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER.

* Use light freezing rain holdover times if positive identification of freezing drizzle is not possible
** This column is for use at temperatures above 0 °C (32 °F) only
*** No holdover time guidelines exist for this condition below -10 °C (14 °F)
‡ Heavy snow, ice pellets, moderate and heavy freezing rain, and hail
† Use light freezing rain holdover times in conditions of light snow mixed with light rain.

CAUTIONS:

- 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 OAT.

- CRYOTECH POLAR GUARD TYPE IV FLUID USED DURING GROUND DEICING/ANTI-ICING IS NOT INTENDED FOR AND DOES NOT PROVIDE PROTECTION DURING FLIGHT.

27

2011-2012 Holdover Times Tables 8/29/11

TABLE 4G. GUIDELINES FOR HOLDOVER TIMES DOW UCAR™ ULTRA+ ADF/AAF TYPE IV FLUID MIXTURES AS A FUNCTION OF WEATHER CONDITIONS AND OUTSIDE AIR TEMPERATURE

CAUTION: THIS TABLE IS FOR DEPARTURE PLANNING ONLY AND SHOULD BE USED IN CONJUNCTION WITH PRETAKEOFF CHECK PROCEDURES.

Outside Air Temperature		Manufacturer Specific Type IV Fluid Concentration Neat-Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours: minutes)					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog	Snow, Snow Grains or Snow Pellets	Freezing Drizzle*	Light Freezing Rain†	Rain on Cold Soaked Wing**	Other‡
-3 and above	27 and above	100/0	1:35-3:35	0:35-1:15	0:45-1:35	0:25-0:40	0:10-1:20	CAUTION: No holdover time guidelines exist
		75/25	N/A	N/A	N/A	N/A		
		50/50	N/A	N/A	N/A	N/A		
below -3 to -14	below 27 to 7	100/0	1:25-3:00	0:25-0:55	***0:45-1:25	***0:30-0:45		
		75/25	N/A	N/A	N/A	N/A		
Below -14 to -24	Below 7 to -11.2	100/0	0:40-2:10	0:20-0:45				

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER.

* Use light freezing rain holdover times if positive identification of freezing drizzle is not possible
** This column is for use at temperatures above 0 °C (32 °F) only
*** No holdover time guidelines exist for this condition below -10 °C (14 °F)
‡ Heavy snow, ice pellets, moderate and heavy freezing rain, and hail
† Use light freezing rain holdover times in conditions of light snow mixed with light rain.

CAUTIONS:

- 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 OAT.

- DOW UCAR ULTRA+ ADF/AAF TYPE IV FLUID USED DURING GROUND DEICING/ANTI-ICING IS NOT INTENDED FOR AND DOES NOT PROVIDE PROTECTION DURING FLIGHT.

28

2011-2012 Holdover Times Tables 8/29/11

TABLE 4H. FAA GUIDELINES FOR HOLDOVER TIMES DOW UCAR™ ENDURANCE EG106 TYPE IV FLUID MIXTURES AS A FUNCTION OF WEATHER CONDITIONS AND OUTSIDE AIR TEMPERATURE

CAUTION: THIS TABLE IS FOR DEPARTURE PLANNING ONLY AND SHOULD BE USED IN CONJUNCTION WITH PRETAKEOFF CHECK PROCEDURES.

Outside Air Temperature		Manufacturer Specific Type IV Fluid Concentration Neat-Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours: minutes)					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog	Snow, Snow Grains or Snow Pellets	Freezing Drizzle*	Light Freezing Rain†	Rain on Cold Soaked Wing**	Other‡
-3 and above	27 and above	100/0	2:05-3:10	0:40-1:20	1:10-2:00	0:50-1:15	0:20-2:00	CAUTION: No holdover time guidelines exist
		75/25	N/A	N/A	N/A	N/A		
		50/50	N/A	N/A	N/A	N/A		
below -3 to -14	below 27 to 7	100/0	1:50-3:20	0:30-1:05	***0:55-1:50	***0:45-1:10		
		75/25	N/A	N/A	N/A	N/A		
below -14 to -27	below 7 to -16.6	100/0	0:30-1:05	0:15-0:30				

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER.

* Use light freezing rain holdover times if positive identification of freezing drizzle is not possible
** This column is for use at temperatures above 0 degrees Celsius (32 degrees Fahrenheit) only
*** No holdover time guidelines exist for this condition below -10 °C (14 °F)
‡ Heavy snow, ice pellets, moderate and heavy freezing rain, and hail
† Use light freezing rain holdover times in conditions of light snow mixed with light rain.

CAUTIONS:

- 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 OAT.

- DOW UCAR ENDURANCE EG106 TYPE IV FLUID USED DURING GROUND DEICING/ANTI-ICING IS NOT INTENDED FOR AND DOES NOT PROVIDE PROTECTION DURING FLIGHT.

29

2011-2012 Holdover Times Tables 8/29/11

TABLE 4I. FAA GUIDELINES FOR HOLDOVER TIMES DOW UCAR™ FLIGHTGUARD AD-480 TYPE IV FLUID MIXTURES AS A FUNCTION OF WEATHER CONDITIONS AND OUTSIDE AIR TEMPERATURE

CAUTION: THIS TABLE IS FOR DEPARTURE PLANNING ONLY AND SHOULD BE USED IN CONJUNCTION WITH PRETAKEOFF CHECK PROCEDURES.

Outside Air Temperature		Manufacturer Specific Type IV Fluid Concentration Neat-Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours: minutes)					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog	Snow, Snow Grains or Snow Pellets	Freezing Drizzle*	Light Freezing Rain†	Rain on Cold Soaked Wing**	Other‡
-3 and above	27 and above	100/0	2:00-3:30	0:40-1:20	0:50-1:30	0:35-0:55	0:15-1:35	CAUTION: No holdover time guidelines exist
		75/25	1:30-2:45	0:30-1:05	0:50-1:15	0:30-0:45	0:10-1:15	
		50/50	0:30-0:45	0:09-0:20	0:15-0:25	0:09-0:15		
below -3 to -14	below 27 to 7	100/0	0:20-1:20	0:30-0:55	***0:25-1:20	***0:15-0:30		
		75/25	0:25-0:50	0:20-0:45	***0:25-1:05	***0:15-0:30		
below -14 to -26	below 7 to -14.8	100/0	0:15-0:40	0:15-0:30				

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER.

* Use light freezing rain holdover times if positive identification of freezing drizzle is not possible
** This column is for use at temperatures above 0 degrees Celsius (32 degrees Fahrenheit) only
*** No holdover time guidelines exist for this condition below -10 °C (14 °F)
‡ Heavy snow, ice pellets, moderate and heavy freezing rain, and hail
† Use light freezing rain holdover times in conditions of light snow mixed with light rain.

CAUTIONS:

- 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 OAT.

- DOW UCAR FLIGHTGUARD AD-480 TYPE IV FLUID USED DURING GROUND DEICING/ANTI-ICING IS NOT INTENDED FOR AND DOES NOT PROVIDE PROTECTION DURING FLIGHT.

30

2011-2012 Holdover Times Tables 8/29/11

TABLE 4J. FAA GUIDELINES FOR HOLDOVER TIMES DOW UCAR™ AD-49 TYPE IV FLUID MIXTURES AS A FUNCTION OF WEATHER CONDITIONS AND OUTSIDE AIR TEMPERATURE

CAUTION: THIS TABLE IS FOR DEPARTURE PLANNING ONLY AND SHOULD BE USED IN CONJUNCTION WITH PRETAKEOFF CHECK PROCEDURES.

Outside Air Temperature		Manufacturer Specific Type IV Fluid Concentration Neat-Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours: minutes)					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog	Snow, Snow Grains or Snow Pellets	Freezing Drizzle*	Light Freezing Rain†	Rain on Cold Soaked Wing**	Other‡
-3 and above	27 and above	100/0	3:20-4:00	1:10-1:50	1:25-2:00	1:00-1:25	0:10-1:55	CAUTION: No holdover time guidelines exist
		75/25	2:25-4:00	1:20-1:40	1:55-2:00	0:50-1:30	0:10-1:40	
		50/50	0:25-0:50	0:15-0:25	0:15-0:30	0:10-0:15		
below -3 to -14	below 27 to 7	100/0	0:20-1:35	1:10-1:50	***0:25-1:25	***0:20-0:25		
		75/25	0:30-1:10	1:20-1:40	***0:15-:1:05	***0:15-0:25		
below -14 to -26	below 7 to -14.8	100/0	0:25-0:40	0:15-0:30				

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER.

* Use light freezing rain holdover times if positive identification of freezing drizzle is not possible
** This column is for use at temperatures above 0 °C (32 °F) only
*** No holdover time guidelines exist for this condition below -10 °C (14 °F)
‡ Heavy snow, ice pellets, moderate and heavy freezing rain, and hail
† Use light freezing rain holdover times in conditions of light snow mixed with light rain.

CAUTIONS:

- 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 OAT.
- DOW UCAR™ AD-49 TYPE IV FLUID USED DURING GROUND DEICING/ANTI-ICING IS NOT INTENDED FOR AND DOES NOT PROVIDE PROTECTION DURING FLIGHT.

31

2011-2012 Holdover Times Tables 8/29/11

TABLE 4K. FAA GUIDELINES FOR HOLDOVER TIMES KILFROST ABC-4 SUSTAIN TYPE IV FLUID MIXTURES AS A FUNCTION OF WEATHER CONDITIONS AND OUTSIDE AIR TEMPERATURE

CAUTION: THIS TABLE IS FOR DEPARTURE PLANNING ONLY AND SHOULD BE USED IN CONJUNCTION WITH PRETAKEOFF CHECK PROCEDURES.

Outside Air Temperature		Manufacturer Specific Type IV Fluid Concentration Neat-Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours: minutes)					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog	Snow, Snow Grains or Snow Pellets	Freezing Drizzle*	Light Freezing Rain†	Rain on Cold Soaked Wing**	Other‡
-3 and above	27 and above	100/0	1:45-3:55	1:00-1:45	1:35-2:00	1:05-1:30	0:20-2:00	CAUTION: No holdover time guidelines exist
		75/25	1:00-1:50	0:30-0:55	0:40-1:05	0:25-0:40	0:10-1:20	
		50/50	0:20-0:35	0:07-0:15	0:10-0:20	0:05-0:10		
below -3 to -14	below 27 to 7	100/0	0:55-2:55	1:00-1:45	***0:35-1:50	***1:05-1:25		
		75/25	0:35-2:10	0:30-0:55	***0:25-1:20	***0:15-0:40		
below -14 to -29	below 7 to -20.2	100/0	0:40-1:00	0:15-0:30				

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER.

* Use light freezing rain holdover times if positive identification of freezing drizzle is not possible
** This column is for use at temperatures above 0 degrees Celsius (32 degrees Fahrenheit) only
*** No holdover time guidelines exist for this condition below -10 °C (14 °F)
‡ Heavy snow, ice pellets, moderate and heavy freezing rain, and hail
† Use light freezing rain holdover times in conditions of light snow mixed with light rain

CAUTIONS:

- 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 OAT.
- KILFROST ABC-4 SUSTAIN TYPE IV FLUID USED DURING GROUND DEICING/ANTI-ICING IS NOT INTENDED FOR AND DOES NOT PROVIDE PROTECTION DURING FLIGHT.

32

2011-2012 Holdover Times Tables 8/29/11

TABLE 4L. FAA GUIDELINES FOR HOLDOVER TIMES KILFROST ABC-S TYPE IV FLUID MIXTURES AS A FUNCTION OF WEATHER CONDITIONS AND OUTSIDE AIR TEMPERATURE

CAUTION: THIS TABLE IS FOR DEPARTURE PLANNING ONLY AND SHOULD BE USED IN CONJUNCTION WITH PRETAKEOFF CHECK PROCEDURES.

Outside Air Temperature		Manufacturer Specific Type IV Fluid Concentration Neat-Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours: minutes)					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog	Snow, Snow Grains or Snow Pellets	Freezing Drizzle*	Light Freezing Rain†	Rain on Cold Soaked Wing**	Other‡
-3 and above	27 and above	100/0	2:35-4:00	1:00-1:40	1:20-1:50	1:00-1:25	0:20-1:15	CAUTION: No holdover time guidelines exist
		75/25	1:05-1:45	0:30-0:55	0:45-1:10	0:35-0:50	0:10-0:50	
		50/50	0:20-0:35	0:07-0:15	0:15-0:20	0:08-0:10		
below -3 to -14	below 27 to 7	100/0	0:45-2:05	0:45-1:20	***0:20-1:00	***0:10-0:30		
		75/25	0:25-1:00	0:25-0:50	***0:20-1:10	***0:10-0:35		
below -14 to -28	below 7 to -18.4	100/0	0:20-0:40	0:15-0:30				

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER.

* Use light freezing rain holdover times if positive identification of freezing drizzle is not possible
** This column is for use at temperatures above 0 degrees Celsius (32 degrees Fahrenheit) only
*** No holdover time guidelines exist for this condition below -10 °C (14 °F)
‡ Heavy snow, ice pellets, moderate and heavy freezing rain, and hail
† Use light freezing rain holdover times in conditions of light snow mixed with light rain.

CAUTIONS:

- 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 OAT.
- KILFROST ABC-S PLUS TYPE IV FLUID USED DURING GROUND DEICING/ANTI-ICING IS NOT INTENDED FOR AND DOES NOT PROVIDE PROTECTION DURING FLIGHT.

33

2011-2012 Holdover Times Tables 8/29/11

TABLE 4M. FAA GUIDELINES FOR HOLDOVER TIMES KILFROST ABC-S PLUS TYPE IV FLUID MIXTURES AS A FUNCTION OF WEATHER CONDITIONS AND OUTSIDE AIR TEMPERATURE

CAUTION: THIS TABLE IS FOR DEPARTURE PLANNING ONLY AND SHOULD BE USED IN CONJUNCTION WITH PRETAKEOFF CHECK PROCEDURES.

Outside Air Temperature		Manufacturer Specific Type IV Fluid Concentration Neat-Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours: minutes)					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog	Snow, Snow Grains or Snow Pellets	Freezing Drizzle*	Light Freezing Rain†	Rain on Cold Soaked Wing**	Other‡
-3 and above	27 and above	100/0	2:10-4:00	1:15-2:00	1:50-2:00	1:05-2:00	0:25-2:00	CAUTION: No holdover time guidelines exist
		75/25	1:25-2:40	0:45-1:15	1:00-1:20	0:30-0:50	0:10-1:20	
		50/50	0:30-0:55	0:15-0:30	0:15-0:40	0:15-0:20		
below -3 to -14	below 27 to 7	100/0	0:55-3:30	1:00-1:45	***0:25-1:35	***0:20-0:30		
		75/25	0:45-1:50	0:35-1:00	***0:20-1:10	***0:15-0:25		
below -14 to -28	below 7 to -18.4	100/0	0:40-1:00	0:15-0:30				

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER.

* Use light freezing rain holdover times if positive identification of freezing drizzle is not possible
** This column is for use at temperatures above 0 °C (32 °F) only
*** No holdover time guidelines exist for this condition below -10 °C (14 °F)
‡ Heavy snow pellets, ice pellets, moderate and heavy freezing rain, and hail
† Use light freezing rain holdover times in conditions of light snow mixed with light rain

CAUTIONS:

- 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 OAT.
- KILFROST ABC-S PLUS TYPE IV FLUID USED DURING GROUND DEICING/ANTI-ICING IS NOT INTENDED FOR AND DOES NOT PROVIDE PROTECTION DURING FLIGHT.

34

2011-2012 Holdover Times Tables 8/29/11

TABLE 4N. FAA GUIDELINES FOR HOLDOVER TIMES LYONDELL ARCTIC SHIELD™ TYPE IV FLUID MIXTURES AS A FUNCTION OF WEATHER CONDITIONS AND OUTSIDE AIR TEMPERATURE

CAUTION: THIS TABLE IS FOR DEPARTURE PLANNING ONLY AND SHOULD BE USED IN CONJUNCTION WITH PRETAKEOFF CHECK PROCEDURES.

Outside Air Temperature		Manufacturer Specific Type IV Fluid Concentration Neat-Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours: minutes)					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog	Snow, Snow Grains or Snow Pellets	Freezing Drizzle*	Light Freezing Rain†	Rain on Cold Soaked Wing**	Other‡
-3 and above	27 and above	100/0	1:55-3:10	0:50-1:25	0:55-1:40	0:45-1:05	0:15-1:25	CAUTION: No holdover time guidelines exist
		75/25	1:20-2:15	0:40-1:05	0:55-1:25	0:30-0:45	0:09-1:20	
		50/50	0:35-0:45	0:20-0:35	0:20-0:30	0:10-0:15		
below -3 to -14	below 27 to 7	100/0	1:00-2:25	0:45-1:15	***0:25-1:30	***0:25-0:30		
		75/25◆	0:50-1:45◆	0:35-0:55◆	0:30-1:15◆	0:25-0:30◆		
Below -14 to -24.5	Below 7 to -12.1	100/0	0:25-0:45	0:15-0:30				

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER.

* Use light freezing rain holdover times if positive identification of freezing drizzle is not possible
** This column is for use at temperatures above 0 °C (32 °F) only
*** No holdover time guidelines exist for this condition below -10 °C (14 °F)
‡ Heavy Snow, ice pellets, moderate and heavy freezing rain, and hail
† Use light freezing rain holdover times in conditions of light snow mixed with light rain
◆ Temperature is limited to -9.5 °C (15 °F) when using 75/25 dilution of this fluid.

CAUTIONS:

- 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 OAT.
- LYONDELL ARCTIC SHIELD TYPE IV FLUID USED DURING GROUND DEICING/ANTI-ICING IS NOT INTENDED FOR AND DOES NOT PROVIDE PROTECTION DURING FLIGHT.

35

2011-2012 Holdover Times Tables 8/29/11

TABLE 4O. FAA GUIDELINES FOR HOLDOVER TIMES OCTAGON MAX-FLIGHT 04 TYPE IV FLUID MIXTURES AS A FUNCTION OF WEATHER CONDITIONS AND OUTSIDE AIR TEMPERATURE

CAUTION: THIS TABLE IS FOR DEPARTURE PLANNING ONLY AND SHOULD BE USED IN CONJUNCTION WITH PRETAKEOFF CHECK PROCEDURES.

Outside Air Temperature		Manufacturer Specific Type IV Fluid Concentration Neat-Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours: minutes)					
Degrees Celsius	Degrees Fahrenheit		Freezing Fog	Snow, Snow Grains or Snow Pellets	Freezing Drizzle*	Light Freezing Rain†	Rain on Cold Soaked Wing**	Other‡
-3 and above	27 and above	100/0	2:40-4:00	1:25-2:00	2:00-2:00	1:10-1:30	0:20-2:00	CAUTION: No holdover time guidelines exist
		75/25	2:05-3:15	1:05-2:00	1:50-2:00	1:00-1:20	0:20-2:00	
		50/50	0:55-1:45	0:25-1:15	0:35-1:10	0:25-0:35		
below -3 to -14	below 27 to 7	100/0	0:50-2:30	0:35-1:10	***0:25-1:30	***0:20-0:40		
		75/25	0:30-1:05	0:40-1:25	***0:20-1:00	***0:15-0:30		
below -14 to -26.5	below 7 to -15.7	100/0	0:20-0:45	0:15-0:30				

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER.

* Use light freezing rain holdover times if positive identification of freezing drizzle is not possible
** This column is for use at temperatures above 0 °C (32 °F) only
*** No holdover time guidelines exist for this condition below -10 °C (14 °F)
‡ Heavy snow, ice pellets, moderate and heavy freezing rain, and hail
† Use light freezing rain holdover times in conditions of light snow mixed with light rain.

CAUTIONS:

- 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 OAT.

- OCTAGON MAX-FLIGHT 04 TYPE IV FLUID USED DURING GROUND DEICING/ANTI-ICING IS NOT INTENDED FOR AND DOES NOT PROVIDE PROTECTION DURING FLIGHT.

36

2011-2012 Holdover Times Tables 8/29/11

TABLE 5. FAA GUIDELINES FOR THE APPLICATION OF SAE TYPE II, TYPE III, AND TYPE IV FLUID MIXTURES MINIMUM CONCENTRATIONS AS A FUNCTION OF OUTSIDE AIR TEMPERATURE

Concentrations in % Volume

Outside Air Temperature (OAT)	One-step Procedure Deicing/Anti-icing[1]	Two-step Procedure	
		First step: Deicing	Second step: Anti-icing[1, 2]
-3 °C (27 °F) and above	50/50 Heated[3] Types II, III or IV	Heated water or a heated mix of Type I, II, III or IV and water	50/50 Type II, III, or IV
Below -3 °C (27 °F) to -14 °C (7 °F)	75/25 Heated[3] Types II, III or IV	Heated suitable mix of Type I, II, III or IV, and water with a freezing point not more than 3 °C (5 °F) above actual OAT	75/25 Type II, III, or IV
below -14 °C (7 °F) to -25 °C (-13 °F)	100/0 Heated[3] Types II, III or IV	Heated suitable mix of Type I, II, III or IV, and water with a freezing point not more than 3 °C (5 °F) above actual OAT	100/0 Type II, III, or IV
Below -25 °C (-13 °F)	**SAE Type II/IV** fluid may be used below -25 °C (-13 °F) provided that the OAT is at or above the LOUT. **SAE Type III fluid** may be used below -10°C (14°F) provided that the OAT is at or above the LOUT.		

1) Fluids must only be used at temperatures above their lowest operational use temperature (LOUT).
2) To be applied before first step fluid freezes, typically within 3 minutes.
3) Clean aircraft may be anti-iced with unheated Type II, III, or IV fluid.

NOTES:

- 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.
- The lowest operational use temperature (LOUT) for a given Type II, III, or IV fluid is the higher 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 7°C (13°F).

CAUTIONS:

- **Wing skin temperatures may differ and in some cases may be lower than OAT. A stronger mix (more glycol) can be used under these conditions.**
- **As fluid freezing may occur, 50/50 Types II, III, or IV fluid shall not be used for the anti-icing step of a cold-soaked wing as indicated by frost or ice on the lower surface of the wing in the area of the fuel tank.**
- **An insufficient amount of anti-icing fluid, especially in the second step of a two-step procedure, may cause a substantial loss of holdover time, particularly when using a Type I fluid mixture for the first step (deicing) of a two-step procedure.**
- **Repeated deicing/anti-icing with heated thickened fluids without the frequent use of Type I fluid/water mixtures for deicing can lead to the buildup of residue which can re-hydrate and freeze on control surfaces, hinges, and associated actuators during flight and restrict movement of these devices, leading to an unsafe condition. If repeated deicing/anti-icing with heated thickened fluids occurs, periodic inspections and removal of residue in accordance with the aircraft manufacturers instructions and procedures should be followed.**

37

2011-2012 Holdover Times Tables 8/29/11

TABLE 6. LOWEST ON-WING VISCOSITY VALUES FOR ANTI-ICING FLUIDS
(See Page 40 for Table 6 Notes)

Table 6-1: Type II Anti-Icing Fluids

FLUID NAME	FLUID DILUTION	LOWEST ON-WING VISCOSITY [a] (mPa.s)	
		MANUFACTURER METHOD	AIR 9968 REVISION A METHOD
ABAX (SPCA) Ecowing 26	100/0	4,900 [e]	4,600 [g]
	75/25	2,200 [g]	2,200 [g]
	50/50	50 [g]	50 [g]
Aviation Shaanxi High-Tech Cleanwing II	100/0	4,650 [c]	4,500[g]
	75/25	9,450 [c]	10,000[g]
	50/50	10,150 [c]	10,200 [g]
Clariant Safewing MP II 2025 ECO	100/0	5,500 [b]	5,750 [g]
	75/25	10,000 [b]	10,000 [g]
	50/50	3,000 [b]	3,250 [g]
Clariant Safewing MP II Flight	100/0	3,340 [g]	3,340 [g]
	75/25	12,900 [i]	12,900 [i]
	50/50	11,500 [g]	11,500 [g]
Clariant Safewing MP II 1951	100/0	2,500 [b]	2, 750 g
	75/25	2,900 [b]	3, 000 g
	50/50	50 [b]	50 g
Kilfrost ABC-3	100/0	2,500 [c]	2,500 [j]
	75/25	2,000 [c]	2,000 [j]
	50/50	400 [c]	400 [j]
Kilfrost ABC-2000	100/0	2,350 [c]	2,350 [g]
	75/25	3,000 [c]	3,000 [j]
	50/50	1,000 [c]	1,000 [j]
Kilfrost ABC-K Plus	100/0	2,850 [c]	2,640 [g]
	75/25	12,650 [c]	12,650 [c]
	50/50	4,200 [c]	5,260 [g]
Newave Aerochemical FCY-2	100/0	7,000 [c]	8,920 [g]
	75/25	18,550 [c]	18,550 [c]
	50/50	6,750 [c]	7,030 [g]
Octagon E Max II	100/0	13,520 [d]	13,520 [g]
	75/25	11,400 [g]	11,400 [g]
	50/50	2,820 [g]	2,820 [g]

Table 6-2: Type III Anti-Icing Fluids

FLUID NAME	FLUID DILUTION	LOWEST ON-WING VISCOSITY [a] (mPa.s)	
		MANUFACTURER METHOD	AIR 9968 REVISION A METHOD
Clariant Safewing MP III 2031 ECO	100/0	30 [h]	Not Applicable
	75/25	55 [h]	Not Applicable
	50/50	10 [h]	Not Applicable

38

Table 6-3 Type IV Anti-Icing Fluids			
FLUID NAME	FLUID DILUTION	LOWEST ON-WING VISCOSITY [a] (mPa.s)	
		MANUFACTURER METHOD	SAE AIR 9968 REVISION A METHOD
ABAX AD-480	100/0	15,200 [e]	12,800 [c]
	75/25	16,000 [e]	12,400 [c]
	50/50	4,000 [e]	3,800 [g]
ABAX Ecowing AD-49	100/0	12,150 [k]	11,000 [g]
	75/25	30,700 [k]	32,,350 [l]
	50/50	19,450 [k]	21,150 [l]
Clariant Safewing MP IV 2001	100/0	18,000 [b]	18,000 [c]
	75/25	8,000 [b]	11,500 [g]
	50/50	1,200 [b]	1,750 [g]
Clariant Safewing MP IV Launch	100/0	7,550 [g]	7,550 [g]
	75/25	18,000 [g]	18,000 [g]
	50/50	17,800 [g]	17,800 [g]
Cryotech Polar Guard	100/0	32,100 [m]	36,300 [l]
	75/25	24,200 [m]	27,800 [l]
	50/50	6,200 [m]	7,500 [g]
Cryotech Polar Guard Advance	100/0	4,400 [n]	4,050 [g]
	75/25	11,600 [n]	9,750 [g]
	50/50	80 [g]	80 [g]
Dow UCAR ADF/AAF ULTRA+	100/0	36,000 [f]	28,000 [c]
	75/25	Dilution Not Applicable	Dilution Not Applicable
	50/50	Dilution Not Applicable	Dilution Not Applicable
Dow UCAR Endurance EG106	100/0	24,850 [f]	2,230 [g]
	75/25	Dilution Not Applicable	Dilution Not Applicable
	50/50	Dilution Not Applicable	Dilution Not Applicable
Dow UCAR FlightGuard AD-480	100/0	15,200 [e]	12,800 [c]
	75/25	16,000 [e]	12,400 [c]
	50/50	4,000 [e]	3,800 [g]
Dow UCAR FlightGuard AD-49	100/0	12,150 [k]	11,000 [g]
	75/25	30,700 [k]	32,,350 [l]
	50/50	19,450 [k]	21,150 [l]
Kilfrost ABC-4 SUSTAIN	100/0	18,400 [c]	18,400 [c]
	75/25	15,400 [c]	15,400 [c]
	50/50	4,700 [c]	5,050 [g]
Kilfrost ABC-S	100/0	17,000 [c]	17,000 [c]
	75/25	12,000 [c]	12,000 [c]
	50/50	2,000 [c]	2,000 [j]
Kilfrost ABC-S PLUS	100/0	17,900 [c]	17,900 [c]
	75/25	18,300 [c]	18,300 [c]
	50/50	7,500 [c]	7,500 [j]

FOOTNOTES A-N are located on page 40

2011-2012 Holdover Times Tables 8/29/11

Table 6-3 Type IV Anti-Icing Fluids (Continued)			
Lyondell Arctic Shield	100/0	23,150 [i]	28,000 [c]
	75/25	21,700 [i]	22,100 [c]
	50/50	6,400 [i]	7,640 [g]
Octagon Max-Flight 04	100/0	5,540 [d]	5,540 [g]
	75/25	15,000 [g]	15,000 [g]
	50/50	5,200 [g]	5,200 [g]

FOOTNOTES

A. The SAE Aerospace Information Report (AIR) 9968 Revision A (December 2004) 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.

B. Brookfield Spindle SC4-34/13R, small sample adapter, 10 mL of fluid, at 20°C, 0.3 rpm, for 15 minutes 0 seconds.

C. Brookfield Spindle LV2-disc with guard leg, 150 mL of fluid, at 20°C, 0.3 rpm, for 10 minutes 0 seconds.

D. Brookfield Spindle LV1 with guard leg, 500 mL of fluid, at 20°C, 0.3 rpm, for 33 minutes 20 seconds.

E. Brookfield Spindle SC4-34/13R, small sample adapter, 10 mL of fluid, at 20°C, 0.3 rpm, for 30 minutes 0 seconds.

F Brookfield Spindle SC4-31/13R, small sample adapter, 10 mL of fluid, at 0°C, 0.3 rpm, for 10 minutes 0 seconds.

G. Brookfield Spindle LV1 with guard leg, 500 mL of fluid, at 20ºC, 0.3 rpm, for 10 minutes 0 seconds.

H.. Brookfield Spindle LV0, UL-Adapter, 16 mL of fluid, at 20ºC, 0.3 rpm, for 10 minutes 0 seconds.

I. Brookfield Spindle SC4-31/13R, small sample adapter, 9 mL of fluid, at 20°C, 0.3 rpm, for 33 minutes 0 seconds.

J. Brookfield Spindle LV1 with guard leg, 150 mL of fluid, at 20ºC, 0.3 rpm, for 10 minutes 0 seconds

K. Brookfield Spindle SC4-31/13R, small sample adapter, 10 mL of fluid, at 20ºC, 0.3 rpm, for 10 minutes 0 seconds

L. Brookfield Spindle LV-2 disc with guard leg, 500 mL of fluid at 20ºC, 0.3 rpm, for 10 minutes 0 seconds.

M. Brookfield Spindle SC4-31/13R, small sample adapter, 9ml of fluid at 20ºC, 0.3 rpm for 10 minutes 0 seconds.

N. Brookfield Spindle SC4-34/13R, small sample adapter, 10mL of fluid at 20°C, 0.3 rpm, for 10 minutes 0 seconds.

SIGNIFICANCE OF TABLE 6. The viscosity values of the fluids in Table 6 are those provided by the fluid manufacturers for holdover time testing. For the holdover time guidelines to be valid, the viscosity of the fluid on the wing shall not be lower than that listed in this table. The user should periodically ensure that the viscosity of a fluid sample taken from the wing is not lower than the value listed here.

2011-2012 Holdover Times Tables 8/29/11

TABLE 7. LOWEST OPERATIONAL USE TEMPERATURES[1] OF ANTI-ICING FLUIDS (2011-2012)

TABLE 7-1: Type I Anti-Icing Fluids				
FLUID NAME	LOWEST OPERATIONAL USE TEMPERATURES WITH DILUTION PER CENT FLUID/WATER AT LOUT IN PARENTHESIS			
	LOW SPEED AERODYNAMIC TEST		HIGH SPEED AERODYNAMIC TEST	
	DEGREES CELSIUS	DEGREES FAHRENHEIT	DEGREES CELSIUS	DEGREES FAHRENHEIT
ABAX DE-950	Not tested[3]	Not tested[3]	-24 (60/40)	-11.2 (60/40)
ABAX DE-950 Colorless	Not tested[3]	Not tested[3]	-24 (60/40)	-11.2 (60/40)
Arcton Arctica DG ready-to-use	-26 (as supplied)	-14.8 (as supplied)	-26 (as supplied)	-14.8 (as supplied)
Aviation Shaanxi Hi-Tech Cleanwing I	Not tested[3]	Not tested[3]	-39 (75/25)	-38.2 (75/25)[4]
Aviation Xi'an Hi-Tech KHF-1	Not tested[3]	Not tested[3]	-38 (75/25)	-36.4 (75/25)[4]
Batelle D[3]: Degradable by Design™ ADF1006A	Not available[2]	Not available[2]	Not available[2]	Not available[2]
Beijing Phoenix Air Traffic CBSX-1	Not tested[3]	Not Tested[3]	-26 (75/25)	-14.8 (75/25)[4]
Beijing Wangye Aviation Chemical KLA-1	Not available[2]	Not available[2]	Not available[2]	Not available[2]
Beijing Wangye Aviation Chemical YJF-1	Not available[2]	Not available[2]	Not available[2]	Not available[2]
Clariant Safewing EG I 1996	-35.5 (75/25)	-31.9 (75/25)	-43 (75/25)	-45.4 (75/25)
Clariant Safewing EG I 1996 (88)	-39.5 (70/30)	-39.1 (70/30)	-44 (70/30)	-47.2 (70/30)
Clariant Safewing MP I 1938 ECO	-25.5 (65/35)	-13.9 (65/35)	-32 (65/35)	-25.6 (65/35)
Clariant Safewing MP I 1938 ECO (80)	-25 (71/29)	-13 (71/29)	-32.5 (71/29)	-26.5 (71/29)
Clariant Safewing MP I 1938 ECO (80) PreMix 55 i.e. ready-to-use	Not tested[3]	Not tested[3]	-19 (as supplied)	-2.2 (as supplied)
Clariant Safewing MP I 1938 TF	-26.5 (71/29)	-15.7 (71/29)	Not available[2]	Not available[2]
Clariant Safewing MP I 1938 TF PreMix 60% i.e. ready-to-use (multiple location)	Not available[2]	Not available[2]	-29.5 as supplied	-21.1 as supplied
Clariant Safewing MP I ECO PLUS (80)	-25 (71/29)	-13 (71/29)	-33 (71/29)	-27.4 (71/29)
Chemical Specialists Prist Wing De-Icer	Not available[2]	Not available[2]	Not available[2]	Not available[2]
Cryotech Polar Plus	-27 (63/37)	-16.6 (63/37)	-32 (63/37)	-25.6 (63/37)
Dow UCAR™ ADF XL54	-33 (as supplied)	-27.4 (as supplied)	-33 (as supplied)	-27.4 (as supplied)
Dow UCAR™ Aircraft Deicing Fluid Concentrate	-36.5 (75/25)	-33.7 (75/25)	-45 (75/25)	-49 (75/25)
Dow UCAR™ PG ADF Dilute 55/45	-24 (as supplied)	-11.2 (as supplied)	-25 (as supplied)	-13 (as supplied)
See next page for additional Type I fluids				

FOOTNOTES 1-3 are located on page 42

41

2011-2012 Holdover Times Tables 8/29/11

Table 7-1 Continued: Type I Anti-Icing Fluids (cont'd)				
FLUID NAME	LOWEST OPERATIONAL USE TEMPERATURES WITH DILUTION PER CENT FLUID/WATER AT LOUT IN PARENTHESIS			
	LOW SPEED AERODYNAMIC TEST		HIGH SPEED AERODYNAMIC TEST	
	DEGREES CELSIUS	DEGREES FAHRENHEIT	DEGREES CELSIUS	DEGREES FAHRENHEIT
Dow UCAR™ PG Aircraft Deicing Fluid Concentrate	-25 (65/35)	-13 (65/35)	-32 (65/35)	-25.6 (65/35)
Harbin Aeroclean Aviation HJF-1	Not tested[3]	Not tested[3]	-35 (60/40)	-31 (60/40)
HOC SafeTemp I ES	Not tested[3]	Not tested[3]	-23.5 (55/45)	-10.3 (55/45)
HOC SafeTemp ES Plus	Not tested[3]	Not tested[3]	-29 (65/35)	-20.2 (65/35)
Kilfrost DF Plus	-24 (69/31)	-11.2 (69/31)	-32 (69/31)	-25.6 (69/31)
Kilfrost DF Plus (80)	-23.5 (69/31)	-10.3 (69/31)	-31.5 (69/31)	-24.7 (69/31)
Kilfrost DF Plus (88)	-24 (63/37)	-11.2 (63/37)	-32 (63/37)	-25.6 (63/37)
Kilfrost DF^{sustain}™	-36 (68/32)	-32.8 (68/32)	-41.5 (68/32)	-43 (68/32)
Lyondell ARCOPlus	-13 (63/37)	8.6 (63/37)	-27.4 (63/37)	-17.3 (63/37)
Newave FCY-1A	-34 (75/25)	-29.2 (75/25)	-34.5 (75/25)	-30.1 (75/25)
Octagon EcoFlo Concentrate	-27 (60/40)	-16.6 (60/40)	-30.5 (65/35)	-22.9 (65/35)
Octagon EcoFlo 2 Concentrate	Not tested[3]	Not tested[3]	-29 (65/35)	-20.2 (65/35)
Octagon Octaflo EF Concentrate	-25 (65/35)	-13 (65/35)	-33 (65/35)	-27.4 (65/35)
Octagon Octaflo EF-80 Concentrate	-25 (70/30)	-13 (70/30)	-33 (70/30)	-27.4 (70/30)
Octagon Octaflo EG Concentrate	-40.5 (70/30)	-40.9 (70/30)	-44 (70/30)	-47.2 (70/30)

FOOTNOTES

1. The lowest operational use temperature (LOUT) for a given fluid is the warmer of:
   a) The lowest temperature at which the fluid meets the low and/or high speed aerodynamic acceptance test; or
   b) The actual freezing point of the fluid plus its freezing point buffer of 10°C (18°F).

   The values in this table were provided by the fluid manufacturer and were determined using pre-production fluid samples when available.
2. Manufacturer has not provided LOUT information at the time of this publication. Contact the fluid manufacturer or use another fluid.
3. Manufacturer has indicated fluid was not tested. Consult with the fluid manufacturer for further guidance..

CAUTION:

- LOUT data provided in this table is based on the manufacturer's data. In case of discrepancies between the values in this table and the fluid manufacturer's data, use the manufacturer's data.
- Fluids supplied in concentrated form must not be used in that form and must be diluted.
- For the fluids in the table that are intended to be diluted, the LOUT is derived from a dilution that provides the lowest possible operational use temperature. For other dilutions, determine the freezing point of the fluid and add a 10ºC (18ºF) freezing point buffer, as this will usually yield a higher (warmer) and more restrictive operational use temperature. Consult the fluid manufacturer or fluid documentation for further clarification and guidance on establishing the appropriate operational use of a diluted fluid.

42

2011-2012 Holdover Times Tables 8/29/11

Table 7-2: Type II (100/0) Anti-Icing Fluids		
FLUID NAME	LOWEST OPERATIONAL USE TEMPERATURES	
	HIGH SPEED AERODYNAMIC TEST	
	DEGREES CELSIUS	DEGREES FAHRENHEIT
ABAX Ecowing 26	-25	-13
Aviation Shaanxi Hi-Tech Cleanwing II	-29	-20.2
Clariant Safewing MP II 1951	-28	-18.4
Clariant Safewing MP II 2025 ECO	-27.5	-17.5
Clariant Safewing MP II Flight	-29	-20.2
Kilfrost ABC-3	-27	-16.6
Kilfrost ABC-2000	-28	-18.4
Kilfrost ABC-K Plus	-29	-20.2
Newave Aerochemical FCY-2	-28	-18.4
Octagon E Max II	-27	-16.6

Table 7-3: Type III (100/0) Anti-Icing Fluids				
FLUID NAME	LOWEST OPERATIONAL USE TEMPERATURES			
	LOW SPEED AERODYNAMIC TEST		HIGH SPEED AERODYNAMIC TEST	
	DEGREES CELSIUS	DEGREES FAHRENHEIT	DEGREES CELSIUS	DEGREES FAHRENHEIT
Clariant Safewing MP III 2031	-16.5	2.3	-29	-20.2

FOOTNOTES

1. The lowest operational use temperature (LOUT) for a given fluid is the warmer of:
   a) The lowest temperature at which the fluid meets the low and/or high speed aerodynamic acceptance test; or
   b) The actual freezing point of the fluid plus its freezing point buffer of 10°C (18°F).
   The values in this table were provided by the fluid manufacturer and were determined using pre-production fluid samples when available.

2. Manufacturer has not provided LOUT information at the time of this publication. Contact the fluid manufacturer or use another fluid.

3. Manufacturer has indicated fluid was not tested. Consult with the fluid manufacturer for further guidance.

CAUTION: LOUT data provided in this table is based on the manufacturer's data. In case of discrepancies between the values in this table and the fluid manufacturer's data, use the manufacturer's data.

43

2011-2012 Holdover Times Tables 8/29/11

Table 7-4: Type IV (100/0) Anti-Icing Fluids		
FLUID NAME	LOWEST OPERATIONAL USE TEMPERATURES	
	HIGH SPEED AERODYNAMIC TEST	
	DEGREES CELSIUS	DEGREES FAHRENHEIT
ABAX AD-480	-26	-14.8
ABAX Ecowing AD-49	-26	-14.8
Clariant Safewing MP IV 2001	-29.5	-21.1
Clariant Safewing MP IV LAUNCH	-28.5	-19.3
Cryotech Polar Guard	-23.5	-10.3
Cryotech Polar Guard Advance	-30.5	-22.9
Dow UCAR™ ADF/AAF ULTRA+	-24	-11.2
Dow UCAR™ Endurance EG106 De/Anti-Icing Fluid	-27	-16.6
Dow UCAR™ FlightGuard AD-480	-26	-14.8
Dow UCAR™ FlightGuard AD-49	-26	-14.8
Kilfrost ABC-4^{sustain}	-29	-20.2
Kilfrost ABC-S	-28	-18.4
Kilfrost ABC-S PLUS	-28	-18.4
Lyondell ARCTIC Shield™	-24.5	-12.1
Octagon Max-Flight 04	-26.5	-15.7

FOOTNOTES

1. The lowest operational use temperature (LOUT) for a given fluid is the warmer of:
   a) The lowest temperature at which the fluid meets the low and/or high speed aerodynamic acceptance test; or
   b) The actual freezing point of the fluid plus its freezing point buffer of 10°C (18°F).

   The values in this table were provided by the fluid manufacturer and were determined using pre-production fluid samples when available.

2. Manufacturer has not provided LOUT information at the time of this publication. Contact the fluid manufacturer or use another fluid.

3. Manufacturer has indicated fluid was not tested. Consult with the fluid manufacturer for further guidance.

CAUTION: LOUT data provided in this table is based on the manufacturer's data. In case of discrepancies between the values in this table and the fluid manufacturer's data, use the manufacturer's data.

44

2011-2012 Holdover Times Tables 8/29/11

TABLE 8. LIST OF FLUIDS TESTED FOR ANTI-ICING PERFORMANCE AND AERODYNAMIC ACCEPTANCE-WINTER 2011-12

Type I Deicing/Anti-Icing Fluids[1]

Company Name	Fluid Name
ABAX Industries (formerly SPCA)	ABAX DE-950
ABAX Industries (formerly SPCA)	ABAX DE-950 Colorless
Arcton Ltd.	Arctica DG Ready to Use
Aviation Shaanxi High-Tech Physical Co. Ltd.	Cleanwing I
Aviation Xi'an High-Tech	KHF-1
Battelle	D^3: Degradable by Design Deicer™ ADF 1006A
Beijing Phoenix Air Traffic Product Development and Trading Co.	CBSX-1
Beijing Wangye Aviation Chem. Prod. Co.	KLA-1
Beijing Wangye Aviation Chem. Prod. Co	YJF-1
Chemical Specialists and Development	Prist Wing Deicer
Clariant GmbH	Safewing MPI 1938 TF
Clariant GmbH	Safewing MPI 1938 TF Pre-mix 60%
Clariant GmbH	Safewing MP I 1938 ECO (80)
Clariant GmbH	Safewing MP I 1938 ECO (80) Pre-mix 55%
Clariant GmbH	Safewing MP I 1938 ECO
Clariant GmbH	Safewing EG I 1996
Clariant GmbH	Safewing EG I 1996 (88)
Clariant GmbH	Safewing MP I ECO PLUS (80)
Cryotech Deicing Technology	Polar Plus
Dow Chemical Company	UCAR™ ADF Concentrate
Dow Chemical Company	UCAR™ ADF XL-54
Dow Chemical Company	UCAR™ PG ADF Concentrate
Dow Chemical Company	UCAR™ PG ADF Dilute 55/45
Harbin Aeroclean Aviation Tech Co. Ltd.	HJF-1
HOC Industries	SafeTemp I ES
HOC Industries	SafeTemp I ES Plus
Kilfrost	Kilfrost DF PLUS
Kilfrost	Kilfrost DF PLUS (80)
Kilfrost	Kilfrost DF PLUS (88)®
Kilfrost	Kilfrost DF^{SUSTAIN} ™
Lyondell Chemical Company	ARCOPlus®
Newave Aerochemical Company	FCY-1A
Octagon Process	EcoFlo
Octagon Process	EcoFlo 2
Octagon Process	Octaflo EF
Octagon Process	Octaflo EF-80
Octagon Process	Octaflo EG

FOOTNOTES 1-2 are located on page 47

TABLE 8. CONTINUED. LIST OF FLUIDS TESTED FOR ANTI-ICING PERFORMANCE AND AERODYNAMIC ACCEPTANCE-WINTER 2011-2012

Type II Deicing/Anti-Icing Fluids[2]

Company Name	Fluid Name
ABAX Industries	ABAX Ecowing 26
Aviation Shaanxi Hi-Tech Physical Chemical Co. Ltd.	Cleanwing II
Clariant GmbH	Safewing MP II 1951
Clariant GmbH	Safewing MP II 2025 ECO
Clariant GmbH	Safewing MP II Flight
Kilfrost	Kilfrost ABC-3
Kilfrost	Kilfrost ABC-2000
Kilfrost	Kilfrost ABC-K PLUS
Newave Aerochemical Technology	FCY-2
Octagon Process	E-Max

Type III Deicing/Anti-Icing Fluids[2]

Company Name	Fluid Name
Clariant GmbH	Safewing MP III 2031 ECO

Type IV Deicing/Anti-Icing Fluids[2]

Company Name	Fluid Name
ABAX Industries	ABAX AD-480
ABAX Industries	ABAX Ecowing AD-49
Clariant GmbH	Safewing MP IV 2001
Clariant GmbH	Safewing MP IV Launch
Cryotech Deicing Technology	Polar Guard
Cryotech Deicing Technology	Polar Guard Advance
Dow Chemical Company	UCAR™ ADF/AAF ULTRA+
Dow Chemical Company	UCAR™ Endurance EG106
Dow Chemical Company	UCAR™ FlightGuard AD-480
Dow Chemical Company	UCAR™ FlightGuard AD-49
Kilfrost	Kilfrost ABC-4 SUSTAIN
Kilfrost	Kilfrost ABC-S
Kilfrost	Kilfrost ABC-S Plus
Lyondell Chemical Company	ARCTIC Shield™
Octagon Process	Max-Flight 04

FOOTNOTES 1-2 are located on page 47

2011-2012 Holdover Times Tables 8/29/11

FOOTNOTES

1. This table lists fluids that conform to anti-icing performance requirements according to SAE AMS 1424, Paragraph 3.5.2 and have demonstrated acceptable aerodynamic performance according to SAE AMS 1424, Paragraph 3.5.3 by the Anti-Icing Materials International Laboratory at the University of Quebec at Chicoutimi, Canada, web site: http://www.uqac.ca/amil/index.htm. The end user is responsible for confirming that other SAE AMS 1424 technical requirement tests, such as materials compatibility, and stability, etc, have been performed by contacting the fluid manufacturer.

2. This table lists Types II, III, or IV fluids that conform to anti-icing performance requirements according to SAE AMS 1428, Paragraph 3.2.4 and have demonstrated acceptable aerodynamic performance according to SAE AMS 1428, Paragraph 3.2.5. The end user is responsible for confirming that other SAE AMS 1428 technical requirement tests, such as materials compatibility, and stability, etc, have been performed by contacting the fluid manufacturer.

47

2011-2012 Holdover Times Tables 8/29/11

ICE PELLET ALLOWANCE TIMES
2011-2012

1. Background: During the winter of 2006-2007, operations in ice pellets were approved for "light ice pellets" with an allowance time of 25 minutes. That time was based on limited research conducted late in the winter of 2005-2006 at the request of various industry groups. Additional and more comprehensive ice pellet research was conducted jointly by the research teams of the FAA and Transport Canada during the 2007-2008 winter season. This research consisted of extensive climatic chamber and wind tunnel testing with ice pellets (light and moderate) and light ice pellets mixed with other forms of precipitation. Additionally, Type IV anti-icing fluid with ice pellets embedded was evaluated for its aging qualities over periods of time beyond the allowance times, when the active precipitation time was limited to the allowance times. Results of this research provide the basis for extended allowance times for operations in light ice pellets, as well as allowance times for operations in moderate ice pellets and light ice pellets mixed with other forms of precipitation. Additional ice pellet research was conducted during the winter season of 2008-2009 which further expanded the ice pellet allowance times under specified conditions. Guidance was also provided for Type IV anti-icing fluid with embedded ice pellets "aged" beyond its allowance time when the precipitation stops at or prior to the expiration of the allowance time.

During the winter of 2009-2010, wind tunnel research conducted with a newer generation type airfoil showed that Propylene Glycol (PG) and Ethylene Glycol (EG) fluids behave differently under certain temperature and ice pellet conditions. Specifically, higher aircraft rotation speeds are required to effectively remove PG fluid contaminated with light or moderate ice pellets at temperatures less than -10°C. Therefore, there are no allowance times associated with the use of PG fluids on aircraft with rotation speeds of less than 115 knots in conditions of light or moderate ice pellets at temperatures below -10°C.

Furthermore, research with this newer generation type airfoil has shown that the allowance times are shorter when using PG fluids under certain conditions for all aircraft regardless of the rotation speed. This research resulted in the allowance time when using PG fluids at temperatures of -5°C and above being limited to 15 minutes in moderate ice pellets

2. Operations in Light and Moderate Ice Pellets and Light Ice Pellets mixed with other forms of precipitation.

A. Tests have shown that ice pellets generally remain in the frozen state imbedded in Type IV anti-icing fluid, and are not absorbed by the fluid in the same manner as other forms of precipitation. Using current guidelines for determining anti-icing fluid failure, the presence of a contaminant not absorbed by the fluid (remaining imbedded) would be an indication that the fluid has failed. These imbedded ice pellets are generally not readily detectable by the human eye during pre-takeoff contamination check procedures. Therefore, a visual pre-takeoff contamination check in ice pellet conditions may not be of value and is not required.

B. The research data have also shown that after proper deicing and anti-icing, the accumulation of light ice pellets moderate ice pellets, and ice pellets mixed with other forms of precipitation in Type IV fluid will not prevent the fluid from flowing off the aerodynamic surfaces during takeoff except as noted above. This flow off due to the shearing forces occurs with rotation speeds consistent with Type IV anti-icing fluid recommended applications, and up to the applicable allowance time listed in Table 9 below. These allowance times are from the start of the Type IV anti-icing fluid application. Additionally, if the ice pellet condition stops, and the allowance time has not been exceeded, and the OAT has remained constant or increased from the temperature on which the allowance time was based, the operator is permitted to consider the Type IV anti-icing fluid

48

effective without any further action up to 90 minutes after the start of the application time of the Type IV anti-icing fluid.

Examples:

1) Type IV anti-icing fluid is applied with a start of application time of 10:00, OAT is 0^0C, light ice pellets fall until 10:20 and stop and do not restart. The allowance time stops at 10:50; however, provided that the OAT remains constant or increases and that no precipitation restarts after the allowance time of 10:50 the aircraft may takeoff without any further action up to 11:30.

2) Type IV anti-icing fluid is applied with a start of application time of 10:00, OAT is 0^0C, light ice pellets mixed with freezing drizzle falls until 10:10 and stops and restarts at 10:15 and stops at 10:20. The allowance time stops at 10:25, however provided that the OAT remains constant or increases and that no precipitation restarts after the allowance time of 10:25, the aircraft may takeoff without any further action up to 11:30.

3) On the other hand, if Type IV anti-icing fluid is applied with a start of application time of 10:00, OAT is 0^0C, light ice pellets mixed with freezing drizzle falls until 10:10 and stops and restarts at 10:30 with the allowance time stopping at 10:25 the aircraft **may not takeoff,** no matter how short the time or type of precipitation after 10:25, without being deiced and anti-iced if precipitation is present.

C. Operators with a deicing program approved in accordance with Title 14 of the Code of Federal Regulations (14 CFR) part 121, section 121.629, will be allowed, in the specified ice pellet conditions and corresponding outside air temperatures (OAT) listed in Table-1, up to the specific allowance time listed in Table-1 after the start of the anti-icing fluid application to commence the takeoff with the following restrictions:

1) The aircraft critical surfaces must be free of contaminants before applying Type IV anti-icing fluid. If not, the aircraft must be properly deiced and checked to be free of contaminants before the application of Type IV anti-icing fluid.

2) The allowance time is valid only if the aircraft is anti-iced with undiluted Type IV fluid.

3) Due to the shearing qualities of Type IV fluids with imbedded ice pellets, this allowance is limited to aircraft with a rotation speed of 100 knots or greater or 115 knots as indicated in the Ice Pellet Allowance Table below.

4) If the takeoff is not accomplished within the applicable allowance time in Table-1, the aircraft must be completely deiced, and if precipitation is still present, anti-iced again prior to a subsequent takeoff. If the precipitation stops at or before the time limits of the applicable allowance time in Table-1 and does not restart, the aircraft may takeoff up to 90 minutes after the start of the application of the Type IV anti-icing fluid provided the temperature on which the allowance time was based remains constant or increases.

5) A pre-takeoff contamination check is not required. The allowance time cannot be extended by an internal or external check of the aircraft critical surfaces.

6) If ice pellet precipitation becomes heavier than moderate or if the light ice pellets mixed with other forms of allowable precipitation exceeds the listed intensities or temperature range, the allowance time cannot be used.

7) If the temperature decreases below the temperature on which the allowance time was based,

a). And the new lower temperature has an associated allowance time for the precipitation condition and the present time is within the new allowance time, then that new time must be used as the allowance time limit.

b). And the allowance time has expired (within the 90 minute post anti-icing window if the precipitation has stopped within the allowance time), the aircraft may not takeoff and must be completely deiced and, if applicable, anti-iced before a subsequent takeoff.

TABLE 9. ICE PELLET ALLOWANCE TIMES 2011 - 2012

	OAT -5°C and above	OAT less than -5°C to -10°C	OAT less than -10°C
Light Ice Pellets	50 minutes	30 minutes	30 minutes[1]
Moderate Ice Pellets	25 minutes[2]	10 minutes	10 minutes[1]
Light Ice Pellets Mixed with Light or Moderate Freezing Drizzle	25 minutes	10 minutes	**Caution: No allowance times currently exist**
Light Ice Pellets Mixed with Light Freezing Rain	25 minutes	10 minutes	
Light Ice Pellets Mixed with Light Rain	25 minutes[3]		
Light Ice Pellets Mixed with Moderate Rain	25 minutes[4]		
Light Ice Pellets Mixed with Light Snow	25 minutes	15 minutes	
Light Ice Pellets Mixed with Moderate Snow	10 minutes		

FOOTNOTES

1. No allowance times exist for propylene glycol (PG) fluids when used on aircraft with rotation speeds less than 115 knots. (For these aircraft, if the fluid type is not known, assume zero allowance time).
2. Allowance time is 15 minutes for propylene glycol (PG) fluids, or when the fluid type is unknown.
3. No allowance times exist for this condition for temperatures below 0 °C; consider use of light ice pellets mixed with light freezing rain.
4. No allowance times exist in this condition for temperatures below 0 °C

Operations in Heavy Snow 2011-2012 (No Change from 2010-2011 Guidance)

1. Tactile and Visual Checks of Aircraft. No holdover times (HOT) exist for heavy snow conditions in the current HOT tables. Review of existing data from past testing has indicated takeoffs may be safely conducted with proper tactile and/or visual checks, as appropriate for the aircraft, and a determination that the fluid has not failed. A tactile and/or visual check in heavy snow conditions must be accomplished in a manner that provides an assessment that can be accurately accomplished. It is imperative that the tactile and/or visual check procedures to determine if the anti-icing fluid has failed in heavy snow conditions be at least as comprehensive as the authorized procedures for the operator's pretakeoff contamination check (when HOTs have been exceeded) for those precipitation conditions for which HOTs exist. Anti-icing fluids dissolve the snow and absorb the resulting moisture into the fluid. When the fluid begins to fail it starts to change in appearance (e.g., less glossy and more opaque) and the snow starts to accumulate on and in the fluid. At this stage, the fluid has failed and takeoff is not authorized. If the operator's procedure to accomplish this check is different from the operator's approved pretakeoff contamination check procedures for other precipitation conditions, this check procedure must be verified and approved by the operator's principal operations inspector (POI).

2. Takeoff in Heavy Snow Conditions. Operators with a deicing program approved in accordance with § 121.629, will be allowed to takeoff in heavy snow conditions subject to the following restrictions:

1) The aircraft must be anti-iced with undiluted Type IV fluid.

2) The aircraft critical surfaces must be free of contaminants, or the aircraft be properly deiced before the application of the anti-icing fluid.

3) When appropriate, the operator must accomplish an approved tactile and/or visual check of the aircraft critical surfaces within 5 minutes of takeoff.

4) If this check is accomplished visually from within the aircraft, the view must be such that it is not obscured by de/anti-icing fluid, dirt, or fogging. If the critical surfaces cannot be seen due to snowfall, distance from the viewing position, or inadequate lighting, or for any other reason, the check must be a visual or tactile check conducted from outside the aircraft.

5) If a definitive fluid failure determination cannot be made using the checks prescribed, takeoff is not authorized. The aircraft must be completely deiced, and if precipitation is still present, anti-iced again before a subsequent takeoff.

Note: Current aircraft certification standards only require testing of flight instrument sensing devices and engine anti-icing systems in moderate snow levels. Ground operations in heavy snow conditions may exceed the capabilities or limitations of these system and devices to adequately provide anti-icing.